THE INTERFACE

IEEE ASEE

April 2003 • NUMBER 1

THE JOINT NEWSLETTER OF THE IEEE EDUCATION SOCIETY AND THE ASEE ELECTRICAL AND COMPUTER ENGINEERING DIVISION

http://www.ewh.ieee.org/soc/es/

ENVIRONMENTALLY SMART ENGINEERING EDUCATION: ENGINEERING EDUCATION REFORM:

A Trilogy (Part 1): A Brief on a Paradigm in Progress

Frank G. Splitt
McCormick Faculty Fellow, Northwestern University
McCormick School of Engineering and Applied Science
FNJSMP@aol.com

This article is appearing in the ASEE Journal of Engineering Education. It is being reprinted here in The Interface, *with permission, in order to achieve the widest possible distribution among those interested in engineering education.*

DEDICATION

This publication is dedicated to the memory of the late Arthur J. Schmitt, the inventive industrialist who founded the Amphenol Corporation in 1932 and the philanthropist who founded the Arthur J. Schmitt Foundation in 1941. Concerned that engineers were being too narrowly educated and that industrial leadership was going by default to those with backgrounds in general education, he became the educational innovator who founded the Fournier Institute of Technology in 1943. Mr. Schmitt's quest was for leadership. His aim was to provide effective industrial leadership via electrical engineers skilled not only in their profession, but in business administration and communications as well. His vehicle was education. Mr. Schmitt often paid tribute to America's engineering genius and cited the importance of engineers in America's future. He believed there was no field with richer rewards, none more intriguing, and none more important to the growth and defense of our nation. His mission continues through the work of the Arthur J. Schmitt Foundation.

Arthur J. Schmitt

(Photo courtesy of the Arthur J. Schmitt Foundation)

For more on Arthur J. Schmitt see: Schaefer, Arthur J., Quest for Leadership: The Arthur J. Schmitt Story, Cathedral Publishing, Chicago, IL.

The International Engineering Consortium sponsored the publication of this trilogy as a public service to academia, government and industry. The Consortium is a nonprofit organization dedicated to catalyzing positive change in the information industry and university communities. It provides high-quality education for industry professionals, academics, and students. Among its initiatives are educational conferences, technology exhibitions, on-line educational programs, and the publication of research studies that focus on major issues and emerging technologies. More than 70 leading high-technology universities are currently affiliated with the Consortium. Industry is represented through the involvement of thousands of executives, managers, and professionals. For more information visit www.iec.org .

FOREWORD

In a changing environment and under pressure we do what we can to avoid being left behind or dealt out. We fall back where we can on the status quo to maintain our comfort zones. So it is with our professions and with undergraduate education reform.

THE INTERFACE is published three times each year by The Institute of Electrical and Electronics Engineers, Inc., 445 Hoes Lane, Piscataway, NJ 08855.
The deadlines are August 30 for the November issue, January 31 for the April issue, and May 31 for the August issue.
Editor:
William Sayle
Electrical and Computer Engineering
Georgia Institute of Technology
Atlanta, GA 30332-0250 USA
+1.404.894.4740 (voice)
+1.404.894.3047 (fax)
bill.sayle@ece.gatech.edu

Printed in USA.

April 2003
TABLE OF CONTENTS

Post-Sputnik, more money for research became available to academia than ever before. Universities adapted and evolved into today's research institutions. Faculty success is now judged by production of new knowledge, publication in the "right" journals, and procurement of outside funding. These research-related measures now dominate decisions about hiring, merit, promotion and tenure. Faculty members are subject matter experts as a matter of survival. The supporting infrastructure grew, too, and needs funding as well, so faculty and administrators have become fundraisers and managers. Without the (mostly) federal funds on which they now depend, some academic units could not meet current payrolls.

Many engineering faculty are buying out teaching time, setting their agendas to respond to granting agencies rather than to students and colleagues, and running near burnout. It can be so difficult to give time and energy to undergraduate curriculum development that too often faculty fall back on familiar material and ways of teaching. Declining enrollments are evidence that this is no longer working well. Student interest in engineering as a career is not being engaged as it once was.

Substantial mismatch exists between the interests and concerns of the MTV generation and those of faculty striving for success on the measures the university rewards. The current undergraduate student body differs in important ways from those of the past. Students have a sense of entitlement to a good grade despite a mediocre performance. They like to manipulate software, but are much less interested in learning the underlying principles. They use their hand-held calculators efficiently, but rarely get the physical picture well enough to recognize errors in the results - even when they grind out nonsense. The instructor is viewed skeptically for suggesting regrouping the symbols in an equation to look for simplifications in the calculation, or even just using approximations like canceling pi squared over 10. The art of the back-of-the-envelope calculation is virtually lost. It is a different world, and the system needs fixing at a time when the nation needs new engineering talent.

There has been progress in both curriculum content and pedagogy in a number of individual engineering programs, and there is evidence from the NSF Engineering Coalitions of increased student retention, faculty rejuvenation and some institutional sharing of successful new approaches. Many engineering programs are still providing undergraduates with Sputnik-era kinds of instruction, however. Too often we employ the teaching styles to which we ourselves once responded. Some of today's dedicated, but overburdened, faculty members invest considerable time and energy in undergraduate program reform as a labor of love and without much expectation of reward. They are virtually powerless to change the priorities and demands of their institutions, and they are only human.

Old ways do not prepare undergraduates well for the 21st Century marketplace, either. Strong messages from the employers of our undergraduates have been heard for some time. ABET responded to industry's warnings with its outcomes-based ABET EC 2000. No longer need a program count beans that fit outdated curricula. Rather, new criteria ask for evidence that the program meets the goals of its own curriculum design. This is an important step forward for undergraduate engineering education. NAE has responded with the prestigious new Gordon Prize for innovation in engineering education and, most recently, with the formation of a Center for the Advancement of Scholarship in Engineering Education that will seek to motivate continuous improvement in engineering education.

The author of these three papers, the trilogy, offers specific suggestions. In a true missionary spirit, he draws on extensive industrial experience, his participation in the early development of ABET EC 2000, and a substantial immersion in academe to provide his own noteworthy insights and a number of provocative ideas. Whether or not you agree with them, this interesting set of papers should be viewed as a valuable contribution to the literature on engineering education reform. It is worthy of serious attention and discussion by all stakeholders in engineering education.

Irene Peden
Professor Emerita, University of Washington

PREFACE

These papers had their genesis at the International Engineering Consortium (IEC) Executive ComForum 2000 where fellow IEC Director **Chris Earnshaw** asked me to supply him with several "white papers." These early 1990s papers supported the IEC's effort to catalyze transformational change in the areas of communications infrastructure, education, and the environment. The letter covering the transmission of the papers became the basis for a paper entitled *Educational and Environmental Initiatives: Some Recollections, Observations, and Recommendations* that was first published by the IEC for distribution at the Spring 2001 *National Electrical Engineering Department Heads Association Meeting*. The paper received widespread distribution, generated useful feedback, and, via the NSF's **Janet Rutledge**, led to an invitation to deliver a keynote address at the 2001 Virginia Tech and EPA sponsored *Green Engineering Conference*. Following the conference, work began on a proposal to close the environmental literacy gap that exists in most of our nation's engineering programs. This proposal effort provided valuable insights and eventually led to a renewed campaign for engineering education reform and an attempt to answer three questions that seem critical for understanding why engineering education reform is needed and needed now.

1. Why is the large change such as that implied by "engineering education reform" needed?
2. Why cannot incremental change make the changes needed on an appropriate time scale?
3. Why do we need to recognize leadership and systemic change in engineering education now?

The answers to these questions can be found in these papers, but perhaps without the focus needed to help those not already committed to understand the urgency and move toward commitment. So, let me offer a few summary answers to these questions as a preface to the papers.

First, engineering graduates need to be significantly better prepared for the 21st-century engineering workplace. Although the (now) traditional engineering education offered at most of our engineering schools provides a good education about the technical aspects of engineering, other areas such as communication competence, ethics and professionalism, sustainable development and the environment, working in teams, the current approach to quality, focus on customer needs, "business" practices, and other non-technical areas seem to receive little or no attention in many engineering curricula. Therefore, many engineering graduates do not have the breadth of jobs available to them they could have. Qualified engineering students at the freshman and sophomore level fail to see engineering as a profession that helps people - one that focuses on meeting people's needs; and/or they find the learning environment unsatisfactory. They then transfer to another field of study.

Second, the changes needed are broad in scope - beyond just changing a few courses. Many of these changes must be made at the same time. Engineering programs need to attract and retain more of the "best and brightest" students on the campus. To make these changes, faculty need to change their view of what the curriculum should be like.

Third, those taking leadership roles in engineering education reform will need to devote a significant portion of their time for an extended period of time to implement the engineering education reforms needed. We also need to involve some of the best minds among our faculties. Without recognition and reward for their efforts, these individuals likely will choose other places to put their efforts.

These views and those expressed in all of the papers reflect an industry perspective. They are based on my fifty years of experience as an engineer - including forty years of workforce experience in the telecommunications industry spanning product design, R&D, and management. Industrial experience as an engineer-practitioner was complemented with service on several industry advisory boards - ranging from service at a community college and two research universities, to service on the ABET Industry Advisory Council and the Educational Activities Board of the Institute of Electrical and Electronic Engineers (IEEE). Close interaction with deans and faculty, on-campus and at several University-Industry Colloquia and other events, sponsored by the International Engineering Consortium, provided valuable insights and feedback as well. Dialogues with students during the course of campus visits and invited lectures influenced my perspectives.

Arthur J. Schmitt had a profound overall influence on my thinking, career, and direction in life via the educational experience he provided at *the Fournier Institute of Technology.* With reference to these papers, perhaps the strongest influence came from the research and commentaries surrounding a number of addresses - related to the future and to the changing needs of industry - given to engineering-school students, parents, faculty and administrators during the period, 1986-1993. The numerous papers and reports on engineering education referenced herein, also contributed to the shaping of my views, particularly those of **Edward W. Ernst**, Distinguished Professor Emeritus, University of South Carolina, and the late **Ernest L. Boyer**, Past President of the Carnegie Foundation for the Advancement of Teaching. However, in the end, the following opinions and views are entirely my own; and, as such, they do not carry or imply formal endorsement by any of my past or present institutional affiliations.

PART I: ENVIRONMENTALLY SMART ENGINEERING EDUCATION:

A Brief on a Paradigm in Progress

Frank G. Splitt

ABSTRACT

Sustainable development has become the dominant economic, environmental, and social issue of the 21st century, yet its broad infusion within engineering education programs remains a challenge. This paper discusses the importance of environment and sustainable development considerations, the need for their widespread inclusion in engineering education, and the impediments to change. The roles of ABET and others in the evolution of these considerations in engineering education are presented; however, it is through the ABET engineering criteria that broad adoption of environment related considerations in engineering education will most likely occur. An effort to achieve this aim is described.

I. INTRODUCTION

Engineering education has undergone significant reform since the mid-1980s, with the environment and sustainable development emerging in the late 1980s as major issues not yet reflected in this reform. Speth and Smart said it well in 1990 [19], *"In survey after survey, people call for a better environment and improved economic conditions. These are not mutually exclusive goals. Rather, they are necessary and mutually supporting conditions... businessmen, environmentalists, and politicians must forego finger-pointing and join together and create a global program for sustainable development."* It was obvious then, that this issue was going to have a significant impact on industry and engineering education in the future.

At about the same time, during his term as the president of the Accreditation Board for Engineering and Technology (ABET), **Ed Ernst** initiated the formation process for an ABET Industry Advisory Council (IAC). It was his view that ABET was in need of more proactive involvement of industry leaders. He also saw ABET in a high-leverage position to affect change in engineering education since a major restructuring of the accreditation criteria and process would have significant long-term effects. The ABET IAC had its first meeting in May 1991, a time when President **James Duderstadt** of the *University of Michigan*, President **Charles Vest** of the *Massachusetts Institute of Technology*, and others, were calling for a fundamental change in the post-World War II model for engineering education. This was also the time when the *National Science Foundation* (NSF) was demonstrating increased interest in curricular innovation [18]. However, it was really the ABET efforts that provided a platform to implement major changes in engineering education as well as a venue for the broad introduction of environmental protection and sustainable development imperatives into engineering programs.

It was evident to the ABET IAC that sustainable development was becoming a dominant economic, environmental, and social issue of the 21st century [3][13], and that a fundamental change in engineering education was required to help the next generation of engineers learn to design for sustainable development and long-range competitiveness. This view was reflected in a letter sent to the ABET president, **Al Kersich**, by ABET IAC chairman, **Mike Emery**, that called upon ABET to bring about a major paradigm shift in engineering education [7]. Among other things, the ABET IAC asked that emphasis be placed on teamwork and an interdisciplinary understanding of the societal, ecological, financial, national, and global impacts of engineering. It also recommended a set of *Accreditation Process Principles and Concepts & Supporting Strategies* that later helped form the basis for ABET Engineering Criteria 2000 (ABET EC 2000): Criterion 3 Programs Outcomes and Assessment [8][24].

The *Accreditation Process Principles* called for the "*understanding of and work toward sustainable development,... safety and environmental impact.*" In the process of balancing specific guidance against flexibility of choice by engineering programs, the wording of the Accreditation Process Principles relative to environmental considerations was subsequently generalized. Thus, Criterion 3 presently does not reflect the emphasis that the ABET IAC *Accreditation Process Principles* placed on these considerations. The ABET IAC also asked that engineering programs seek to provide their graduates with a combination of skills, attributes, and characteristics among which were: *"A holistic approach to achieve solutions to engineering challenges by integrating the elements of general education including human needs, culture, history and tradition, sociology, politics and government, economics and the environment.*" Emphasis on the environment and sustainable development was considered one of the ABET IAC's more important recommendations and was promulgated as such at ABET and American Society for Engineering Education (ASEE) conferences [21].

Looking back, it can be understood why Criterion 3 was generalized to the extent that it was. The burden of developing case studies and other mechanisms that enable student learning in the areas listed is exactly where it should be - on the engineering programs. Unfortunately, a significant opportunity for an appropriate level of guidance may have been lost in the process of getting to this end objective.

II. AN ENVIRONMENTAL LITERACY GAP

Much of environmental engineering education, meaning environmental topics and considerations, are to be found mostly in civil, environmental, and/or chemical engineering programs. This creates a two-part problem in engineering education. First, environmental design constraints and opportunities should permeate all engineering disciplines, as environmental factors need to be considered at the beginning of every engineering problem; and second, as good as ABET EC 2000 is, its criteria are open to an interpretation that can permit an environmental literacy gap to exist in our engineering programs and disciplines.

The beauty of the ABET engineering criteria structure is that the environmental literacy gap can be closed by adding the word "environmental" to Criterion 3(f), rewording Criterion 3(h), or by requiring, in Criterion 4, that environmental impact is considered in the student's capstone project. Since ABET engineering criteria are focused on student outcomes, new courses would not be mandated. The programs would be free to develop their own innovative ways to guide all engineering students to an understanding environmental factors are an element of "best engineering practice;" and, that this understanding will be an important outcome of their engineering education. However important, the infusion of environment into the ABET engineering criteria will not be easy.

An effort to close the environmental-literacy gap was initiated early this year. The National Council for Science and the Environment (NCSE), Northwestern University, and Virginia Tech endorsed a related proposal while personal endorsements and commentaries came from academe and industry, see the Appendix and Reference [25]. The proposal is in the process of ABET review, endorsed in principle, by the Accreditation Policy Council of the IEEE Educational Activities Board.

A. The Importance of Sustainable Development

Numerous organizations and efforts have cited the importance of sustainable development. For example, the National Science Board (NSB) began its report, *Environmental Science and Engineering for the 21st Century* [14], with the statement, "*Within the broad portfolio of science and engineering for the new century, the environment is emerging as a vigorous, essential, and central focus... The environment is no longer simply a background against which research is conducted, but rather the prime target* *for increased understanding."* The NSB recommended that *"Environmental research, education, and scientific assessment should be one of NSF's highest priorities;"* and called on the NSF to *"encourage proposals that capitalize on student interest in environmental areas while supporting significantly more environmental education efforts through informal vehicles."* Over the past twelve years, the *National Academy of Engineering* (NAE), through its program on *Technology and Sustainable Development*, has conducted a series of industrial ecology workshops and related studies with numerous publications - all with the aim of illuminating the relationship between technology, economic growth, and the environment [10] [11][26]. Further, during a May 2000, Executive Summit at the World Telecommunications Congress (WTC) organized by International Engineering Consortium (IEC)-Director **Chris Earnshaw**, thirteen of the world's leading telecommunications companies pledged to work together to promote a range of measures designed to realize the positive impact of the communications industry on the global environment and on sustainable development. Earnshaw and BT see "a virtuous circle between the success of our business and sustainable business practice..." [5].

Finally, the 2001 *BusinessWeek* 50 (BW-50) contained an interview with a BW-50 *Master of Innovation* in energy efficiency [2], **Amory B. Lovins**, CEO (Research) at the R*ocky Mountain Institute*. Lovins and his co-authors expand on the subject in *Natural Capitalism* [12][27]. In their book, they claim that most businesses still operate according to a worldview that has not changed since the start of the Industrial Revolution when natural resources were abundant and labor was the limiting factor of production. The authors go on to provide a number of case studies and explain how the world is on the verge of a new industrial revolution wherein business and environmental interests will increasingly overlap, and in which companies can improve their bottom lines while helping to solve environmental problems and foster the innovation that drives future improvement. These, and other efforts, provide a wake-up call for our engineering programs to guide students to a basic understanding of environmental impact on design.

B. The Impediments to Change

The examples mentioned above present many openings for dialogue and debate on both the extent and the manner in which the concepts of sustainable development and sustainable business practice can be integrated into the curriculum of our engineering programs. Such integration can best be described as disruptive educational "product" innovation. Engineering education innovators are thus faced with the innovator's dilemma - aptly described by Clayton Christensen [4]. The dilemma is that educational products in this vital area do not represent the coin of today's academic realm - simply put, they do not fit the present-day rewards and recognition systems operative at most of our engineering programs [20][25]; further, there is strong resistance to embedding additional requirements in the ABET criteria.

Views similar to the above have been expressed by **Suren Erkman** [9] and **John Ehrenfeld** [6]. In a historical view of industrial ecology [9], Erkman states: *"there is a need for integrating industrial ecology into new management practices. Education of engineers, economists, managers and natural scientists becomes crucial, in order to deal with a serious cultural problem: ecologists usually don't know about the industrial system. On the other hand, engineers, and people from industry in general, have a very naïve view of nature and are very defiant against ecologists and ignorant about scientific ecology."* MIT's Ehrenfeld discusses the role of universities in industrial ecology [6] and states: *"the university can and must play a central role in developing the concept of industrial ecology and institutionalizing its practice."* According to Ehrenfeld, to do this, the universities must overcome strong disciplinary barriers, jealousies, and their own political dynamics, as well as enter into a broad discourse among all the players. He also sees the need to reconstruct the disciplines in a way that mimics the seamless web of the very world we are attempting to understand.

These views may appear to be a bit harsh, but they are not all that new. In a 1938 lecture, given to the College of Engineering at the University of Wisconsin [15], **Aldo Leopold**, a foremost conservationist and environmental scholar, pointed out the adverse ecological consequences of civil engineering. Of particular interest are his comments: *"Every professional man must, within limits, execute the jobs people are willing to pay for. But every profession in the long run writes its own ticket. It does so through the emergence of leaders who can afford to be skeptical out loud and in public - professors, for example. What I here decry is not so much the prevalence of public error in the use of engineering tools as the scarcity of engineering criticism of such misuse. Perhaps that criticism exists in camera, but it does not reach the interested layman."* Leopold felt that an understanding of ecology *"is by no means co-extensive with 'education'; in fact, much higher education seems deliberately to avoid ecological concepts* [16]."

III. OUTLOOK FOR THE FUTURE

Experience teaches that change must sometimes come from outside. For example, **Karl Martersteck**, a former vice president at AT&T Bell Laboratories and former president and CEO of ArrayComm, pointed out that [17][25]: "environmental concerns are not likely to find a place in most engineering curricula without a forcing function such as the ABET criteria." At the 1998 Engineering Foundation Conference (EFC'98) - *Realizing the New Paradigm for Engineering* - ABET EC 2000 was looked to as a mechanism that could be used to drive as well as enable change [1][22].

It is expected that commonplace practice of sustainable development and business practice will evolve over time, either by choice or by catastrophe. The key to evolution by choice is expected to be the growing awareness by the financial and investment communities of the intrinsic value of ecoefficiency - maximum long-term economic gain and minimum overall environmental impact - as defined by the *World Business Council on Sustainable Development* [23][28] - and "blueprinted" in *Natural Capitalism [12]*. Businesses will then exert an ever-increasing demand for engineering graduates conversant with environmental issues and economics, and, most importantly, engineers skilled in systems thinking and in related ecoefficient design and manufacturing practices. In turn, this change will give birth to a new paradigm in engineering education - environmentally-smart, life-cycle design for competitive advantage.

Green Engineering Programs are a good beginning - so too, are Engineering Forums such as the AAES/ASEE *Engineers Forum for Sustainable Development* and the *Institution of Electrical Engineers*

(IEE) Professional Network on Engineering for a Sustainable Future. Noteworthy, is the work of the NCSE to bring about the full implementation of the recommendations set forth in the NSF's report on its future role in environmental science and engineering [14]. Encouraging, as well, is the work done by the Technical Activities Committees of the various Engineering Societies, the Association of Environmental Engineering and Science Professors (AEESP) and the American Academy of Environmental Engineers (AAEE). All of these have the opportunity and the wherewithal to develop traction to help propel the engineering community along the arduous path to commonplace industrial and academic practice of sustainable and environmentally conscious engineering.

IV. CONCLUSION

As we continue to move into the 21st century, helping academia understand the escalating changes in industry, and the relationship of the changes to the concepts of sustainable development and sustainable business practice, will present a major challenge. Significant advances in industry's supporting technologies and services, together with their business and environmental implications make academia's learning needs substantial. ABET, acting in its consultative capacity, can play a vital role in this area. Nevertheless, what appears to be common sense has yet to become common practice. Not until we see most of our engineering programs placing a high value on these concepts, as evidenced by incorporation in the program's mainstream value network, will we know that we have progressed beyond the early adopter phase of concept diffusion. We will then witness most of our engineering programs operating to bring balanced perspectives to engineering via the ecoefficiency paradigm - environmentally smart, life-cycle design for competitive advantage. Today, it remains a paradigm in progress.

ACKNOWLEDGMENTS

Over the years, many organizations and people contributed to the work described in this paper at different times and in a variety of ways. Ultimately, people, and not organizations, really helped to make things happen. My appreciation and thanks go to Bob Barnett, Wayne Bennett, Ted Bickart, Michael Bunch, John Birge, Dave Blockstein, Joe Bordogna, Steve Carr, Dick Carsello, Jerry Cohen, Elizabeth Coles, Mike Emery, Chris Earnshaw, John Ehrenfeld, Ed Ernst, Sam Florman, Bob Frosch, Jim Gibbons, Jack Gibbons, Mike Gorman, Mike Gregg, Abe Haddad, Martin Hellman, Hazel Henderson, Kristin Hill, Bob Janowiak, Ken Laker, Amory Lovins, Karl Martersteck, Jim McKelvey, Curt Meine, Art Moeller, John Pappas, Jim Plummer, Jim Poirot, John Prados, Manijeh Razeghi, Mike Sanio, Bill Schowalter, Tim Trick, Jim Vaughan, Julia Weertman, and Jim Wolter.

REFERENCES

1. Agogino, Alice M., Edited Transcripts of the Workshop Presentations, Proceedings of the 1998 Engineering Foundation Conference, New York, NY, June 3-6, 1998.
2. *Amory Lovins*, BusinessWeek 50, Masters of Innovation Section, Spring 2001.
3. Brewer, Garry D., *Business and the Environment: A Time for Creative and Constructive Coexistence*, The Twenty-fifth Annual William K. McInally Memorial Lecture, School of Business Administration, The University of Michigan, March 31, 1992.
4. Christensen, Clayton M., *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*, Harvard Business School Press, Boston, MA, 1997.
5. Earnshaw, Chris, *Digital Futures Report*, Digital Futures Conference, London, March 1, 2001.
6. Ehrenfeld, John R., *Industrial Ecology and Design for the Environment: The Role of Universities*, The Greening of Industrial Ecosystems, pp 228-240, National Academy Press, Washington, D.C., 1994.
7. Emery, Michael B., (*On Accreditation Process Principles and Concepts & Supporting Strategies*), Letter Correspondence to Albert T. Kersich, ABET President, Sept. 29, 1993.
8. Engineering Accreditation Commission, *Criteria for Accrediting Engineering Programs* (Effective for Evaluations During the 2001-2002 Accreditation Cycle), ABET, Baltimore, MD, Dec. 26, 2000.
9. Erkman, Suren, I*ndustrial Ecology: A Historical View, Journal of Cleaner Production*, January 1997.
10. Frosch, Robert A., et al, The Bridge, National Academy of Engineering, Vol. 23, No.2, Summer 1993.
11. Frosch, Robert A., et al, The Bridge, National Academy of Engineering, Vol. 29, No.1, Spring 1999.
12. Hawken, Paul, Lovins, Amory, and Lovins, L. Hunter, *Natural Capitalism: Creating the Next Industrial Revolution*, Rocky Mountain Institute, 1999.
13. Hatch, Henry J., *Accepting the Challenge of Sustainable Development*, The Bridge, National Academy of Engineering, Washington, DC, Spring 1992.
14. Kelly, Eamon M., et al, *Environmental Science and Engineering for the 21st Century: The Role of the National Science Foundation,* National Science Board and National Science Foundation, NSB 00-22, Arlington, VA, February 2000.
15. Leopold, Aldo, *Engineering and Conservation*, The River of God and Other Essays, pp 249-254, The University of Wisconsin Press, Madison, WI, 1991.
16. Leopold, Aldo, *The Land Ethic*, A Sand County Almanac With Essays on Conservation From Round River, Ballantine Books Edition, September 1970., pp 237-264.
17. Martersteck, Karl, *Personal Endorsement of a Change to ABET Criteria EC 2000*, Personal Communication, January 31, 2002. See also [25].
18. Meyers, Carolyn and Ernst, Edward W., *Restructuring Engineering Education: A Focus on Change, Division of Undergraduate Education*, Directorate for Education and Human Resources, National Science Foundation, Arlington, VA, April 1995.
19. Speth, James G. and Smart, S. Bruce, *The New Renaissance*, Business Week, June 18, 1990.
20. Splitt, Frank G., *The Challenge to Change: On Realizing the New Paradigm for Engineering Education, Submitted to the Journal of Engineering Education*, May 2002. See also [25].
21. Splitt, Frank G., *The Industrial Needs of the Engineer in the 21st Century: An Update*, ABET Annual Meeting, San Antonio, TX, Oct. 29, 1992; ASEE, New England Section, 71st Annual Fall Conference, Northeastern University, Boston, MA, Oct. 22, 1993.

22. Parrish, Edward A., EC 2000: *A Driver for Change*, Proceedings of the 1998 Engineering Foundation Conference, New York, NY, June 3-6, 1998.
23. World Business Council for Sustainable Development (WBCSD), *Eco-efficient Leadership for Improved Economic and Environmental Performance*, WBCSD, Conches-Geneva, Switzerland, 1996.
24. www.abet.org (ABET re: *Engineering Criteria 2000: Criterion 3 Programs Outcomes Assessment*)
25. www.ece.northwestern.edu/EXTERNAL/Splitt/ (Additional information re: [17] [20])
26. www.nap.edu (National Academy Press)
27. www.natcap.org (Natural Capitalism)
28. www.wbcsd.org (World Business Council on Sustainable Development)

This article is appearing in the ASEE Journal of Engineering Education. It is being reprinted here in The Interface, with permission, in order to achieve the widest possible distribution among those interested in engineering education.

Space limitations did not allow the inclusion of the Appendix, however, it can be viewed at http://www.ece.northwestern.edu/EXTERNAL/Splitt/SplittWebEngrEdu ReformTrilogy.doc.

Note that the Appendix to Part I contained selected commentaries such as the following from **Dr. John H. Gibbons**, (former) Assistant to the President for Science and Technology and Director of the White House Office of Science and Technology.

"I have become acquainted with efforts to propose a seemingly minor but important and timely change to "ABET Engineering Criteria 2000" that would upgrade knowledge of environmental implications of engineering designs. I believe that such a move to foster and integrate environmental considerations BROADLY across engineering education is sorely needed. Essentially all engineering disciplines now play a role in the move toward "dematerialization" of net resource flows (lifecycle design) in providing goods and services."

Coming Up...

Next issue (August 2003) —PART II

THE CHALLENGE TO CHANGE: On Realizing the New Paradigm for Engineering Education

And, in November 2003—PART III **ENGINEERING EDUCATION REFORM: A Path Forward**

Or, if you cannot wait until August, you can view the entire article (all three parts) at http://www.ece.northwestern.edu/EXTERNAL/Splitt/ SplittWebEngrEduReformTrilogy.doc

From the Vice-President for IEEE Education Activities

IMPACTING THE PUBLIC

James M. Tien
IEEE Vice-President EAB

Aside from Dilbert in the comics and the villain in the movie Jurassic Park, engineers are virtually invisible to the general public in the United States, the United Kingdom and a number of other countries. On the other hand, in certain parts of the world (e.g., Germany, France, and China), it is common for an engineering degree to confer status and position. It is time for all engineers to be recognized and respected as professionals; we are vital to every country's economy.

Aside from ego, why is this important? Invisibility is not without consequences. Fewer students studying engineering means less technological innovation and invention in the 21st Century. And who will replace the engineers that will retire in the next ten years? Further, a population that does not value engineering won't study science, technology, engineering and mathematics (STEM). They will not be able to understand technology. They are doomed to make uninformed decisions on far ranging items from genetically modified foods to alternate energies to space travel.

In Article I, Section 2, the IEEE Constitution states [IEEE] "... shall endeavor to promote understanding of the influence of ... technology on the public welfare." Raising the level of technological literacy and redeeming the title of engineer is an educational issue; it is appropriate that the IEEE Educational Activities Board (EAB) take the lead in this endeavor. Recognizing that thus far EAB has not focused on this issue, the new IEEE EAB Public Awareness Committee was formed. It is tasked with addressing this continuing problem, in partnership with our sister societies in the engineering profession.

NAE Survey

In April 2001, IEEE with most of the other professional engineering organizations and industry took part in a National Academy of Engineering (NAE) survey. We detailed our pre-college and general public outreach activities designed to raise the technological literacy of the general public. In 2002 their report "Raising Public Awareness of Engineering" was released (http://www.nap.edu/books/0309086248/html/).

The Survey shows that in the last 20 years, despite good works and intentions of IEEE and other engineering associations to raise the level of awareness of engineering contributions to the public good, surveys show that the percentage of people who can describe what an engineer does stubbornly remains at about 30% of respondents. When asked to name those inventions or technologies that have changed the 20th Century, respondents named items such as transportation, communications, and medical technologies. However, only that same 30% associated engineers and engineering with these items.

This percentage is exactly where it was 20 years ago. At best, the initiatives have stopped a deeper decline in respect for engineering. At worst, they have had no impact whatsoever. This disconnect between public perception and actuality is a long term, persistent, and, to the engineering community, almost unfathomable fact.

A compendium of ad hoc initiatives to improve pre-college education and increase the enthusiasm students have in STEM has been initiated by every professional engineering association. And yet, the single most reliable predictor of a student choosing the engineering major in college remains that of having a role model, usually a parent, who is an engineer. That shows that engineers can be effective role models, but keeps the profession on a feudal footing.

After analyzing the survey, the NAE proposed that the goal of improving public awareness of engineering should be to achieve "more technical literacy among decision makers, more technical literacy in the general public; and more and better prepared students in engineering." They went on to recognize, "There are two equally important methods to achieve the goal: In the short term, focus on public relations/public affairs. In the long term, focus on education." By short-term they mean immediate implementation once a strategy is decided upon. By long-term they mean that implementation will take years to do and even more years to ascertain effectiveness.

IEEE

The work done by EAB on the long-term education goal has already begun. The Deans Summits I and II conferences have brought together university deans of engineering and deans of education to address how to realign curricula to improve the preparation of new pre-college teachers so that they will have the proper background for focusing on engineering accomplishments. For current teachers, The Teacher In-Service Project for Sections provides projects and instruction to current teachers, so that they can immediately implement what they learn in the classroom. At an individual level, the EAB website has a compendium of information to assist the engineer in directly helping teachers in the classroom.

Work on the short-term goal of promoting general understanding of engineering and addressing the lack of public awareness will be the foremost focus of The IEEE EAB Public Awareness Committee.

The IEEE constitution clearly authorizes "collaboration with public bodies and with other societies for the benefit of the engineering professions as a whole" (Article 1, Section 2). The Committee has been tasked with identifying possible coalition partners; identifying a consistent message and how it should be conveyed; and finding ways to track outcomes.

The Committee plans to build a coalition with representatives of other engineering organizations to address the public relations problem and find solutions that can be implemented in the broadest possible way. **Constantine Anagnostopoulos**, cna@kodak.com, chairs the Committee.

Conclusion

Based on the NAE survey we can see that our ad hoc methods are not enough to get the job done. We cannot do it alone. Coordination, a consistent message throughout the engineering community, and finding, evaluating, and duplicating those programs that have been proven to be effective is a big goal. One thing engineers do not lack for is stamina, tenacity and the ability to be creative. These three qualities will be needed to do this job.

NAE recognizes the need for collaboration and recommends convening two conferences, one for the long-term educational goals; the second for the short term public relations goals.

The IEEE EAB is ready to take the lead in representing IEEE by serving on whatever blue ribbon commissions, working groups, and symposia the NAE may establish. However, we are not waiting to be led. We are renewed in our efforts to solve this problem.

James Tien
j.tien@ieee.org

From the IEEE Committee on Engineering Accreditation Activities

Review of 2002 Accreditation Results

Ken Cooper, Chair, IEEE CEAA
Westinghouse Savannah River Company
k.cooper@ieee.org

As you all are aware, the CEAA reviews all of the visit reports for the programs for which IEEE is responsible. Our purpose in reviewing these reports is to determine the necessary support for program evaluators that we need to provide in order to achieve our primary objective of high quality consistent program evaluations. This support is provided through mentoring, advising and training.

As a program evaluator, when you agree to a visit assignment you receive e-mail from CEAA thanking you for accepting the assignment and identifying the CEAA members who will review your report. It is very important that you submit a copy of your report to the CEAA members identified. We had some difficulty this past year getting all of the visit reports so we could perform our reviews. I encourage you to please submit your reports to the people identified.

The CEAA members identified in the e-mail you receive also represent a resource to assist you with your visit. Please do not hesitate to contact the CEAA members identified if you have any questions.

The e-mail also contains guidance for your review, which is based on issues identified from the review of previous years reports, feedback from the formal training sessions, guidance from the IEEE EAC members and specific feedback from program evaluators.

The review of the 2002 visit reports indicated that programs are still having problems with the engineering criteria. In particular, issues with satisfying criterion 2, program objectives, and criterion 3, outcomes, still exist.

The big issue with criterion 2 seems to be a well-documented, detailed process identifying responsibilities, the timing of actions, and how decisions will be implemented. In addition to documentation of the process, documentation of applying the process has been found to be lacking. A significant number of this years' reports contained statements indicating that the feedback loop was not closed and responsibilities had not been identified.

The issues with criterion 3 are a clear indication of where the required outcomes are addressed and how they are evaluated. Many programs provide a mapping of the outcomes to the courses. However, many programs identify outcomes different from (a) - (k) defined in the criteria and don't provide a linking document. The other issue is with assessment methods and a definition of success for the outcome. Many of the assessment methods are very subjective and make it difficult for the program evaluator to judge. In many cases, a clear definition of the process and responsibilities would make evaluation of this criterion much easier.

The new issue that surfaced this year was satisfying the major design experience requirement. There were many findings that the requirements were not satisfied. I am not sure if there is so much concentration on criteria 2 and 3 that the other criteria are not getting the attention or what. It is something that program evaluators should be aware of and the programs preparing for a visit in the near future should make note of.

Well, I hope this benefits both program evaluators and programs up for accreditation. On the program evaluator side, please help the CEAA meet its objectives by submitting your reports, and any other information which was key to your decisions, promptly.

Thanks,

Ken Cooper
k.cooper@ieee.org

From ECEDHA

David L. Soldan, President
Steve Goodnick, Vice-President
Ken Jenkins, , Secretary - Treasurer
Electrical and Computer Engineering Department Heads Association (ECEDHA)

Nanotechnology Education

In my last column I (David Soldan) talked about the fact that ECEDHA was expanding the services offered to members. An example of that is the two day workshop on NanoEngineering Education presented on January 27th and 28th, 2003, in Santa Clara, CA.

This workshop was presented by ECEDHA and the International Engineering Consortium (IEC), in partnership with and supported by the National Science Foundation. The two-day workshop was held in connection with the IEC DesignCon 2003 Conference. The workshop was organized by **James Aylor**, Chair of the Electrical and Computer Engineering Department at the University of Virginia, and past president of ECEDHA, **Stephen Goodnick**, Chair of the Electrical Engineering Department at Arizona State University, and current vice-president of ECEDHA, **Kenneth Jenkins**, Head of Electrical Engineering at Pennsylvania State University, and current secretary/treasurer of ECEDHA, and **Barry Sullivan**, from the International Engineering Consortium, which supports ECEDHA.

The following summary of the workshop was written by Steve Goodnick and Ken Jenkins.

Introduction

The purpose of this workshop was to begin to create an agenda for the education of the engineering faculty and students with interest in the area of nanoscience and engineering. Over 50 Electrical and Computer Engineering department heads or their representatives attended the workshop, with the purpose of addressing the impact in graduate and undergraduate programs due to the rapidly emerging technologies associated in this field. This first day was dedicated to providing a framework for addressing issues in nanotechnology through a series of invited tutorials by international experts in various areas of nanotechnology, from both industry and academia. The program began with James Murday, Executive Secretary of the National Nanotechnology Initiative (NNI) who spoke on this national initiative. He was followed by Sandwip Tiwari of Cornell, Director of the NSF National Nanofabrication Users Network, who spoke about challenges to nanoengineering education as well as some current highlights in nanotechnology today. Closing the morning session, Phil Kuekes, member of the Technical Staff of Hewlett Packard Research Laboratories, Palo Alto, spoke on issues related to fault-tolerant architectures and their implementation in novel molecular organic memories and logic reported by HP. Over lunch, Sandeep Malhotra, Vice President of Ardesta, provided a venture capitalists view of nanotechnology. Monday afternoon led off with James Bain, from Carnegie Mellon University who discussed the every shrinking world of non-volatile memory and its relation to emerging nanotechnologies. George Bourianoff from Intel gave the industry perspective on the end of the roadmap in terms of semiconductor scaling, and nanotechnological alternatives that may emerge in the next decade. Finally, Stephen Fonash from Penn State University discussed a variety of different issues in nanotechnology with a focus on emerging sensor technologies. Dinner featured a keynote speech from Jim Plummer, Dean of Engineering at Stanford University, who gave an overview of challenges to universities regarding nanotechnology including the role of biological sciences and Bioengineering as a new discipline. All the talks were very well received by the attendees.

The second day of the workshop was solely an Academic Workshop for ECEDHA members and representatives. After introductory remarks by Vasundra Varadan and Kishan Baheti from NSF, the workshop broke into working groups headed by group leaders tasked to address the issues and solutions regarding nanotechnology in ECE education. These issues included Undergraduate Education (headed by Douglas Tougaw, Valparaiso University), Graduate Education (by Robert Trew, North Carolina State University), Continuing Education, (by Bob Janowiak, IEC, Interdisciplinary Programs (by April Brown, Duke University), and Faculty Development (by Lex Akers, University of Missouri). Each of the groups met separately and prepared an analysis of each of these issues for presentation to the whole workshop. A summary of their findings were as follows:

The Undergraduate Experience

The introduction of nanotechnology to undergraduate students is presently being implemented by way of two distinct approaches. The first is an early introduction to general non-technology concepts through freshman "discovery" seminars. Typical concepts introduced in these seminars involve organic optical elements, carbon nanotubes, nanowires, nanothermal effects, and nanomagnetics. Freshman seminar courses are generally presented in "show and tell" style designed to interest students in pursing further studies in the subject subsequent years. A second level of introduction of students to nanotechnology occurs in senior capstone design courses. By this time the students have developed enough technical background and analytical skills to engage in the design, fabrication, and testing of elementary nano-scale devices and circuits. Successful studies at this level require nanoscale CAD support and access to fabrication and testing facilities. Nanoeducation requires systemic change, and the necessary programmatic changes must carried out in the context of the local goals and culture of the university. Nanoeducation opens many doors to great opportunities for interdisciplinary team work.

The NSF-sponsored National Nanotechnology Users Network currently involves a small group of universities who provide Research Experience for Undergraduates (REU) through summer visitation programs and internships. These opportunities are helpful to institutions that do not have their own nanotechnology facilities, although they require students to spend periods of time away from their home institutions to work with trained technical personnel. Enough flexibility must be provided within the curriculum to allow students to take advantage of these REU opportunities without disrupting normal progress toward their degrees.

The Graduate Experience

The workshop invoked considerable debate about whether nanotechnology is really a new discipline, or whether it is a natural result of progress in microelectronics. On several occasions the notion that existing educational programs, and particularly graduate programs, in microelectronics can be "morphed" into viable nanotechnology graduate programs, was promoted. Most institutions appear to be hesitant to launch new MS degree programs in nanoengineering/nanoscience, primarily because the discipline is not ready for such degrees yet. However, nanotechnology options have been successfully introduced into Ph.D. programs at some institutions. Ph.D. programs seem to be better able to accommodate the broad needs of nanoeducational activities. It was emphasized that to make nanotechnology options work at any degree level, it is essential to have at least one magnet course that draws sufficient student interest.

The necessary skill set in graduate nanotechnology programs includes probability, quantum mechanics, electromagnetics, bonding chemistry, and thermodynamics, and economics of manufacturability.

Challenges to Academic Administrators

Conducting research in the most areas of nanoengineering/nanoscience often requires faculty to spend time working in institutions away from their home institutions, and to spend extraordinary amounts of time interfacing with professional technicians who facilitate the use of nanotechnology processing equipment. As a result patterns of teaching activities and research publications for such faculty may not follow traditional models. This implies that academic administrators, especially department heads and deans, will have to "walk an extra mile" to document the quality of promotion and tenure cases for faculty working in nanotechnology areas, so these cases can achieve success at higher levels of the university. It will be important for administrators to be keenly aware of these special needs during the hiring, mentoring, and promotion of tenure track faculty.

Challenges to Industry

It is predicted that the scaling down of dimensions in present semiconductor technologies will continue for the next 10 - 12 years, until a hard limit of Moore's Law is finally reached. By the end of that time it will be necessary for radical new technologies to be introduced if continued progress in reducing device dimensions and increasing chip density is to be maintained. This implies that industry faces the enormous challenge of developing commercially viable nanoscale chip technologies within the next 10 years. Fundamental advances are needed in new switching mechanisms, new architectures built from quantum cellular automata, new ways to design for fault tolerance, new methods to achieve low power circuit designs, and new methods for testing very dense and highly integrated nanoscale systems-on-a-chip. During the next 10 years it will be necessary for industrial scientists and engineers to work with academic researchers in multi disciplinary teams in order to meet this formidable challenge.

Foundry Facilities and CAD Software to Support Nanoeducation

Most of the breakout groups at the workshop came to the conclusion that low cost nanotechnology foundry facilities will be needed to support programs in nanoengineering/nanoscience. Foundry facilities similar to those provided by MOSIS are recommended. To date there are no such nanoscale fabrication facilities available to university researchers, largely due to the fact that nanofabrication covers a broad spectrum of activities and to date there are no industry standards to unify designs and layouts.

Similarly, the availability of CAD software for the design, simulation, testing, and layout of nanoscale circuits and devices is currently limited. While some capabilities are being provide by Cadence, AutoCad, MoleSpice, and other commercial CAD packages, there is yet to become available a set of industry standards for CAD software to support the development of nanoscale electronics. The rate at which new nanotechnologies being to appear in commercial will very likely be tied to the rate at which nanoscale CAD software becomes available.

A Challenge to All

Dr, James Plummer, Dean of Engineering at Stanford University, in his plenary talk made the point that the cost of facilities to support research and education in nanoengineering and nanoscience is so large that it is beyond the capability of any single institution to support such activities alone. In the future it will be necessary for institutions to form coalitions and work in teams, which often will include universities, private companies, and government laboratories. A grand challenge to all is to develop models and working prototypes of how effective coalitions can be formed and how quality facilities can be managed and financially supported collectively.

The results of the workshop are being drafted into a report for NSF for dissemination in late spring 2003. The tutorial presentations will be available through the web page of the IEC.

David L. Soldan, Kansas State University
Steve Goodnick, Arizona State University
Ken Jenkins, Pennsylvania State University

From the President of the IEEE Education Society

David V. Kerns
Franklin Olin College of Engineering

Recognition for Accomplishments in Engineering Education

Colleagues,

It's important that we continue to explore ways to bring widespread recognition to the importance of excellence and innovation in engineering education. One important approach is to have our members who have made significant contributions become the recipients of high-profile awards. This brings recognition to the individual and our society.

On occasion, important awards have gone unfilled as a result of the lack of well-documented and supported nominations. This was not because there were not qualified candidates deserving recognition, but more likely because no one took the time to champion the candidacy of one of our colleagues who would have been successful at winning, and achieving well-deserved personal and professional recognition.

I'd like to encourage you to spend some time exploring the IEEE website (www.ieee.org) and the ASEE website (www.asee.org) for awards related to excellence in engineering education. There is a variety of prestigious annual awards and, upon review, you may feel that someone you know deserves one of these awards.

The IEEE Education Society offers annually several awards that are normally presented at the Frontiers in Education (FIE) Conference. These awards include the IEEE Education Society *Meritorious Service Award*, the IEEE Education Society *Achievement Award*, the IEEE Education Society *McGraw-Hill/Jacob Millman Award*, The IEEE Education Society *Transactions on Education Best Paper Award*, and the IEEE Education Society *Hewlett-Packard/ Harriett B. Rigas Award*. Although our website does not currently list these awards, we are in the process of updating the website and before the next nomination cycle, further information and nomination procedures will be posted. You should also remember that colleagues with significant accomplishments can be nominated as a Fellow of the IEEE.

The IEEE has an institute-wide award, the *James H. Mulligan, Jr. Education Medal* (formerly the IEEE Education Medal) established in 1956 to recognize the importance of the educator's contributions to the vitality, imagination, and leadership of the members of the engineering profession. This award has a nomination deadline of July 1.

The IEEE Educational Activities Board (EAB) sponsors the following awards, which can be reviewed on their website (http://www.ieee.org/organizations/eab/eab.htm):

- Meritorious Achievement Award in Accreditation Activities
- Meritorious Achievement Award in Continuing Education
- Major Educational Innovation Award
- Pre-College Educator Award
- Meritorious Service Citation
- Employer Professional Development Award
- Sections Professional Development Award

These awards have a nomination deadline of April 30.

The ASEE also has a variety of awards that recognize engineering education excellence. There is the ECE Division *Hewlett-Packard Frederick Emmons Terman Award*, presented at the Terman luncheon at the FIE conference. The ASEE website describes two awards for excellence in engineering education, two awards for excellence in engineering technology education, and a number of prestigious special awards.

As a result of a motion made by **Burks Oakley** at the last Education Society AdCom meeting in Boston, we are investigating the possibility of establishing a new IEEE Education Society award for young faculty, which (for now) we are defining as Education Society members within 10 years of the Ph.D. degree. This award would honor distinguished accomplishments in engineering education made by individuals early in their career; the working title is "IEEE Education Society *Young Educator Award*". **Dan Litynski**, our vice-president and awards chair, is leading the development of a proposal in this area, and I ask you to forward any comments or suggestions on this idea to him (dan.litynski@wmich.edu).

I encourage you to review our members who have made appropriate contributions, take the time to get accurate and up-to-date information, and prepare nominations for a colleague you believe worthy of recognition. This takes time, but it's important and worth the effort. Our collective effort to bring recognition to outstanding individuals will also bring increased recognition of the importance of excellence in engineering education, and enhance the professional environment for us all.

David Kerns
david.kerns@olin.edu

Nan Marie Jokerst, Georgia Tech, receives the Hewlett-Packard Harriett B. Rigas Award at the 2002 Frontiers in Education Conference.

IEEE Education Society Officers for 2003

President
David Kerns
Olin College of Engineering, USA
David.kerns@olin.edu

Vice President
Dan Litynski
Western Michigan University, USA

Secretary
Joseph Hughes
Georgia Institute of Technology, USA
Joe.Hughes@ece.gatech.edu

Treasurer
Rodney Soukup
University of Nebraska-Lincoln, USA

Administrative Committee

In addition to the officers and committee chairs, twelve at-large members serve three-year terms on the administrative committee of the IEEE Education Society.

Terms ending in 2005
Malany M. Ciampi
SENAC, University Center of Lusiada, Brazil
melany@sp.senac.br

Victor P. Nelson
Auburn University, USA
nelson@auburn.edu

Wayne Johnson
Hewlett-Packard, USA

Russell Meier
Milwaukee School of Engineering
meier@msoe.edu

Terms ending in 2004
Jeffrey Froyd,
Texas A&M University, USA
froyd@tamu.edu

Susan Burkett
Boise State University, USA
sburkett@boisestate.edu

Susan M. Lord
University of San Diego, USA
slord@SanDiego.edu

Claudio da Rocha Brito,
SENAC, University Center of Lusiada, Brazil
cdrbrito@lusiada.br

Terms ending in 2003
Kruno Hernaut, Siemens AG, Germany,
Kruno.Hernaut@CP.SIEMENS.DE

Haniph Latchman, University of Florida, USA
latchman@ufl.edu

Tony Mitchel, North Carolina State University, USA
tmitchel@eos.ncsu.edu

Melinda Piket-May
University of Colorado at Boulder, USA
Melinda.Piket-May@colorado.edu

SCIENCE & TECHNOLOGY IN THE WORKPLACE: EXTENDED LEARNING

George Rodgers
GRodg82505@aol.com

(Or, EL VIA TV LINKS BETWEEN HIGH SCHOOLS, one of a series of articles)

BACKGROUND: By mid-point in our experiment we had installed several improvements in the series for post-calculus HS curricula; we were ready to reach out to other schools in Fairfax County as a prelude to extending EL links to a wider Virginia, and perhaps beyond. We patterned our approach on the Northern Virginia Community College (NVCC) system, where we were engaged in EL for telecommunication courses. Both link systems, NVCC and Fairfax County School System are independently administered, a point perhaps for partial consolidation of assets in the interests of efficiency. EL is exploited in Virginia for those VCC courses with limited enrollments per campus individually but which for aggregate registrations could meet thresholds. {For example an average enrollment of 5 (motivated) students per campus with 4 institutions yields 20 total, breaking the threshold established for a particular course.} Additionally, for our pro-bono effort we might achieve a welcome economy of volunteer teacher assets in the seminar *S&T IN THE WORKPLACE*.

CONTENT PARALLELED ON THE LINK: Three cameras were found useful for our link segments. Identical lesson plans and sequences prepared for conventional classroom presentation were used. (reported in earlier issues of *The Interface*) Visual content consisted of three views. One camera for prepared slides, a graphics view, to be discussed via a window inset image on another camera output for the lecturer at the podium or whiteboard; giving mixed images simultaneously was an asset, replicating conventional board presentations with visual and audio together. The third camera was used for class scanning and particularly for questions raised in the lecture. An especially useful tool was use of the window in various modes; the downside for this feature was the need for an off-camera operator to run controls while airing single and multiple images.

REMOTE CLASS "FACILITATORS": Whereas we could break up the remote and local groups in a NOVA CC telecommunications class, thereby selecting a motivated group of high performers for remote sites, this was awkward for volunteering HS student groups at such. It became apparent that for the HS students at remote locations we should train our own IEEE volunteers for in-class assistants, (facilitators) not to carry out the lesson plan but to frame questions for on-line interaction as well as other class chores with teacher presence. It was too big a burden for remote site regular faculty teachers. We trained 5 IEEE volunteers by having them audit a regular seminar segment; these volunteers were competent and interested participants. One retiree from MIT had assisted in the late 1950s work which for the SPUTNIK ERA had revised chemistry and physics experiments with innovative lab features, tailored to secondary curricula.

If preparation of a 10- to 20-page handout covering each session was vital in the single-class mode, it was even more crucial for EL sessions at remote sites. Extensive coordination was an essential, stressing ties for volunteer lecturers, for school support at all sites, and for lag times in preparation and distribution of each session.

EL BEYOND FAIRFAX COUNTY: Our efforts to extend the seminar beyond the County were limited to Virginia schools who were members of the national magnet school Consortium; we were unable to elicit volunteer members for this EL movement beyond the Capital Area. Organizational boundaries between IEEE Regions 2 and 3 were involved to some extent. Additionally we attempted to tie into another magnet school in Maryland and were unsuccessful.

SUMMARY: An effort to bring the seminar to a Louisiana magnet school (Natchitoches) was similarly thwarted by both organizational difficulty and mismatch between communications bands on the links. Workshops were held at the annual ASEE "Frontiers in Education" on the topic of EL (11/97, Pittsburgh) and at the "New Horizons" meeting (4/98, Fairfax) for Virginia schools; published papers for both of these were co-authored by Principal Geof. Jones of Alexandria's Thomas Jefferson High School for Science and Technology (TJHSST). Common workshop issues included lack of classroom mobility by EL lecturers, constrained by lens coverage, c: 4 feet; audio feedback interference; need for audio-tracking at the instructor camera; software to counter student anonymity at remote sites; need for HDTV to offset poor eye-contact; creative use of window-imaging. Interestingly, issues of network organization were not serious for normal school links; for us, such issues were a problem. Consolidation and issuance of a workbook to preserve and improve lesson plans were recommended, along with better organization.

George Rodgers
GRodg82505@aol.com

From the President of the ASEE ECE Division

S. Hossein Mousavinezhad
Western Michigan University

Dear ASEE ECE Division Member,

Happy New Year! 2002 was a great year for the electrical and computer engineering division of the ASEE, including excellent attendance and quality paper and other presentations at the Montreal Conference, June 16-19, 2002. (Please refer to my column, *The Interface*, November 2002, pp 6-7, for further information on ECE sessions and other related issues.)

A measure of increased interest in ECE division affairs was the excellent attendance we had during our business breakfast meeting on Monday June 17, 2002 in Montreal. We are going to have another excellent program in Nashville, June 22-25, 2003 (program chair, **Dr. Stan Burns**, is working hard to finalize the program/sessions so we can look forward to another superb conference). I also want to encourage all of you to attend the ECE brainstorming session in Nashville (BSECE, session 1632), I have invited **Dr. Vasundara Varadan**, Division Director of NSF's Electrical & Communications Systems, to join us for this discussion. Please let me know your thoughts and feedback re ECE division Activities. I am looking forward to meeting most of you this summer in Nashville.

Let me conclude by mentioning a couple of closely related activities in IEEE as they relate to engineering education. I was honored to be selected as Education Society membership development chair during the FIE 2002 conference in Boston last November. I want to encourage IEEE members to consider joining EdSoc and help us to get additional members in the US and worldwide. According to **Dave Kerns**, president of EdSoc, "EdSoc is a unique society within IEEE, being entirely dedicated to engineering education." We are also organizing the *eit2003 conference* in Indianapolis, June 5-6, 2003 (papers still being accepted, please visit www.cis-ieee.org/eit2003 for additional information.)

Respectfully submitted,
Seyed Hossein Mousavinezhad,
ASEE ECE Division Chair, January 2003
hossein.mousavinezhad@ieee.org
(269) 387-4057, FAX (269) 387-4096
http://www.wmich.edu/ece

From the Editor

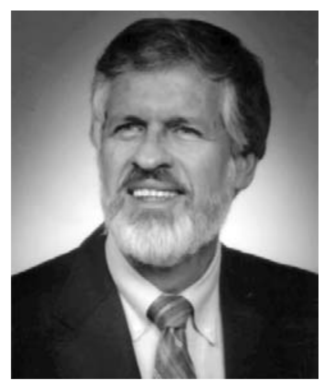
Bill Sayle
sayle@ece.gatech.edu

If you have read this far, you have undoubtedly realized we have a "packed issue". Our officers of the IEEE Educational Activities Board (VP **Jim Tien**) and the IEEE Education Society (President **David Kerns**) have begun their new terms. **Hossein Mousavinezhad**, Chair of the ASEE ECE Division, is well into his term. Please support these colleagues as they work within our two societies to further the goals of engineering education.

Many of you may have heard previously about the **Frank Splitt** article, which appears as the cover story in this issue of *The Interface.* A number of you may have already received a copy of the complete trilogy. I believe it contains important ideas. Space does not allow us to reprint the entire trilogy in *The Interface.* But, it's accessible on the web at http://www.ece.northwestern.edu/EXTERNAL/Splitt/SplittWebEngrEduReformTrilogy.doc

Thus, you may read it without having to secure your own printed copy or having to wait for the second and third parts to appear in future issues of *The Interface.* Many of you also may not be aware that Frank Splitt worked with **John Prados** in the "early days" on what eventually became ABET's Engineering Criteria 2000.

Travels. Recently my wife and I had the opportunity to visit one of our daughters in rural Guatemala. The village, in which she is living and working on a volunteer basis, received electrical service about four years ago. It has no bank, no postal service, and only three telephone lines. Most of the residents of this village are indigenous people of Mayan descent. A large part of their daily work involves cutting and carrying wood for the cooking fires, which burn much of the day inside their homes. Many of the people suffer eye and lung damage from breathing the smoke from these fires. The cutting of wood results in deforestation, which is not healthy for the planet. Two projects are ongoing in this village: one involves the construction of vented cooking stoves and the other involves the planting of macadamia trees, which will create a high-value cash crop as well as provide additional nutritional value and aid in reforestation. I mention this experience because it is a reminder of how untouched much of the world's inhabitants are in this so-called technological age.



Bill Sayle
Editor, The Interface

New IEEE Fellows

Congratulations to these newly elected fellows of the IEEE!

Mr. Richard A. Ackley,
for technology leadership for advanced radar systems.

Prof. Gerald L. Engel,
for contributions to computer science and engineering education.

Prof. Rolf Ernst,
Technical University of Braunschweig
for contributions to the design automation of co-design hardware and software embedded systems.

Prof. Akinori Nishihara,
Tokyo Institute of Technology
for contributions to the theory and design of digital signal processing.

Mr. Carl D. Avers,
for contributions to engineering education and accreditation of engineering programs.

Dr. John Andrew Orr,
Worcester Polytechnic Institute
for contributions to electrical and computer engineering education.

Dr. Susan Manning Blanchard,
North Carolina State University
for contributions in the field of cardiac electrophysiology and for innovations in biomedical engineering education.

Dr. Mustafa Okyay Kaynak,
Bogazici University
for contributions to variable structure systems theory and its applications in mechatronics.

Prof. Andreas Savva Spanias,
Arizona State University
for contributions to speech processing and its industrial applications.

IEEE Education Society Standing Committee Chairs

AWARDS COMMITTEE
Dan Litynski
Western Michigan University, USA
dan.litynski@wmich.edu

CONSTITUTION and BYLAWS COMMITTEE
Burks Oakley II, Chair
University of Illinois
oakley@uillinois.edu

NOMINATING COMMITTEE
Marion Hagler
Mississippi State University
hagler@ece.msstate.edu

PUBLICATIONS COMMITTEE
William E. Sayle II, Co-Chair
Newsletter Editor
Georgia Institute of Technology
bill.sayle@ece.gatech.edu

David A. Conner, Co-Chair
Transactions Editor
University of Alabama in Birmingham
daconner@uab.edu

4th International Conference on Information Technology Based Higher Education and Training

Victor Schutz
Past-President
IEEE Education Society

ITHET '03 July 7-9, 2003, in Marrakech, Morocco

Details: ***http://www.emi.ac.ma/ithet03/***

—-*HP (Hewlett-Pakard) is a major sponsor* of ITHET'03. We want to thank Lueny Morell (HP Director, University Relations Latin America) and her boss, Wayne C. Johnson (HP Executive Director of University Relations Worldwide) for their generous support.Wayne Johnson was recently nominated and elected to the AdCom of the IEEE-Education Society.

—-*Security:* Morocco is a safe and USA/Western friendly country.
Please refer to *www.state.gov* or the leading article on Morocco ("Dreams in the Desert") in the *SMITHSONIAN*, August 2002, Vol.33, No.5 or the extensive articles in the Travel-Section of the *New York Times* in recent months.

—-*IHET History:* Was conceived and initiated by AdCom member Okyay Kaynak. So far, the conferences were 2000 (Istanbul, Turkey), 2001 (Kumamoto, Japan) and 2002 (Budapest, Hungary) with the **support and encouragement of the AdCom of the IEEE/Education Society.**

Amine Benkiram is putting together a *first-class global technical meeting*. He is also working hard to make it into an *unforgettable cultural experience*.

Please, look at his *http://www.emi.ac.ma/ithet03/* or e-mail *ithet03@emi.ac.ma*

See you in Marrakech.......

Vic

Victor K. Schutz, Ph.D.
Past President
IEEE Education Society

Phone: +1-610-649-9331
E-mail: v.schutz@ieee.org

The INSTITUTE OF ELECTRICAL & ELECTRONICS ENGINEERS, INC.
445 Hoes Lane • Piscataway, NJ 08855-1331, USA

Non-Profit Org.
U.S. Postage
PAID
Easton, PA
Permit No. 7