# The Interface

August 2004 • Number 2

The Joint Newsletter of the IEEE Education Society and the ASEE Electrical and Computer Engineering Division

http://www.ieee.org/edsoc

## The IEEE Education Society is On The Move!

*by Rob Reilly*

Under the leadership of Education Society (EdSoc) President **David Kerns**, it has been my pleasure to work with a number of Society members who have been more than willing to contribute their expertise and time to several projects. The Chapter Committee is expanding by leaps-and-bounds; the Web site is ready-for-action and seems to be a good place to visit at least once a month; we have a Society-wide mailing list; we also have an opt-in mailing list that provides professional development experiences; and we have a regularly occurring newsletter. None of these projects would have come-to-pass with the support of a number of Society leaders who have generously given of their time—**Burks Oakley** (USA), **Marion Hagler** (USA), **David Conner** (USA), **Bill Sayle** (USA), **David Kerns** (USA), **Trond Clausen** (Norway), **Ted Batchman** (USA), **and Manuel Castro** (Spain).

As Chair of the Chapter Committee, it has been my privilege to get to know a number of EdSoc members throughout the world. In May 2003 President David Kerns wanted to see what could be done in regard to supporting the existing EdSoc Chapters and forming new chapters. This effort has been quite productive as quite a few leaders in the various IEEE Sections were ready-and-willing to start a chapter.

Thus far new chapters have been formed in France, Spain, Romania, Greece, Santa Clara Valley (California USA), St Louis, Connecticut and Taipei (Taiwan). And the chairs of the existing chapters are doing some very impressive work.

We shall see a number of other chapters formed in the near future. Currently there are Chapter Formation drives going full-blast in the following IEEE Sections: Portugal, Malaysia, Alabama, Austria, Baltimore, Philadelphia, Singapore, Germany, Slovenia, Houston, Central & Southern Italy, and in the United Kingdom and Republic of Ireland. These petition drives should be completed by September or October.

The EdSoc Chapter Committee itself is also quite active. It is intent upon supporting the existing chapters and the developing chapters. Toward that end the Chapter Committee has made several recommendations to the Administrative Committee, which were focused on financial support for the chapter. The goal is to provide the chapter leaders with the means to do great things in their Section. If you are interested in what these proposals are see: *http://www.ewh.ieee.org/soc/es/chapters.html* or just go the EdSoc's Main Page and click on the Chapter Committee link (*http:// www.ieee.org/edsoc*).

Forming a Chapter is a relatively simple process at this point. If you're interested in forming a chapter in your IEEE Section just contact me (*reilly@media.mit.edu*). The Chapter Formation Petition, which needs 12 EdSoc member's signatures, can be easily customized and made available online. And with the IEEE's e-Notice function, which can automagically send bulk email to all EdSoc members, sending a Chapter Formation Petition to everyone in question is relatively effortless. Then it's all downhill from there!

With the support of the committee's Vice Chair, **Trond Clausen** from Norway, **Manuel Castro** in Spain, and the involvement of a large group of EdSoc leaders throughout the world, this committee has accomplished a great deal.

For more Chapter information see: *http://www.ewh.ieee.org/soc/es/chapers.html*

Ahhh…then there's the Web site. With the support and guidance of **Bill Sayle**, the Society's Web site has reached 'cruising altitude.' The Web site renovation project began in May 2003 and evolved along two fronts. One was a redesign of the site's appearance and structure, and the other front involved updating the information that was (or should be) on the Web site. That's done,

*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.*
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now it's just a matter of updating information and adding new material as it becomes available. *[Editor's note: The new web site owes its existence to Rob's hard work.]*

It was my pleasure to work with **Marion Hagler** to place the CD-ROM based *Supplements* to the *IEEE Transactions on Education* online. Up to that point this terrific resource was not available through IEEE Explore to Society members and there were no more CDs—so this material was just not available. Now the Supplements are available on the EdSoc's Web site (and the archive is searchable via the Web site 'Search' mechanism).

Other critical Web site tasks required the support and time commitment of a number of EdSoc leaders. These tasks involved the chairs of the various standing committees revising/reviewing all the material that was on the Web (or should be there). **Burks Oakley**, who was instrumental in establishing the Web site years ago and was the first Webmaster, reviewed and updated the Society's By Laws and Constitution, and has been a continuing source of guidance for me. *IEEE Transactions on Education* Editor-in-Chief **David Conner** has been instrumental in revising and updating the Web page material that falls in his domain, and he is always available for guidance and support.

With the support of the people I have named and many others, the Web site is now averaging over 60 logins per day, where it was averaging 28 logins per day in May 2003. The Web site's monthly usage is now well over 1,500 logins per month (with a high of 2,083 in March 2004), which is a noticeable increase from May 2003's 493 logins.

We now have a monthly electronic bulletin, the *News&Notes*, which is designed to provide rapid information flow for the Society and is a complement to *The Interface*. The IEEE has initiated an *e-Notice* mechanism by which a newsletter (or any material) can be sent, in our case, to every Education Society member. The *e-Notice* mechanism interrogates the IEEE's master membership database, retrieves a listing of members' email addresses and sends out the material. This has been a terrific feature put in place by the IEEE.

We have an *opt-in* mailing list, which is designed to provide professional development to our members. This is, what amounts to be, an asynchronous online talk show conducted via group email. For example, **Ted Batchman** made a presentation entitled "*Getting Published in the IEEE Transactions on Education*." Ted was asked one question per-day and he would respond to that question, and, that question and answer would be pumped-out to all those who were subscribed to the mailing list. This process continued for 10 days. It was a terrific exchange. It is archived on the EdSoc's Web site (*http://www.ewh.ieee.org/soc/es/batchman.html*).

Ted Batchman was followed by **David Fogel** whose talk was entitled: "*Ever Think About Becoming a Book Author,*" which presented the ups and downs of getting a book published. That talk is archived at: (*http://www.ewh.ieee.org/soc/es/fogel.html*).

Both these presentations were terrific and were 'attended' by over 300 people.

The initiatives of Society President David Kerns, which have been supported by the AdCom, will lay the groundwork to make the Education Society a move vibrant and truly worldwide organization.

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# The Academic Scholar

*By James M. Tien*
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In the May 1994 issue of *Prism*, the publication of the *American Society for Engineering Education*, I commented on the then newly issued National Research Council's "*Vision for Engineering Education*". While for the most part I endorsed the NRC's vision, I suggested that they put to rest the seemingly divisive and opposing views regarding research and teaching. In fact, I suggested that the focus should be on scholarship, which goes hand-in-hand with learning. That is, the learning process requires the constant infusion of output from scholarly discoveries – be it new knowledge from faculty undertaking research or new pedagogies from faculty involved in teaching. More specifically, all engineering academics – including all engineering students – should be simultaneously engaged in the conduct of scholarship and the business of learning. There are not two groups of faculty (i.e., researchers and teachers), only possibly two scholarship foci (i.e., knowledge and pedagogy).

A decade later, I am happy to say that the controversy between research and teaching has subsided and the academic scholar has emerged to cope with and contribute to the fast-pace of technological changes and to meet the need to continuously update the content and delivery of the engineering curricula. The academic scholar brings to the university grants, patents, prestige, and often attracts the enrollment of the best and brightest students. The university can boast of scholars and their well-educated students to prospective industry partners and employers. But as wonderful as this all is, it is all incidental to the main objective. The main objective for the academic scholar is her scholarly endeavors: finding new knowledge in her field of research and developing new pedagogical means for educating and mentoring students.

For the student, this means that the teacher is always in "active" mode. She is authentic in her knowledge, having come from the lab where she has expended her time and energy to further knowledge discovery. She is up to date on the latest in her field, not only from keeping up with the available material, but from having published it herself. The best and the brightest students often decide on a university on the basis of the faculty's scholarship and reputation. As a matter of fact, the 2004 IEEE President's Scholarship winner turned down two full financial aid awards to other fine institutions in order to study with MIT's Dr. Rodney Brooks for just this reason. Indeed, the student gets a teacher who is primed to be a mentor. The academic scholar works in teams with post docs, grads, and undergrads. One can easily find students in her classes that would fit in well with her research team.

The academic scholar is also ready to be the first colleague the student has – treating the student in the research setting as if he was already at peer level. This gives a boost of confidence to the student. It is an added inducement to the student to stay with the strenuous curriculum and an added bonus to the hands-on labs now proliferating at the undergraduate level at many universities. Such undergraduate research opportunities help to induct the student gradually into the community of engineers, teaching the ethos of the profession along with the hard science. Additionally, the student gets classroom reinforcement for lab procedures that have the added dimension of being current because of the academic scholar standing in front of him. Ethics, documentation, close observation, questioning, attention to detail serve the student as well in the classroom as in the lab. The academic scholar is in a position to insist on the same rigor in the classroom as in the lab.

One reason for student attrition is the lack of student involvement in enough real-life situations, hands-on work, or exposure to those making engineering contributions. An academic scholar in the classroom can counter student cynicism with personal and current stories of research work and how they relate to course assignments. It is a way to keep the students energized and learning. Moreover, the academic scholar can sensitize the student to the fact much of the advances in engineering is multidisciplinary in scope. No matter at which strata the student is in, whether near to graduation or not, identifying workplace realities will help to focus the student's mind on the course material.

The academic scholar must also reinforce her professional career by adding pedagogical development to her scholarly activities. Teaching is not a solo act. It involves engaging and keeping the interest of every student in the classroom. Pedagogical content and delivery mechanisms must be researched, developed and refined in order for the teacher to remain productively connected with her student. Not surprisingly, scholarship fortifies the teacher for the unexpected question – the question that isn't to the point, but one that wanders around, just off the mark. It may be the question that is about to take the student on a big leap forward in the understanding of the material at hand.

New knowledge and new pedagogy are both complementary and mutually supportive. Announcing new research results during a class, for instance, leads to the discussion of unforeseen implications. It can add new wrinkles to known solutions. Explaining one's research results in the context of an established course syllabus helps to both clarify and update the material. It can change what one teaches as well as how one teaches.

Finally, the academic scholar – by her continuous contributions to knowledge and pedagogy – serves as a role model. Her presence announces to the student that it is the duty of the professional engineer to engage in continuing education. Learning – and discovery – is a lifelong activity.

## From the Chair of the ASEE ECE Division

# Breadth and Depth in ECE

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By the time you read this commentary, the 2004 ASEE National Meeting will be history. The breadth and depth of the presentations from our colleagues was astounding. As engineering educators and practitioners, the presentations and posters provided guidance as to where we have been and where we are headed.

The "*Undergraduate Research and New Directions*" session illustrated the importance of our undergraduate students developing a facility in seeking new knowledge in a variety of disciplines. Topics in this session will help our students become the leaders in industry and academia. Building upon this session, there are many new and exciting topics put forth in the "*New Trends in ECE Education*". Gone are the days of using the amount of chalk dust generated in the classroom as a metric for inspiring students to become creative and productive engineers. A small sample of the large number of exciting and innovative projects and programs engaged by faculty, industry colleagues, and students was very well illustrated at the "*Poster Session*". I personally think that one of the best parts of the "Poster Session" is the opportunity to discuss these projects with the authors. Their creativity and enthusiasm really shows through. Over the last decade, we have seen a proliferation of interdisciplinary programs where ECE plays a dominant role. These were discussed in the "*Forum for Non-Traditional Engineering programs"*. Technology innovations and associated cost reductions have made it possible for us to teach and students to learn using paradigms presented in the "*Teaching and Learning with Technology*" session. These new learning and instructional delivery paradigms are also evident in presentations in the "*ECE Online Courses, Labs, and Programs*". "Online" is definitely here and growing. As illustrated in the "*Course and Curriculum Innovations*" and "*ECE Laboratory Development and Innovation*" sessions, we as educators are now being challenged by recognizing new teaching and learning techniques. The increased emphasis and importance of senior design projects was well recognized in the *"ECE Capstone Design and Engineering Practice"* session. Underlying all these changes and innovations is the recognition that we have to define what is topically important in each of our programs in order to provide the depth and breadth for our students in engineering fundamentals, technical topics, liberal education, and communication skills. Of course we have to do this generally within a 4-year window. Of course, all of these program innovations, resultant impacts on engineering education, and issues including engineering professionalism and practice were included in discussions in the "*Accreditation and Related Issues in ECE*" session. Critical to engineering education is what potential students have for background, skills, and motivation. Recognition of the importance was provided in the "*Pre-College and ECE Education*" session. Of course an appreciation and knowledge of mathematics as a foundation for engineering was recognized by presentations in the "*ECE Education and Engineering Mathematics*" session. It is truly unfortunate we could not accommodate all of the papers offered by our colleagues on these very important and timely topics.

To paraphrase some of the very relevant comments put forth by **Joseph L.A. Hughes** in his 2001 *Interface* article. We, as faculty, work very hard to help our students become good engineers. Successful faculty, especially new tenure-track faculty, must meet the demands of quality teaching and creative research and scholarship as part of their career development and, of course, find balance between their professional and personal life. Nothing can substitute for instilling a love for the ECE profession by having dedicated and inspiring faculty who enjoy what they are doing and are rewarded for their efforts. We in the ASEE and the ECE Division must continue to help our colleagues achieve these goals.

I invite your comments and suggestions for making the ASEE 2005 National Meeting a success. Please feel free to contact me at sburns@d.umn.edu or at +1-218-726-7506.

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## From the Chair of the IEEE Committee on Engineering Accreditation Activities

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First, I would like to introduce myself as the incoming chair of the IEEE Committee on Engineering Accreditation Activities. It is an honor and a pleasure to serve with this great group of people, and to serve the extremely important function which CEAA carries out. Essentially, CEAA makes accreditation happen for all of the undergraduate programs (principally electrical and computer engineering) under the IEEE umbrella. However, CEAA does not make any accreditation decisions – that power belongs to the Engineering Accreditation

Commission of ABET. CEAA can, and does, originate changes to the Criteria, and that is an important role. Some clarifying modifications to the criteria have just been adopted, thanks in large part to efforts of several CEAA members with endorsement from the entire committee.

I have previously written for *The Interface* when I was president of the ECE Department Heads Association, and now I will take a different perspective from CEAA. In this piece I would like to introduce several topics, and I invite (actually, I plead for) your feedback and comments. It is obvious that the Electrical and Computer Engineering profession is undergoing several changes and stresses at present, and that these will result in a different profession in the future. Some of these factors include: rapid globalization of engineering, resulting in "offshoring" of design work that had traditionally been performed in the U.S.; continued broadening of the profession with more and more "electrical engineers" not dealing directly with circuits or electrons; and the emergence of nanoscience and nanoengineering which broaden ECE and also relate it more closely to physics, chemistry and mechanical engineering. These issues are very broad, with implications far beyond undergraduate engineering programs and accreditation. However, these undergraduate programs do represent the absolute foundation of the engineering profession, so we have an obligation to understand the overall situation in order to help the ECE profession to continue to thrive.

Growing out of the above situation, there are several more specific issues to which the accreditation process should respond. These include:

- **Academic minors** The idea that some technological education is desirable for a broad range of professions is gaining acceptance; this leads to the suggestion of academic programs typically referred to as "minors" which complement the students' major programs of study. Minors in engineering disciplines have been viewed with concern by accreditors for at least one reason: the fear that a student with only a minor in engineering might consider himself/herself prepared for an engineering position. This is a legitimate concern, but the potential benefits, both to society and to the profession, of opening up our courses to more non-majors seem very substantial. Most students only take engineering classes if they intend to become engineers. This is certainly not true with English, Psychology, and most other important academic subjects.
- **Expanding range of specialized programs** As the profession broadened in the past, new majors with titles such as "Optical Engineering," and "Telecommunications Engineering," have arisen, and ABET has offered to accredit these programs. More recently programs with titles such as "Entertainment Engineering" have been introduced. There is little doubt that the creation of new programs is appropriate and beneficial, but it is less clear how they should be accredited. Should new program criteria be written? What societies should be involved?
- **Innovation** Are the new ABET criteria stimulating program innovation in the areas referred to above, or in other areas? I have not yet seen much evidence of this, but perhaps it is still too early to expect to see a cause and effect relationship.

Please let me hear your thoughts. Email me at orr@wpi.edu.

## *From the USA Electrical and Computer Engineering Department Heads Association*

# Globalization and Workforce Training in Electrical and Computer Engineering Education

**Ken Jenkins**

**Stephen Goodnick**

*Ken Jenkins, ECEDHA President*
*Stephen Goodnick, ECEDHA Past-President*

The ECEDHA annual meeting was held this year in Orlando, Florida, USA on March 16-22$^{nd}$. The meeting was well attended with over 180 Chairs and Heads present. As always, there were many sessions devoted to varied topics of interest to heads of ECE departments such as future research directions, diversity in ECE programs (the subject of our last *Interface* column), ABET and undergraduate education issues, public policy, and engineering education research.

We were fortunate to have **Dr. William Wulf**, President of the USA National Academy of Engineering, as a plenary speaker, where he presented a keynote talk entitled "*Thoughts on the Globalization of Engineering and Its Implications for Engineering Education*." This issue is currently at the forefront of public discussion (particularly during an election year), and Dr. Wulf's insights on these issues stimulated a great deal of discussion throughout the meeting. Electrical and Computer Engineering are fields that are heavily impacted by the global economy in areas such as software, electronics manufacturing and electronic design, and organizations such as IEEE USA have been very involved in the debate. We decided to devote this issue's column to the issue of globalization and ECE education from the perspective of ECEDHA.

One problem in the debate on out-sourcing and globalization is the lack of hard data concerning the impact of this evolution on engineering jobs in the United States. As Dr. Wulf aptly phrased it in his plenary address, 'the plural of anecdote is not data.' In fact, much of this discussion is shaped by anecdotal evidence as opposed to aggregate statistics. Most of us know of someone over the past 2-3 years who was laid-off during the high-tech recession, from companies which were at the same time building manufacturing and design capabilities off-shore. In fact, it was somewhat surprising to read of recent May 2004 labor statistics which claimed to show only a minor portion (less than 5%) of job losses in the workforce identifiable with out-sourcing. One wonders if such statistics truly account for the large growth of off-shore facilities, and associated obsolescence of older US based facilities, as opposed to simply measuring direct loss of individual jobs due to out-sourcing. Engineering unemployment is relatively high (about 6% at the time of this article), comparable to the national unemployment rate overall, whereas in the past it has been mainly below the national average, especially during the late 1990s. However, there has not been a noticeable decline in starting salaries evidencing an engineering glut.

The lack of hard data has led to conflicting predictions of future engineering needs in the US, with some government entities continuing to predict a shortage of scientists and engineers in the future, while IEEE USA predicts an engineering oversupply. Comparison of numbers of engineering graduates worldwide versus the USA are also highly variable. While it is well known in the US that the number of engineering BS graduates peaked in the mid-1980s close to 80,000, and has declined to a steady state value of around 60,000, the numbers graduating in China and India are reported as anywhere from 5 to 10 times the U.S. number. Regardless of the exact number, it is clear that many more engineers are graduating per year in Asia than in the US, and that based on the steady flow of H1B visas over the past decade, a significant fraction of the engineering workforce in the US has been imported from abroad. It is not clear that this trend will continue in the future as job opportunities in the Asian countries increase. The relative fraction of graduates overall with engineering degrees in India and China is much higher than in the US, approximately 45% of all degrees for example in China versus just 6% in the US. Clearly there is a huge engineering talent pool abroad, at a cost often substantially less than in the US, and with a shrinking difference in the perceived educational quality (if not higher than in the US from top schools in the far East such as the IITs in India).

So, what are the ramifications for ECE education in the US? Several issues come to mind. One is the need to educate engineering students for competitive careers in a global economy. Students need to be trained with an awareness of global issues, cultural values, global economics, and an increased sense of life-long learning beyond the present ABET directed outcomes. A second issue for ECE educators is recruiting students into our programs in the face of the negative publicity of out-sourcing, and the perceived undercutting of the value of an engineering degree in the US due to global competition. Is ECE in fact following the ways of the railroad industry of the 20th century or the steel industry of the 21st century? Overcoming such perceptions is a challenging task at present. Another challenge is retraining engineering professionals in fields that have suffered from excessive out-sourcing. Addressing this challenge will require a new emphasis on continuing education in providing opportunities for engineers at all career levels to refresh and change the direction of their evolving careers.

In his plenary remarks, Dr. Wulf argued that in order to keep engineering jobs in the US, we have to make our graduates so valuable that relative salary cost differences are not a major discriminator. How can this be accomplished? One strategy is to instill in students the ability to work across hierarchical levels of design. Compartmentalized skills are the easiest to out-source, hence training students in the ability to work across many system levels will be valued. Coupled with this will be an increased focus on multidisciplinary skills. Engineers who are adaptable across several disciplines and can change in response to a rapidly changing work environment will be those most likely to succeed. In addition, it is still perceived that one of the main assets of the US engineering workforce is the basic sense of entrepreneurship and ingenuity arising from the entrepreneurial culture of the US. This ability should be one which educational programs seek to capitalize on and foster in molding engineers for the future.

Finally, the large percentages of engineering degrees granted abroad as a fraction of total numbers of degrees versus the US points to another trend which engineering programs in general should consider, that of the BS engineering degree as the 'liberal arts degree' of the 21st century. Engineering has traditionally prided itself on being a transition profession, with engineering students often praised as the first person in their family to attend a college or university. Indeed most engineering students believe they will practice engineering throughout their entire careers. However, it is becoming increasingly apparent that an undergraduate engineering education provides an excellent basis on which to build careers in medicine, law, or business. The majority of engineering degrees granted in countries such as China are not simply leading to increased employment of engineers, but as educational backgrounds leading to careers in public service, business, many other endeavors. The relatively large fraction of government officials with engineering credentials there versus the US points to a quite different cultural view of a scientific or engineering background, one that should perhaps be cultivated more in the US in preparing engineering students not just for careers in engineering, but in non-engineering professions as well. Hence there is arguably a case for developing the BS engineering degree into a more broad based educational experience, one allowing students to pursue careers across many fields, and ultimately making the MS degree the first professional degree.

Regardless of whether any or all of the above observations and recommendations remain relevant as the issue of globalization of the engineering profession is better understood, it is clear that the members of ECEDHA, as heads of ECE programs, have an important responsibility in adapting our programs to train engineers for careers in a global economy, and insuring that the US engineering degree remains a premier degree internationally.

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# Structured Learning Design For Engineers (SLeaD)

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## Abstract

In this paper we present a structured approach for an effective learning design suitable for educators in the engineering field. We promote structured practice (culture) for engineering instruction design, based on the popular learning paradigm (1).

The Structured Learning Design for engineers (SLeaD) assumes that instructors are responsible over developing and deploying specific procedures to provide an effective and productive learning experience for their students.

## The SLeaD

The Structured Learning Design (SLeaD) is based on recognized cognitive models of the human's learning process, as well as our own observation and experience in the field of engineering instruction. SLeaD provides 10-guidlines that optimize the process of learning design. The instructors' job is to guide, promote, and nurture students' learning, rather than dictate or dispense knowledge. In this model students learn benefiting from instructors guidance, leadership, and supervision. This is consistent with the new learning paradigm, and Johnson, Johnson & Smith (2) belief: " Learning is conceived of as something a learner does, not something that is done to the learner".

### 1- Adapt Problem-Solution Approach

Engineering is the field of Problem-Solving. Therefore, instruction design should emphasize the Problem-Solution approach (3). In this approach the application domain is analyzed; first, an in-depth requirement elicitation for a desired solution is collected, second, abstract models for the problem are developed from this requirement, and thirdly, an engineering solution is proposed. Problem centered instructions are more tangible and comprehensible for learners than content-oriented ones (4)

### 2- Emphasize Learners Needs and Wants

When learners develop interest and appreciation for new knowledge, they exert more effort and learn it faster (3). We stress here the importance of clarifying the purpose of learning a specific knowledge. Merril Dargues in his Component Display theory (5) stated that learners should be indulged in experimentation, and active participation which should accommodate their needs and wants. However, educators need to make sure that a connection (or at least an appreciation) exists between the instructors' objectives and the learners' needs and wants.

### 3- Apply Modeling Techniques

An essential step in understanding and conquering an engineering problem is to reduce it to its simple elements by extracting all distracting details and exposing its major components; this is done by applying modeling techniques of abstraction.

Instruction design can benefit from modeling by abstracting the problem and providing clear simple concepts prior to indulging learners with details.

The Minimalist Theory (6,7,8,9) encourages instruction to avoid details, which may be of no interest to learners, especially for initial knowledge assertion.

### 4- Adapt Instructions to Learners' Experience

The Minimalist Theory states that Learner's experience must be an important factor in instruction design (6). Instruction design should realize the experience, knowledge and competence level of learners. The "functional context" learning approach (10, 11) stresses the importance of making learning relevant to the experience of learners. The learning of new information is facilitated by connecting it to knowledge already possessed and transforming old knowledge into new accumulated knowledge.

### 5- Use Patterned Assertion

When a student (learner) is presented with new basic knowledge for the first time, it is called knowledge assertion. When this process of assertion is presented in terms of simple Algo-Heuristic or symbolic forms, we call it patterned assertion.

The "Algo-Heuristic" theory (12) argues that all cognitive activities can be analyzed into operations of an algorithmic, semi-algorithmic, heuristic or semi-heuristic nature.

### 6- Encourage Collaborative and Creative Learning

Learning for engineers is by nature interactive, because it employs collaborative interdisciplinary activities, and it's creative because it requires critical thinking. Faculty members who promote interaction among students in and out of class are rewarded with improved student learning and achievement. Instruction design should encourage learner-directed activities, which means more initiatives and participation from learners (2). The "Situated Learning" theory (7) emphasizes social interaction and collaboration of talents. Collaborative effort is a culture that needs to be promoted.

### 7- Provide a State-of-Art Exposure

Engineering instructors would face a daily update of knowledge or risk being obsolete, and irrelevant. Texts, Labs, data, and even theories are subject to changes without notice. Therefore, engineering instruction design is a dynamic process. In the age of the internet, and information explosion, instruction design should provide tools for reaching out and collaboration with industry researchers.

### 8- Use Effective Learning Tools

Many higher learning institutes are deploying a cutting edge technology to enhance the learning experience. However, there is always a need to integrate these advanced tools into the instruction design. From a functional point of view, Learning Tools can be divided into two categories; instruction illustration tools, and experiential tools:

#### *Instructional Illustration Tools*

Any technology that is designed to enhance knowledge exposure, presentation and demonstration is called instructional tools. Web-support, networking, illustration software, animation, and multimedia are all tools deployed today to support the learning process.

### *Experiential Tools*

Any technology that is designed to enhance research tools, labs control, interactive learning, and evaluation is called experiential tools. This includes simulation, emulation, and web-enabled control systems.

## 9- Incorporate Original Research For Learning

Research has been always an integral part of learning. Research objectives can be grouped into three categories; investigative, problem-solving, and development research.

## 10- Develop effective Evaluation Procedures

No learning experience is complete without an effective evaluation process. This evaluation must satisfy several objectives, such as proper learning assessment, and feedback adjustment. A major benefit of evaluation, besides assessment, is that, it provides motivation. Keller (14) identified four categories of motivating factors in his ARCS model: attention, relevance, confidence, and satisfaction. These goals guide the evaluation/feedback process. In the ARCS model, the instructor achieves attention, and relevance based on evaluation design, this provides confidence and satisfaction for their learners.

## Conclusion

In this paper we presented our Structured Learning Design for Engineers (SLeaD) by presenting its 10-guidelines for this instruction design. Learning experience and its instruction design for engineers are unique due to the fast pace of changes in technology and the very nature of the engineering discipline.

Under the new Learning Paradigm, producing more with less becomes possible because the more that is being produced is learning and not hours of instruction. The instructor's main duty is to optimize the learning experience, guide, inspire, coach, and make learning productive by deploying structured methods (processes) and tools to enrich the learning experience.

Effective instruction based on SLeaD should improve learning and empower students with strong learning skills and techniques suitable for engineers.

We presented 10-guidelines for developing learning instructions and indicated how relevant these guidelines are to the learning paradigm and to engineering disciplines.

A major performance evaluation criterion for higher learning institutes should be the level of learning competence of graduating students; that is their learnability and capacity to learn efficiently and be trained through their professional career development.

The instructors' duties first are towards their students: to improve their learning quality and pace, while guiding their quest for new knowledge.

By investing in and supporting a productive learning environment, that is structured and engineering-conscious, we can graduate students equipped with knowledge and sharp skills to conquer future knowledge and achieve excellence in their professional engineering development.

## References


1 Barr, Robert B. and Tagg, John. "From Teaching to Learning—A New Paradigm for Undergraduate Education." [The original Tagg & Barr paper article appeared as: Barr, R. & Tagg, J. (1995). A new paradigm for undergraduate education. Change, November/December, 13-25.

2 Johnson, D., R. Johnson, and K. Smith, 1991, Active Learning: Cooperation in the College Classroom, Interaction, Edina, MN.

3 Experiential Learning, Rogers, C. R. & Freiberg, H. J. (1994), Freedom to Learn (3rd edition), Columbus, OH: Merrill/Macmillan.

4 Knowles, M. (1984) The Adult Learner: A Neglected Species (3rd ed.). Houston, TX: Gulf Publishing.

5 Merrill, M. D. (1983). Component Display Theory. In C. Reigeluth (ed.) Instructional Design Theories and Models. Hillsdale, NJ: Erlbaum Associates.

6 Van der Meij, H. & Carroll, J. M. (1995), Principles and heuristics for designing minimalist instruction. Technical Communications, 42(2), 243-261.

7 Lave, J., & Wenger, E. (1990). Situated Learning: Legitimate Peripheral Participation. Cambridge, UK: Cambridge University Press.

8 Gagne, R., Briggs, L. & Wager, W. (1992). Principles of Instructional Design (4th Ed.). Fort Worth, TX: HBJ College Publishers.

9 Gagne, R. (1985). The Conditions of Learning (4th ed.). New York: Holt, Rinehart & Winston .

10 Sticht, T. (1988). Adult literacy education. Review of Research in Education, Volume 15. Washington, DC: American Education Research Association.

11 Carroll, J.M. (1990). The Nurnberg Funnel. Cambridge, MA: MIT Press.

12 Landa, L. (1976). Instructional Regulation and Control: Cybernetics, Algorithmization, and Heuristics in Education. Englewood Cliffs, NJ: Educational Technology Publications.

13 Johnson, D., R. Johnson, and K. Smith, 1991, Active Learning: Cooperation in the College Classroom, Interaction, Edina, MN.

14 ller, J. M. (1983). Motivational design of instruction. In C.M. Reigeluth (Ed.), Instructional-Design Theories and Models. Hillsdale, NJ: Erlbaum.

# Prekindergarten- High School (PK-12) Education and the Information Explosion

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*Chair, Education Committee*
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With the rapid advances in information technology, more and more information is becoming available on the internet, all the way from peer reviewed to unreliable information. At times the magnitude of the information can overload our mental ability to absorb information, resulting in what seems to be an information explosion. Thus the need for developing new methods to deal with this information explosion suggests itself. The purpose of this paper is to propose new methods that are pertinent to the development of a PK-12 program. Particular attention will be given to the fields of mathematics, science and engineering. Preceding the discussion of curricula, the challenge on how to deal with the information explosion will be considered.

## A. Information Control

### *1. Linking Multidisciplinary Topics*

One way to control the information explosion is to develop a search engine that uses a data base of keywords in different disciplines, links identical keywords and then validates these multidisciplinary keywords. An example of a multidisciplinary keyword is *boundary layer*. The proposed search engine would determine that the keyword boundary layer exists around the earth, a geophysical concept, as well as around the human skin, a physiological concept, and that it is used in other disciplines, such as fluid dynamics and solid state physics. Unfortunately, available library search techniques are unidisciplinary and thus not capable of making multidisciplinary searches. These search techniques are needed to, in a sense, compress information and thus markedly enhance the accessibility to information. Although such linkages are used for website searches, peer reviewed information is not routinely available.

Linking of keywords can be thought of as transcending concepts linking multidisciplinary topics. Thus, the keyword *boundary layer* is a transcending concept that links multidisciplinary topics. One way of structuring multidisciplinary information is using a linkage matrix formulation with the column headings in the vertical direction the transcending concepts, namely validated keywords, and the row headings in the horizontal direction the linked disciplines. Each matrix element refers to the specifics of each discipline such as *earth* in geophysics or *skin* in physiology. In a sense we are talking about a multidisciplinary thesaurus. Of course like a dictionary, a multidisciplinary thesaurus would have to be updated regularly.

### *2. Evaluation of Website Information*

Critical thinking, already taught in PK-12 education, needs to be rigorously applied not only to publications, but also to the website. This means that students must be taught to routinely ask themselves whether website information is peer reviewed and if not whether this information is worthwhile. With an information explosion surrounding us, critical thinking is as important in our website age as it was in the Renaissance age. With more and more Internet information becoming available, the need to teach critical thinking will most likely increase in importance during our century.

## B. K-12 Education

### *1. Early Childhood Education*

Referring to the introduction of mathematics, science and engineering in early childhood education, it needs to be stated that young children are not ready yet to acquire a basic understanding of these three fields. Instead, teaching awareness of these fields by participating in fun experiments and games suggests itself. Their sense of curiosity and their interest in making things plays an important role in the success of these activities.

To make young children aware of how mathematics and science are linked, select for example a container with specific dimensions, a mathematical concept, and fill it up with cold water and ice cubes. Then heat the container until all the ice cubes disappear, illustrating what science is all about. Mention that the heater used is a human-made product, designed by engineers. To link mathematics and engineering, have the young children use for example a certain number, a mathematical concept, of Ego blocks to build a bridge, illustrating what engineering is all about.

To reinforce the practical awareness of mathematics, science and engineering, the development of a single literacy standard linking these three fields in a fun way might be desirable. Developing this awareness in early childhood will greatly facilitate the learning process in these three fields in later classes.

### *2. Linking Mathematics, Science and Engineering*

With the many recent technological advances in our century, mathematics, science and engineering are often linked through transcending concepts. Sometimes scientific breakthroughs cause engineering inventions, such as in the case of the DNA discovery resulting in DNA technology and sometimes engineering breakthroughs cause scientific discoveries, such as in the case of rocket technology resulting in space exploration. This linkage needs to be strengthened in the general K-12 educational program by introducing an engineering curriculum requirement.

Only one state, namely Massachusetts last year, has recognized the importance of introducing an engineering requirement in its general K-12 education program. It needs to be mentioned here that due to the close links between science and engineering, some students learn more readily engineering because of their affinity with science and that other students learn science more readily because of their affinity with engineering, thus increasing the number of students that become competent in both science and engineering. For students who have a better affinity with engineering because of their ability in early childhood to make things, this way of learning science might be particularly beneficial to some students of a lower socioeconomic background, including some students from underrepresented population groups.

## C. A Pilot Study

Ideally speaking the proposed search engine could easily determine the various linkages between mathematics, science and engineering. A less effective approach is to establish these links of the pertinent curricula by visual inspection. This was done on a pilot basis by linking K-12 literacy standards in mathematics, science and technology using the linkage matrix formulation. This matrix has the row headings of mathematics, science and engineering and it has the column headings, analysis, understanding and development. Thus for example the elements for the transcending concepts analysis are problem, environment and need for mathematics, science and engineering respectively. Of course linkage matrices can also be developed within the topics of each of these three fields.

### D. Curriculum Integration

Before discussing curriculum integration, it needs to be mentioned that some multidisciplinary topics cannot be linked through transcending concepts. The proposed search engine would determine the number of unrelated keywords that need to be considered separately. There are two ways of integrating K-12 curricula. One is horizontal and the other is vertical integration. The horizontal integration deals with curriculum topics taught in each of the K-12 class levels. The vertical integration deals with various topics, one at a time, taught throughout K-12. In either case, course glossaries might be useful for initiating a computer search.

As to the vertical integration of the K-12 program, reference needs to be made to the AAAS (American Association for the Advancement of Science) *Atlas of Science Literacy.* The atlas for various topics of the K-12 science curriculum uses a matrix formulation with the rows being the concepts transcending each topic and the columns being the K-12 time span. The elements of each topic matrix are frequently linked by arrows, making this matrix formulation a rather complex mapping presentation, At this time an atlas of engineering literacy is not available.

Using the proposed search engine with the linkage matrices might reduce the complexity of the various maps of the AAAS atlas due to the presence of its many linkage arrows. For purposes of analysis of the data, it might be worthwhile to use the linkage matrix formulation with keywords at different hierarchal levels. Of course, only experimenting with the data of keywords can give an answer as to whether indeed this hierarchal analysis is meaningful. A spinoff of the proposed search engine programs might be that they facilitate looking at the advantages and disadvantages of curricula and furthermore they might suggest novel approaches which might have been missed otherwise.

### E. Final Comments

PK-12 education is confronted with a new challenge in the 21st century, namely how to modify our PK-12 program to control the impact of the information explosion on the learning process of our children. It seems to me that there are three aspects to this challenge. The first aspect is to modify early childhood education by teaching our kids an awareness of fundamental topics, such as mathematics, science and engineering. The second aspect is to emphasize the teaching of critical thinking to develop the ability in all students to differentiate between useful and worthless website information. The third aspect entails casting off our tradition of unilateral specialization and replacing it by a PK-12 multidisciplinary educational process, based on the proposed use of a search engine program that links disciplines.

# CALL FOR PAPERS — 2005 ASEE ANNUAL MEETING

## Electrical and Computer Engineering Division

The Electrical and Computer Engineering Division seeks abstracts for papers to be presented at the *2005 ASEE Annual Conference* to be held in *Portland, Oregon USA*.

Topics of particular interest include: Curricular and design innovations, laboratory development and innovation, asynchronous and Web-based teaching and learning techniques, undergraduate research, assessment of teaching and learning, novel methods for implementing ABET Engineering Criteria 2000, globalization of engineering education, entrepreneurship in ECE programs, trends in computer engineering and electrical engineering education, *and pedagogical issues arising from the emergence of new areas such as* bioengineering and life sciences, information engineering/technology, wireless and broadband communications, optoelectronics and nanotechnology. Other topics of general interest in electrical and computer engineering education/research will also be considered.

Abstracts of 200-300 words must be submitted electronically through the ASEE CAPS system. Authors of accepted abstracts will have the opportunity to submit a full paper, which will be peer-reviewed for possible inclusion in the conference proceedings. Papers must be submitted and accepted for presentation in order to be presented at the conference. Proposals for special paper sessions or panel discussions should be submitted to **Satinderpaul Singh Devgan, ASEE ECE Division at sdevgan@tnstate.edu**. Individuals interested in organizing/moderating a session or participating in the peer-review process should contact the above for more information.

Papers are being accepted for the following sessions sponsored by the ECE Division of ASEE.

- Undergraduate Research and New Directions (Session #1332)
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- ECE Capstone and Engineering Practice (Session # 3232)
- ECE Laboratory Development & Innovations (Session # 3432)
- Pre-College and ECE Education (Session # 3532)
- ECE Education and Engineering Mathematics (Session # 3632)

# IEEE Education Society Nominating Committee Requests Recommendations and Petitions

According to the Constitution and Bylaws of the *IEEE Education Society* (*http://www.ewh.ieee.org/soc/es/constitution.html*), the election of officers for one-year terms and the election of members-at-large of the Administrative Committee for 3 year terms beginning in January 2005 will occur at the fall meeting of the Administrative Committee during the Frontiers in Education Conference in Savannah, GA (*http://www.fie-conference.org/04/*).

The terms of all officers and four members of the Administrative Committee end on December 31, 2004. According to the Constitution and Bylaws, those people with a "*" following their names in the list below are ***ineligible*** for renomination to serve in that particular position.

**Officers:**
President, David V. Kerns, Jr.*
Vice President, Daniel Litynski*
Secretary, Joseph L. A. Hughes*
Treasurer, Rodney J. Soukup*

**Members-at-large of the Administrative Committee:**
Susan Burkett
Jeff Froyd
Susan Lord
Claudio da Rocha Brito

The current President, Vice President, and Secretary are each serving second one-year terms and hence are ineligible to serve an additional term. The current Treasurer is serving his sixth one-year term, the limit specified in the Bylaws.

By tradition (not a part of the Bylaws), the *Nominating Committee* offers nomination as a candidate for President to a person who is serving a second one-year term as Vice President. By similar tradition, the Nominating Committee offers nomination as a candidate for Vice President to a person who is serving a second one-year term as Secretary. Again by tradition, the Nominating Committee offers nomination as a candidate for a second consecutive three-year term as a member-at-large of the Administrative Committee to any current member-at-large who is serving in the last year of their first consecutive term.

The Nominating Committee welcomes both recommendations and petitions for nomination (25 signatures guarantees nomination according to the Bylaws) for any of the Society offices and for members-at-large of the Administrative Committee. According to the Bylaws, recommendations and petitions are to be submitted to the Nominating Committee by September 15th. Earlier would be nice.

**Please send me questions, suggestions, and petitions.**

*Marion Hagler, Chair (Junior Past President)*
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# From Your Editor

*Bill Sayle*
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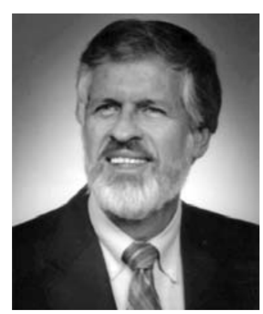
Electrical and computer engineering has always been known as the fast-changing field of engineering. Some of our colleagues in other fields of engineering are often envious of how rapidly things do change in our fields.

Of course, these envious colleagues are sometimes reminded of how easy it is for them to learn evolutionary changes in processes and technology occurring in their "more mature" fields. Most of the changes in their fields are brought on by our technology improvements, for example, better computational and communication technologies. With our technological innovations and the resulting business ventures, we in ECE are also more susceptible to the "downs" as well as the "ups" in our field.

In this issue of *The Interface*, you have read, I hope, all of the articles. The article by **Stephen Goodnick** and **Ken Jenkins** on the effects of global developments on the USA engineering scene remind us of how engineering is the big enabler of development, worldwide. The impact of globalization on engineering education in the USA will be great and engineering programs would be well-advised to read this article carefully and consider some of the proposed changes. In his article, **Jim Tien** speaks of the academic scholar and broadens this concept to the education of undergraduate students.



The two organizations that sponsor *The Interface*, the ECE Division of the ASEE and the Education Society of the IEEE, each hold an important conference annually in the field of engineering education. The ASEE *Annual Conference*, held each June, and the IEEE/ASEE *Frontiers in Education* Conference, held in October or November of each year provide excellent opportunities for persons involved in engineering education to get together and share stories about "what worked" and "what did not work". They also give everyone a chance to meet each other in an informal setting. The next *FIE Conference* will occur **20-23 October** of this year in **Savannah, Georgia, USA**. If you have not been to Savannah, or even if you have been to Savannah, this would be an excellent time to take advantage of the opportunity to meet your colleagues in a relaxing environment. General Chair **Joseph Hughes** and his team of program chairs have planned an excellent conference with just the right amount of balance between technical sessions and informal social events. I urge you to attend if at all possible. For further information, please consult www.fie-conference.org (Yes, this was a commercial.)

I hope everyone is enjoying a productive and pleasant summer (northern hemisphere) or winter (southern hemisphere).

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