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From the President of the IEEE Education Society

THE TIMES THEY ARE A'CHANGING

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The words of **Bob Dylan**, “the times they are a’changing”, seem particularly relevant now. Why? I’m now sitting in my hotel room in Beijing, China, just after a session at the 3rd ASEE *International Colloquium on Engineering Education*. Educators from all over the world are here discussing, debating and deliberating a range of topics on reform in engineering education.

Much of the discussion on these topics follows, refines and further develops important, but familiar issues such as those at recent Frontiers in Education (FIE) Conferences and ASEE *Annual Meetings*. What appears significantly different is the expanding cast of players and their clear commitment to excellence and reform in engineering education. While some individuals from outside (and inside) the USA have been active leaders for such reform, (many friends and colleagues for years), the commitment of numerous and diverse governments and large foreign institutions to the major restructuring of their engineering education is relatively new. As I am now in China, first consider with me China as an example.

China graduates more engineers than any other country in the world. China currently has 3.7 million engineering students and now graduates almost 700,000 engineers per year, up over 100% in the last three years. This is about 10 times the number of engineering graduates the USA produces; the USA is fourth in engineering graduate production, also behind India and Japan. The prestigious Tsinghua University in Beijing, similar to other top schools in China has approximately a third of its students majoring in engineering. In Chinese culture, engineers are highly respected, and many top leaders in government and industry have engineering backgrounds.

It’s no secret that China has emphasized manufacturing

within all engineering disciplines and has emerged in recent years as a world leader in the manufacture of almost every product, from simple consumer products to complex mechanical and electronic systems. Many products marketed under brands familiar in the USA are actually made in China.

No matter what you may think about “outsourcing” of engineering jobs from the USA, it’s clear that many engineering jobs related to the production of products are now being performed in China, and in other countries, where the cost of production is dramatically lower. I’ve heard some say that countries now becoming world leaders in product production still rely on the USA and other western countries for creative design of products. Is there any reason to believe that if this is true, that it will last forever?

I found it most interesting that the papers presented by Chinese authors and discussions I had with Chinese faculty showed a strong interest in the same issues of engineering curriculum reform that we are discussing and implementing in the USA and in other western countries. The Chinese presentations suggest that they are well on the way to reforming the old Soviet style education, and have begun introducing early in their curriculum project-based courses with specific instruction in teaming, in creativity, innovation and design. Intel recently announced it is moving almost 1000 integrated circuit design jobs to China.

There are certainly other examples. India, which graduates over a quarter of a million engineers a year, conducts courses to teach English speaking students how to speak “American English” and call centers and customer service operations for many high-technology companies are moving there. Software engineering is now routinely performed by engineers in India,

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a trend that has been growing dramatically in recent years.

There has been active work in Europe and elsewhere to construct common engineering degree structures that would allow engineering students and graduates to move more freely around the globe. The Bologna convention, the Washington accord, and expanding interest in ABET’s “substantial equivalency” status support these developments.

So, what’s my point?

Engineering is truly global, and that fact has implications in engineering curriculum design that cannot be ignored. I don’t write to give answers to the issues posed here, but to put a point to the questions. And it’s not about the USA losing jobs and others gaining; jobs from China may move to India (or vice-versa), if the job can be performed there with better quality at lower cost.

As each of us considers, in our own countries, how we can reform our curricula we should consider carefully what it is that we can provide our graduates that give them knowledge and skills that can compete in the world market of engineering.

I think we may go a long way in this, just by making our students aware of this world dynamic. If students know they will be competing and teaming with engineers from other countries and other cultures, they will automatically become more interested in learning other languages, studying and appreciating other cultures and understanding the way peo-

ples from other cultures think, work, and live.

This cross-cultural interaction will certainly help in invigorating our profession with new energy and ideas, and strengthen the mutual understanding between citizens of different countries. I suggest that curricula should be designed to make it possible for engineering students to spend a semester studying abroad (at the junior or senior year). This is common in the liberal arts, and almost impossible for most engineering students. Consider strengthening exchange programs, so that visiting faculty and students from other cultures are richly represented in our programs. Engineering advising should include clear articulation of the benefits of foreign languages and of courses outside of technical areas that promote understanding of other cultures.

Although this has now reached the level of a cliché, we do live in a global society. Engineering education of the 21st century must sustain our students in a world that’s a’changing. The old way just won’t meet the needs of the next generations of students.

Engineers of the future must be citizens of the world, and our new engineering curricula must support them in this new world.

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RAISING PUBLIC AWARENESS

James M. Tien
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In 2003, the IEEE Educational Activities Board (EAB) created a new standing committee – the Public Awareness Committee (PAC). For the first time ever, a major board of IEEE took on the responsibility of addressing an issue that has been plaguing the engineering profession in many places around the world and for many years—understanding and appreciating what engineers do. This responsibility is explicitly identified in the IEEE Constitution, which states that the IEEE “shall endeavor to promote understanding of the influence of such technology on the public welfare”. While the IEEE-USA has worked with the American Association of Engineering Societies (AAES) at the national level, there has never before been a coordinated effort to globally address the issue.

Within the U. S., the National Academy of Engineering (NAE) took on this issue in 2001 by conducting an extensive survey of engineering societies, industry, universities, foundations, government agencies, museums, media and national laboratories. The survey revealed that many, if not all, of these entities are concerned about the image of engineering and engineers and had established some level of outreach to address their concerns. Many of these outreach programs are aimed at the pre-college education community. Indeed, the EAB has a Pre-College Education Coordinating Committee (PECC) that has been working diligently to enhance the level of technological literacy of pre-college students and teachers worldwide since 1999. However, awareness is not only a pre-college issue. It is a multi-faceted and global issue.

The entire engineering community should be concerned that the public does not understand the contributions that engineers make to the world economy and to everyone’s quality of life; that government leaders in most countries don’t understand technology and engineering any more than the average citizen, yet they are making decisions every day that impact public welfare and safety; and that the lack of public understanding and appreciation are undermining the attractiveness of the engineering profession for many young people. In short, and as **William A. Wulf**, U. S. NAE President states, “We have a society profoundly dependent upon technology, profoundly dependent on engineers who produce technology and profoundly ignorant of technology.”

Industry should also be concerned, especially with the quality, quantity and diversity of the engineering pipeline. Industry has a great deal at stake when it comes to promoting engineering as a respected and rewarding profession worldwide. Many of the most powerful, international companies depend on engineers, not only for product design, development and production, but also for basic operational and infrastructure support. Without quality engineers manning

network systems, factory floors and information technology teams, these monoliths would crumble in no time. They should be very interested in partnering with associations, universities and pre-college educators to inform the public on what engineers do and how their critical discoveries and innovations are contributing to the advancement of society.

Some say that engineering has suffered from an “image problem” because of its identification with the 19th century industrial revolution that led people to link engineering with engines as in “locomotive engineers.” In the 20th century, engineers were considered “geeks”, thus promoting the image of being very intelligent but divorced from reality and not worldly. All too often the work engineers do is confused with science, a matter not easily clarified given the overlap of scientific breakthroughs and engineering innovations. In fact it is a cliché that scientists are credited with technological successes and engineers are blamed for their failures. Look at the Hubble Telescope incident. From the very outset, astronomers and scientists were credited with its successful deployment, and engineers were blamed for miscalculations in the design of its mirrors.

In 1998, AAES commissioned a survey on public awareness of engineering to be conducted by Harris Interactive, Inc. This poll was repeated in both 2000 and 2002. The results indicated that engineering generally ranks below professions like law, police work, and the ministry. Moreover, the Harris polls suggest that while the general public is confused, if not ignorant, about the contributions of engineers versus those of scientists, they nevertheless consider engineers to be less prestigious than scientists.

The EAB PAC is focusing on gaining a fuller understanding of the issue and identifying how they can address these image and perception problems at a global level. According to Joel Snyder, past president of IEEE and current PAC chair, the overall goal of PAC is “to enhance the perceived status of engineers and the engineering profession globally and to educate the general public about how technology influences our daily lives and the role that engineers play in creating that technology.”

To start with, PAC is proposing a global survey of IEEE members, similar to the U. S. polls conducted by Harris Interactive, Inc., to answer a number of critical questions. While it is understood that many cultures highly value engineers while others, like the U.S., are less appreciative, it is not clear to what extent this is true and, most importantly, what are the cultural influences that determine this difference? Do people in India truly understand more about what engineers do than people in the England? Why is it that in Turkey as many stu-

dents want to become engineers as doctors or lawyers? Why is the ratio of engineers to lawyers much higher in countries like China and Japan than in the U. S.? More importantly, what can be done to raise the public's awareness and appreciation for engineers and engineering

PAC will also try to understand some widely-held perceptions. For example, it is generally accepted that in China engineering is a highly respected profession. Yet, in an article in the NAE publication, *The Bridge*, **Zhu Guangya** the president of the Chinese Academy of Engineering from 1994-1998, states that "the important role of the engineer in society is yet to be adequately recognized. If this situation doesn't improve, we will have difficulty encouraging promising people to consider engineering as a career."

More recently, in a press release on 17 September, 2003, IEE (Institute of Electrical Engineers) President, Professor **Mike Sterling** wrote that "in many developing countries, the popularity of engineering as a career is under pressure and employers in some fields are reporting serious difficulties in recruiting appropriately qualified staff. In the Asia Pacific region, however, expansion is still strong and growing even stronger." What are the factors that make engineering a valued profession in China? Is it just economic drivers and the growth of capitalism, or is there something deep in the Chinese culture that was tapped into?

We know that in many countries settled by the British Empire, engineers evolved from technician status and yet their image did not improve. In western European countries

such as Italy, Germany, and France, engineers were held in high esteem and endowed with titles preceding their names much like we address doctors. But as the 21st century unfolds, this seems to be changing. At an IEEE Region 8 committee meeting in late 2003, the agenda called for Region 8 to focus on "Improving the Engineering Professional Image to the Public." Meeting chair, **Dr. Kurt Richter**, professor emeritus, Technical University of Graz, Austria warns that IEEE volunteers from Europe "report that fewer and fewer high quality students are entering engineering programs. They, like their American counterparts, are seeking MBAs or MD degrees."

What is causing this shift? What role can PAC – in partnership with other professional and educational organizations and engineering-oriented corporations – play in this and in other global reports about the image of engineering and the awareness of what engineers do? Now that we have a committee in place to speak to these issues, we have an opportunity to study the situation, develop an action plan and finally to look for strategic alliances among all the stakeholders. PAC plans to work with industry and potentially other engineering societies that are interested in raising the level of awareness and esteem. A global "engineering-aware public" will succeed in encouraging, supporting and rewarding the bright young people who seek careers in engineering.

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From the IEEE Committee on Technology Accreditation Activities

THE ENGINEERING TEAM

(Adopted by the Engineering Liaison Committee, March 24, 1995, State of California)

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In today's modern industry, a number of players are involved in developing new products, forming what is commonly known as the "**engineering team.**" These team players are **engineering scientists, engineers, engineering technologists, engineering technicians, and vocational technicians.**

Since engineering technologists and engineering technicians are relatively new on the team, some discussion regarding the field of "engineering technology" is needed.

Engineering technology (ET) education emphasizes problem solving, laboratories, and technical skills; it prepares individuals for application-oriented careers in industry, typically in manufacturing, field-service, marketing, technical sales, or as technical members of the engineering team.

According to a national accrediting agency (TAC/ABET), graduates of baccalaureate-level engineering technology (BET) programs are called "engineering technologists," and graduates of associate degree (AS) programs in engineering

technology are called "engineering technicians."

The upper-division coursework of BET programs is designed to provide additional analytical and problem solving beyond those learned at the two-year level. Most BET programs are accredited by TAC/ABET, and are designed to accept appropriate coursework in math, science, and a technical specialization completed at approved associate-degree programs. With careful planning students may transfer with maximum efficiency.

The definitions described herein are intended to conform with ABET criteria for engineering and engineering technology.

DEFINITIONS

Engineering scientists

- are the most theoretical of the team members.
- They typically seek ways to apply new discoveries to

advance technology for mankind.

- Most engineering scientists have an earned doctorate in engineering.

Engineers

- use the knowledge of mathematics and natural sciences gained by study, experience, and practice, applied with judgment, to develop ways to economically utilize the materials and forces of nature for the benefit of mankind.
- Engineering involves a wide spectrum of activities extending from the conception, design, development and formulation of new systems and products through the implementation, production and operation of engineering systems.
- Engineers often work closely with engineering scientists in developing new technology via research projects.
- A minimum of four years of study is required to become an engineer. Mathematics and science are emphasized.
- Most baccalaureate-level engineering programs are accredited by EAC/ABET.

Engineering technologists

- are graduates of bachelor-level programs in engineering technology.
- They apply engineering and scientific knowledge combined with technical skills to support engineering activities.
- Their areas of interest and education are typically application oriented, while being somewhat less theoretical and mathematically oriented than their engineering counterparts.
- They typically concentrate their activities on applied design, using current engineering practice.
- Technologists play key roles on the engineering team; they are typically involved in product development, manufacturing, product assurance, sales, and program management.
- TAC/ABET specifies that faculty who teach in these programs have a minimum of a master's degree in engineering or engineering technology or equivalent, or a PE license and a master's degree.*

Engineering technicians

- work with equipment, primarily assembling and testing component parts of devices or systems that have been designed by others; usually under direct supervision of an engineer or engineering technologist.
- Their preferences are given to assembly, repair, or to making improvements to technical equipment by learning its characteristics, rather than by studying the scientific or engineering basis for its original design.
- They may carry out standard calculations, serve as technical sales people, make estimates of cost, assist in preparing service manuals, or perform design-drafting activities. As a group, they are important problem solving individuals whose interests are directed more to the practical than to the theoretical aspect of a project.
- They are frequently employed in laboratories and/or manufacturing facilities where they may set up experiments, accumulate scientific or engineering data, and/or service

or repair engineering or production equipment.

- Two years of college-level work leading to an associate degree, typically taken at community colleges or certain technical institutes, is required to become an engineering technician.
- TAC/ABET specifies that faculty who teach in these programs have a minimum of a master's degree in engineering or engineering technology or equivalent, or a PE license.*

Vocational Technicians

- Programs of study are also available for individuals who wish to obtain skill-training in a field of specialization with less emphasis on scientific or mathematical principles.
- An individual completing such a program is typically called a "vocational" technician, e.g., air-conditioning technician, draftsman, surveyor aide, etc.
- Faculty who teach these programs are usually craftsmen or specialists in their field, and/or graduates of professional education programs.
- Graduates of vocational technician training programs may be accepted into a two-year or four-year degree program after considerable math, science, and other requirements are satisfied.

***Note:** Technical support skill courses, such as drafting, machine shop or electronic assembly, may be taught by faculty having at least a bachelor's degree in an appropriate science or engineering-related field. They are expected to be artisans or masters of their crafts.

[BET Subcommittee of the ELC, March 23, 1995]

LYLE MCCURDY

Dr. McCurdy earned his BS and MS degrees in Engineering Technology (Electronics emphasis) from Arizona State University in 1971 and 1973 respectively, and earned his Ph.D. in Technical Education from Texas A&M University in 1986. He has recently retired from full-time teaching in Electronics and Computer Engineering Technology at Cal Poly Pomona with over thirty years in the teaching field. and is active in numerous IEEE functions. He is past chair of the IEEE Foothill Section, and currently serving as treasurer of the IEEE Los Angeles Council. He is also a board member of the IEEE Committee on Technology Accreditation Activities (CTAA) committee where he serves as chair of the Criteria Subcommittee. The IEEE CTAA committee is responsible for recommending the program criteria (to TAC/ABET) and evaluating, selecting and assigning program evaluators for the following programs:

CET = Computer Engineering Technology
EET = Electrical-Electronic Engineering Technology
EMT = Electro-Mechanical Engineering Technology
IET = Information Engineering Technology
LET = Laser-optics Engineering Technology
TET = Telecommunications Engineering Technology

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From the Chair of the IEEE Committee on Engineering Accreditation Activities



A New Vision for ECE Education

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IEEE, through CEAA, has been invited to contribute a vision statement for electrical and computer engineering education, as an example of such statements for all of engineering. This invitation came from **Jim Bernard**, a member of the ABET Engineering Accreditation Commission and a member of the Advisory Committee to the NSF Engineering Directorate. Jim plans to take these examples to the next Advisory Committee meeting in November.

A review of committee agendas and presentations (at <http://www.eng.nsf.gov/engadvise/index.htm>) shows that the committee understands the importance of engineering education as well as of disciplinary research, and further that the committee views engineering education as currently being in a critical transition period. Susan Conry, member of CEAA and of the ABET Engineering Accreditation Commission (EAC), is chairing the group responding to this request and the first draft of her subcommittee's work appears here:

Electrical and Computer Engineering Education in the 21st Century

A Vision of the Future of ECE Education

"21st century engineers will need to be astute makers, trusted innovators, agents of change, master integrators, enterprise enablers, technology stewards, and knowledge handlers." [Bordogna, *IEEE Spectrum*, vol. 38, p. 17, Jan. 2001]

Education in electrical and computer engineering in the 21st century will foster the development of engineers who are prepared to fill the multiple roles society demands of them. The educational experiences of each student will be firmly grounded in the fundamental principles of our disciplines. These educational experiences will require students to develop problem-solving skills that make use of innovative thinking strategies and an awareness of the social and ethical implications of engineering solutions as well as their professional responsibilities. Application of these skills to the solution of realistic problems in a timely manner will be a hallmark of electrical and computer engineering education. Thus

electrical and computer engineering education in the 21st century will embrace pedagogy and principles that educate engineers who are comfortable with changing technology and have the ability to deploy new tools and technology in appropriate ways through a lifetime of professional activity.

We invite your comments and suggestions. Please email Susan at conry@clarkson.edu. In my experience, meaningful vision statements are quite challenging to write, and Susan has created an excellent draft. What makes a vision statement useful and meaningful? In thinking about this I did a small amount of web-based literature review, and came across a wealth of information, some of which appeared to be valid, and some of which simply demonstrated the pitfalls of believing what you read on the web. A useful vision statement should be brief, inspiring to those charged with achieving it, sufficiently specific that it can be translated into goals and actions, and potentially achievable. Classic examples are Dr. Martin Luther King's "I have a dream" speech and president Kennedy's statement that "By the end of the decade, we will land a man on the moon."

Implicitly, the old vision of ECE education was "to prepare students to be good engineering employees or good graduate students." Not very inspiring, I think we all will agree. Susan has made a great start on a new vision for ECE education. Now, can we add to the value of the statement without adding to the length? Remember that a vision statement does not have to define every aspect of the endeavor; rather it should paint a picture of what we all would be intensely proud of achieving.

Following is ABET's vision statement: "ABET will provide world leadership in assuring quality and in stimulating innovation in applied science, computing, engineering, and technology education." CEAA takes its role in this process seriously, and we want to hear from our constituents in ECE education regarding the following question: Are the ABET criteria and the overall accreditation process helping your program achieve its vision and goals? If so, please provide some examples of successes. And if not, please tell us why not. We certainly hope that most of the answers are positive, but in either case, we do need to hear from our constituents!

Email me at j.orr@ieee.org.

John A. Orr

Jerry Yeargan — 2004 IEEE Haraden Pratt Award



“For outstanding contributions to the Engineering Accreditation Activities of IEEE.”

Dr. **Jerry R. Yeargan**, widely known as a skillful and charismatic diplomat who excels at the art of creative compromise, has been recognized for his outstanding service to IEEE and ABET with the **2004 Haraden Pratt Award**.

Jerry played a seminal role in the merger of ABET and the Computer Science Accreditation Board (CSAB), enabling unprecedented synergy in the accreditation of computer science, computer engineering and software engineering programs.

An IEEE Fellow, Jerry has served as IEEE representative director on the ABET Board of Directors and as ABET President. He has served on the IEEE Board of Directors as vice president of Educational Activities, and as president of the IEEE Education Society. He is a fellow of the American Soci-

ety for Engineering Education and is a former chair of the ASEE Electrical Engineering Division. He has received many other honors, including the IEEE Educational Activities Board Meritorious Service Award, the IEEE Education Society Achievement Award, the Arkansas Academy of Electrical Engineers Award, the Haliburton Outstanding Faculty Award and the University of Arkansas College of Engineering Outstanding Service to Students Award.

In addition to his extensive ABET, ASEE, and IEEE service activities, Jerry is a Distinguished Professor and the Texas Instruments Chair of Mixed-Signal and Linear Microelectronics in Electrical Engineering at the University of Arkansas at Fayetteville, where he has taught since 1967.

Congratulations Jerry on a well-deserved major award!

TOWARDS AN EUROPEAN GLOBAL HIGHER EDUCATION AREA: ITS EFFECTS IN SPAIN

by the Board of the Spanish Chapter of the IEEE Education Society (Edmundo Tovar, Francisco Arcega, Francisco Jurado, Martin Llamas, Francisco Mur, Jose Angel Sanchez, and Manuel Castro)

A. Convergence at Higher Education: Bologna Initiative

After a successful economical union in the last decades, the next strategic challenge for the European Union (EU) has been Education. Since 1998, with a political decision made by European Education ministers at Bologna, a common policy was established in the field of Higher Education with the aim to have created and developed around 2010 a unique “European Higher Education Area” (EHEA). The Bologna Declaration focused on the promotion of several evolution lines that the national systems should try to reach in ten years. The ministers affirmed their intention to [1]:

- Adopt an easily readable and comparable system degree, through the implementation of the Diploma Supplement.
- Adopt a system essentially based on two homogeneous main cycles: undergraduate and graduate.
- Establish a widely used credit system adoption, such as the European Credit Transfer System (ECTS).
- Promote mobility by overcoming obstacles to the effective free movement of people.
- Promote European co-operation in quality assurance.
- Promote of the necessary European dimension.

This was the beginning of the also-called Bologna Process. Two years later, 33 European ministers met in Prague (2001) to set directions and priorities for the following years [1], to reaffirm their commitment to the previous objectives and to emphasize as important elements of the EHA the lifelong learning, the involvement of students and enhancing the attractiveness of this area to other parts of the world. When

ministers met again in Berlin (2003) they defined three intermediate priorities for the next two years: quality assurance, the two-cycle degree system and recognition of degrees and periods of studies. Ministers also considered it necessary to go beyond the present focus on two main cycles to include the doctoral level as the third cycle and to promote closer links between the EHEA and the European Research Area. The next milestone in this process will be in 2005.

B. Difficulties of implementation

All these convergence objectives collect the idea of “A Europe of Knowledge” expressed through the building of an EHEA. Dangers of non-convergence can appear under several forms, such as difficulty in mobility and the non-possibility of access to specific professional positions even with the required qualifications. All actors involved in higher education are beginning to interpret the Bologna process. For this reason a common policy, as in the principles established at Bologna, can avoid dangers that could come from the previous process. However, in practice the implementation of these principles will be addressed to conflictive situations or to more cases of non-acceptability [2].

Some of the goals seem to be contradictory since the Declaration aims to improve the convergence and harmonization of educational systems [3], and acknowledges, at the same time, divergent cultures and languages of member countries. This ambivalence can explain why there are many open issues related to the Bologna process. These changes can lead to a conflict with a politically imposed ideology, so important that we should

assure the acceptability conditions. In brief, we can summarize the basic parameters of survival for the traditional universities, as the following [4]: intellectual integrity, openness of access to higher education for all and disadvantaged groups, greater responsiveness to demands for more relevant courses and greater involvement of universities with the communities that surround them, continuity of employment and physical safety. Any event, by exceeding these parameters, would end in disastrous conflict, at least in a classical model of university.

To these basic parameters, we should add the effects produced by globalization, a consequence of the revolution in Information Technology, which can explain the new forms, explained previously, of Higher Education systems.

Another risk associated to the convergence is the reason why it is introduced. "Convergent change is planned by governments not simply because they feel an obligation to comply with the Bologna Declaration, but because there is a compelling need for them to move in that direction in their own interest..." What would be the price of not taking action now? For governments, if countries do not converge their reform, efforts could produce a division in Europe with negative consequences for non-convergent systems.

C. Implications in the Technical Education Superior in Spain

From Bologna, one should expect a series of national reforms, possibly taking inspiration from other countries with their systems in line with this convergence process. Spain is one example of national reforms along the year 2003 with a giddy avalanche of legislative norms and their correspondent drafts. They are oriented for a two-tier structure (bachelors-master), implantation of ECTS and Diploma Supplement, and all are combined with independent accreditation. Specific actions toward the implementation of Bologna' principles in each state have been controversial. Opinions from the directors of technical schools in Spain show a clear divorce with the opinions of politicians. The main argument is that Spanish engineers are not worse-trained than other European or American engineers. A declaration of the Engineering Board manifests more risks as how to proceed with the transition of current engineers to the new common European model, including the attribution of professional competencies.

D. Role of different actors in Spain

The implementation problems in Spain of the Bologna process, as in the rest of the European countries are very hard and conflictive, so all the support provided is very important. We have chosen to describe two of them: the roles of the national agency for quality and the professional associations for education.

1. The Spanish National Agency for Quality Assessment and Accreditation (ANECA)

The control mechanisms in the implementation of the Bologna process in Spain are in the charge of the ANECA. The Spanish National Agency for Quality Assurance and Accreditation (ANECA) is a State foundation created by the

Ministry of Education, Culture and Sports in implementation of article 32 of the Universities Law (Organic Law 6/2001, 21 December). As stated in article 31.3 of the Universities Law and in the Foundation Statutes, its purpose is to help to assess and publicize Higher Education performance and to reinforce transparency and comparability in the Spanish system.

For the first year of its operational existence ANECA has defined its structure, functions, competences and activities and has drawn up a Service Charter [7], which defines the characteristics and general terms of each of its programmes and sets forth the principles that guide it in implementing its activities and exercising its powers. Its actions are channelled through five general programs, Institutional Assessment Programme, Certification Program, Accreditation Program, Teaching Staff Assessment Program, and a specific European Convergence Program, intended to promote and facilitate the convergence of official university courses of study towards the European Higher Education Space [8]. To this end, it fosters the dissemination and awareness of the contents of the Bologna Declaration, the pilot experiments in the design and introduction of degrees structured in the manner defined at Bologna, and giving support for coordinated inter-university projects for establishment of the European Credit System. These objectives are pursued by means of institutional assessment reports, preliminary to certification and accreditation processes, and by initiatives to foster quality in university activities.

2. The Spanish Chapter of the IEEE Education Society

Authors of this paper constitute its Board. We think that the Spanish Chapter of the Education Society, created this year, has a very important mission because of the new education system based on the Bologna declaration helping teachers in these changes [8]. Our Chapter must help the staff with the educational material and with the abilities for developing the new educational system.

This idea can be achieved by having a good web directory of educational materials and with a good intercommunication of docent staff. It is fundamental to share ideas and resources. Not every person must do every thing, every design of lab practice or activity in the classroom.

Apart from a Dissemination Committee, the Spanish chapter of the IEEE-EdSoc is organized through two more Committees, Technical and Activities. Its objectives support the different actors involved in the Bologna process, as for example, identifying the existing procedures of accreditation in education within the areas of engineering for its correct implementation or sponsoring forums for educators to evaluate educational programs and approaches. As well, it is clear that our problem is similar to other European countries, so we need to share our solutions with other chapters of the IEEE Region 8.

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Vocational School Transformation May Force Engineering College Changes

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In 1979 the first modern plan for 3 years’ vocational school training of craftsmen was put into operation in Norway. As a result of the North Sea oil and gas activities, the training of “process operators” was the first program to be effectuated.

Contradictory to other vocational school programs, the form and content of this training scheme resembled that of technical education. The theoretical content, including mathematics, science and languages was presented as if the group of students were an engineering class. The students spent much time in laboratories and in the writing of reports.

In the 1980’s and 1990’s a series of training programs of similar form were launched, notably for electricians, numbering about 11 closely-related trades within high and low voltages, automation and electronic trades.

Recruitment of pedagogically trained teachers mainly at the Bachelor and Master levels was the obvious prerequisite for this transformation. Engineers, some holding trade certificates were teaching technical courses and supervising laboratory work. Similarly, university-educated teachers were responsible for teaching science and language courses.

Partly due to the efforts of industry’s confederations, talented and ambitious young people found the new vocational school attractive. As a result, the admission became highly competitive. Only those with the best Junior High School grades were admitted.

The first year of training took place at school, with teachers working in their traditional role. The second year the students had theory at school and practical training in industry, super-

vised by their teachers. The teacher role changed to become an organizer of learning with the full responsibility of student professional development. In the third year, the cooperating industry businesses took over all learning responsibility except grading reports etc., and the formal accreditation. Simultaneously, the teacher role changed once more: now into a responsible leader of learning processes. The teacher made contacts, discussed learning objectives with industry partners, and was responsible for student and program evaluation, etc.

It is important to underline, that from 1994 this scheme was imposed on all public schools by law. This law also reconfirmed the principle of equivalency between theoretical and practical secondary education – all offering three-year programs.

These changes have been carried through almost unnoticed by most engineering colleges, which in the meantime experienced student draught and a very low retention rate. However, one engineering school did notice the vocational school development and, in 1995, prepared a pilot project on direct admission from the new vocational school’s electrically-related departments. In partnership with industry confederations politicians, the Ministry, schools, and professors had to be convinced that this plan should be given a chance. Thus, after seven years of work the first “vocational students” were admitted to a pilot class, following a moderately modified plan of study, fall semester, 2002. The pilot program will last through five years. The outcome of the program is expected to be engineers with at least identical theoretical level as for present engineering education programs – plus practical

hands-on literacy. If proved successful, the vocational school may become the normal source of engineering education recruitment in Norway.

An educational research program was designed to assure the quality. Thus, a number of tests have been given the “vocational” group, and compared to relevant reference groups. One test was given unannounced a couple of weeks after school start, others mid-year and combined with final exams. Great care was taken to assure identical tests when possible. Equivalent tests were given in cases where “identity” was considered meaningless. Such tests have been and will be carried out for each pilot class during the five testing years.

The results, which have been presented at four international conferences on engineering education, reveal that:

In all tests, the “vocational” students have obtained better results than “ordinary” students, recruited from senior high

school’s science departments or equivalent.

In a number of technical tests like, for instance, Electrical Engineering Fundamentals and Digital Systems, they have significantly outperformed their reference groups. This is of particular interest to the college, since the reference groups in these tests were its own sophomores, having studied these courses in their recently-completed freshman year.

Finally, take into consideration that each one of these “vocational” students has at least one trade certificate relevant to electrical engineering in addition to months of practice. Then, it may feel rightful to ask if vocational school transformation may force engineering college changes

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Book Review: Technical Therapy for Analog Circuit Designers

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I had been teaching undergraduate electronics for a few years, after a decade in industry, when I heard a compelling paper at the 1991 FIE Conference at Purdue University. The speaker was **R. David Middlebrook**, award-winning Caltech Professor and internationally known authority on power electronics.

What struck me about Dr. Middlebrook’s presentation was its profound practicality for the pivotal area of electronic circuit design. More specifically, he was presenting a new way of thinking, a new paradigm if you will, of how to do analysis of real-world circuits to maximize its usefulness while minimizing its complexity. This was done by largely bypassing the complexity altogether, while yielding a result more useful for design.

To me that was a big deal. My experience as student, engineer, and professor had convinced me that something was missing in how we taught analysis. Despite the many things we did right, I felt that students were not developing an adequate degree of intuitive and practical analytical skills. After his talk I responded by remarking that I considered the content to be highly significant, something I wished I had gotten in school myself. This has been the response of hundreds of practicing engineers and students who have taken Dr. Middlebrook’s Structured Analog Design course over many years. Based on a set of practical circuit theorems he has developed, plus his concepts of Design-Oriented Analysis and Low-Entropy expressions, he has succeeded in bridging the gap between academia and the ‘real world’ of design. Too often, says Middlebrook, recent graduates ‘fall off a cliff’ when they start their first job and realize that the analysis techniques they

learned don’t seem adequate. Middlebrook’s proven methods have empowered graduates to start their careers better equipped to tackle real design problems and has enabled experienced engineers to boost their productivity.

With the intent of reaching a larger educational audience, Dr. Middlebrook has produced the DVD Technical Therapy for Analog Circuit Designers.* It contains 19 hours of video and hundreds of pdf illustrations of a recent live presentation of his course. The DVD’s ancillary 64 page Owner’s Manual contains summary commentaries and movie sound track quotes that identify each section, each indexed to the movie timeline. This media form provides the advantage of direct exposure to Middlebrook’s engaging style and persuasive logic. First, he gives the motivation and background for why a better approach is needed. In an often humorous and anecdotal style, Middlebrook describes the dilemma facing the fresh graduate and how his approach provides ‘therapy’ for the angst they experience on their first job. Subsequent chapters illustrate detailed practical solutions via such tools as ‘Using Normal and Inverted Poles and Zeros’, ‘Improved Formulas for Quadratic Roots’, ‘The Input/Output Theorem’, ‘The Extra Element Theorem’, and ‘The Feedback Theorem’. Viewers should give themselves adequate time to absorb this worthwhile, paradigm-shifting message. Microsoft Power Point conversion of his scanned hand-written illustrations would have helped.

This is the distillation of decades of thoughtful development by a top educator. He contends that the only analysis

worth doing is what is useful for design. His message is authenticated by numerous detailed practical examples. I have used his methods with success in my classes. We need to improve the job of equipping students and ourselves with techniques that empower the design process. R. David Middlebrook has done just that. Educators and students qualify for the greatly reduced price of \$100 (see

<http://www.ardem.com>).

[R. David Middlebrook is Professor Emeritus of Electrical Engineering at California Institute of Technology.]

*R. David Middlebrook, Technical Therapy for Analog Circuit Designers on Data DVD ROM featuring Design-Oriented Analysis - How to get more results for less work, Ardem Associates, 2004.

CHARTING A COURSE FOR A FUTURE IN PRE-COLLEGE PREPARATION (A New Paradigm for the S&T Workplace)

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A modern Swiss scholar, **Hans Kung**, has sketched Western humanity's advances over the past 50 millennia, in terms of about 800 "units of human lifetime years", 62 years each. To wit, 650 such units (c: 40,000 yrs.) were those of oral conversation and tribal language evolution. Then there were 70 units where hand-written communications between generations were first exploited by Greeks, Hebrews (Bible), mid-Eastern, etc. civilizations. Next Kung defines 6 units of printing beginning with wide use of paper and the printing press. Then there were 4 units of "measurement and precision" development during a Scholastic-Enlightenment Era. We then experienced 2 units where engines, electric motors and spin-offs prevailed from Edison, Steinmetz and peers, causing revolutionary labor-saving advances in home and factory (Note that "women's lib" was sparked in this time span.). Next a single unit, where a majority of nations was involved with industry.

Now we are in the "post-industrial era" according to this Tubingen sage; life in our beloved America and indeed in the world is accelerating. Evidence of this is painfully obvious in the "outsourcing" problem for many in our U.S. skilled labor pool; not only are menial and technical jobs being shifted to India, Hong Kong, the Phillipines and Caribbean, Eire, etc., but also to South America, Africa and Asia where often a language barrier exists. It no longer is necessary to speak English for U.S. computer-link jobs in far-away places. My thesis advisor, MIT's **Dave C. White**, dedicated a decade of his life to 1950s India, teaching EE to north Indian students; that job has been taken over by natives. His former students are now teaching Hindus to respond to programming specs for software produced overnight via world satellite links...at 20% of U.S. labor costs. Our **Dr. Rustgi**, from a Delhi family, comments to me while freezing off my skin sins: "...no way to block the outsourcing wave...it's inevitable..." The pertinent IEEE/ASEE question arises as to where American education should proceed to retain former world potency and to respond to a new and complex world job model...a new paradigm for schooling to mesh with future job markets.

A recent IEEE national convocation featured a speaker from a West Coast CalPERS group; from her labor back-

ground she posited a realistic working framework for "techies" in century twenty-one. She anticipated a working life spanning ages 25-75, recognizing extended lifetimes; average duration for each job in a dynamic (highly multi-disciplinary) workplace would now be 5-10 years for a new specialized skill. Each job would be cotemporaneous with its own accompanying training period

for new enhanced skills matched to a more skilled, follow-on job, which might (or not) be related to a current position. For example a job position using statistics applied to earth science, such as plate movement, tidal cycles, etc. could be easily transposed to a position in life sciences, for example tracing medical vectors for disease propagation. A total of 5-10 employers might be served over a lifetime career with retirement around mid-70th years (in contrast to the milieu decades earlier, due to advances in medical science.). With an average "half-life" for a specific college professional course shrinking below 6-8 years, it is predictable: that critical university courses would migrate to third-world countries, training native specialists overseas; similar to the eleemosynary experience of my 1950s thesis advisor.

An example of this job-mobility was often common for defense workers of the Cold War era; many EEs of that time frame might have started in sonar, radar or communications. As DOD contract patterns mutated it was realistic to acquire jobs in related areas with a minimum of additional skills; for example to move from radar to sonar the principal difference is found in the propagation environment. Different statistical techniques are endemic but the basics are found in echo analyses. More complex approaches are present for Doppler and Doppler-dot interpretation, viz. 3-D Fourier-Fresnel imagery. Comparable imagery techniques are applicable with modification for medical processes such as tomography, MRIs, EEGs, EKGs, X-ray imaging, and others in the life sciences. Voice interpretation has wide applicability for word recognition, security screening, language translation, print-to-speech translation and inverse, etc. Tectonic plate shifting, tidal and sea-



sonal ocean movements, weather phenomena, astronomical data, comprise a statistical data set from the natural sciences. A common utility extant in all three S&T areas is the sequence of data vector arrays, preprocessing and filtering, cross-correlation and sorting out of noise and interference for information recovery through post-processing. Introductory skills in these mathematical sequences have widespread applicability to the S&T workplace whereas others such as those in Bessel Functions, String Theory, Infinite Series, etc., are fairly limited, with limited stand-alone utility. In setting up our experimental seminar sequence we gravitated towards these pertinent multipurpose utility routines.

The point is clear that high school exposure, prior to beginning college years, in these common routines can serve our neophyte technologists well, reducing early college dropout rates. (A consistent secondary school problem of "senioritis" may be ameliorated by introduction of this challenge for 11-12th graders.) Our HS seminar in Northern Virginia, an enhancement effort, was tailored to introduce basic techniques. We appreciated that each of the five math topics in our sequence (complex matrices, transforms, probability and statistics) could be expanded dramatically in coming college curricula. An added plus for selected high schoolers in this seminar is its location on an experience summary resume for college admission and student summer employment. Student college transition would be mitigated and rationalized for our trained students by demonstration of math competence.

There has been recent activity by local universities in Virginia, in becoming involved in outreach to high schools through prep/enhancement courses. This could be a most salutary move for S&T education across the U.S. in adapting to this new paradigm for college work. Such preparatory courses, with appropriate design, could readily be credited towards majors in technical degrees. From a university faculty base (We used local guest lecturers.) covering science and engineering, the utility of mathematics could be readily demonstrated for local HS pupils, through relevant applications in specific data samples. A symbiotic partnership with ASEE, IEEE, ASME, and other professional groups could be most advantageous for participating colleges, similar to that which occurred in the late 1950s introduction of calculus to HS curricula under the Eisenhower Project. A marriage of

college faculty members with diverse professional societies could be readily exploited in such pre-college work. Our lessons from a decade of teaching in S&T IN THE WORKPLACE classrooms could surely prove to be most apt.

REPORT ON SERIES OF OPED PIECES IN IEEE/ASEE PUBLICATION *The Interface*

The above report is the last in a series that has been running in *The Interface* since 2001, recounting our Northern Virginia Section's effort to introduce post-calculus math into secondary education.

We carried out a year-long study in 1988 of means to introduce extended math course material for High School juniors and seniors preparing for S&T colleges. Senior advice then was to make sure that we addressed those students aiming for the full range of technology, not limited solely to future Electrical Engineering majors. Sound advice for our course, S&T IN THE WORKPLACE..

We prepared a full semester course to be taught 2 hours per week and presented our plans to several local HS teachers' meetings for commentary and modifications. Several initial runnings in regular County secondary schools proved unsatisfactory; former Asst. Principal **Don Weinheimer**, of Thomas Jefferson High School for Science and Technology (TJHSST), recommended we approach Principal **Geof Jones** with the 15 weeks seminar. We ran the series: Complex Matrices, Fourier Transforms, Laplace Transforms, Probability and Statistics. The seminar was taught by volunteer IEEE members from the local workplace, initially 40 in all. These volunteers each produced a class paper, of 20-30 pages, for their sessions. The school, through its guidance department, provided reproduction and other related services for the Wednesday 2-hour sessions. The decade of the 1990s was used to refine the course over seven semesters of the experimental course. We published numerous reports for IEEE/ASEE and for the Virginia Teachers Associations during the 1990s and following. This series began in 2001. We hope that our experience will prove useful for the coming workplace.

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Abstract/Proposal Deadline: January 10, 2005

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► ABSTRACT DEADLINE: JANUARY 10, 2005

The 2005 Frontiers in Education Conference (FIE 2005) continues a long tradition of promoting the widespread dissemination of innovations that improve computer science, engineering, and technology (CSET) education. FIE is a major annual international conference devoted to improvements in CSET education. It is an ideal forum for sharing your ideas, learning about new developments in CSET education, and interacting with your colleagues.

CSET education faces significant challenges, such as rapidly evolving technologies, globalization, changing student demographics, and problems associated with funding higher education. Moreover, the rapidly emerging global economy is profoundly affecting the employment patterns and the professional life of CSET graduates. Articles in recent issues of the *ASLL Prism* and other CSET education literature suggest that current educational practices and policies are not sufficient for dealing with these changes. Successfully addressing these issues will require innovative solutions, including use of new pedagogies and technologies that improve student learning; partnerships among universities, industry, government, and K-12 educators; curriculum reform; and distance learning. This year, we are especially interested in abstracts that address changes foreseen for CSET education and CSET graduates because of predicted changes in the industries they will enter.

► WHAT MAY YOU SUBMIT?

You may submit abstracts for peer-reviewed full papers and for works-in-progress (WIPs). You also may submit proposals for panels and interactive sessions and for workshops. These four formats are described in detail in this call for papers and at www.fie-conference.org.

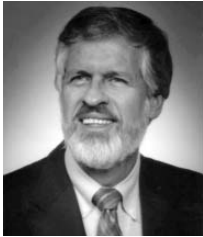
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Full papers	Submit abstract	Submitters will be notified of acceptance or rejection	If your abstract is accepted, a complete paper is due	Authors will be notified of peer review results	Modified papers due
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► TOPICS OF INTEREST

- Accreditation and assessment
- Active learning
- Capstone and senior design experiences
- Computer and Web-based software
- Creative design experiences
- CSET educational research
- Distance learning: Methods, technologies, and assessment
- Diversity: Valuing it, achieving it, and teaching it
- Entrepreneurship programs
- Ethics: Creative ways to teach and assess it
- Faculty development
- First-year courses and programs
- Globalization: Preparing faculty and students
- Innovative degree programs and curricula
- Innovative uses of technology in the classroom
- K-12 initiatives and partnerships
- Laboratory experiences: On-site and at a distance
- Learning models
- Lifelong learning
- Nontraditional students
- Partnerships (industry, government, university, international)
- Service learning
- Software engineering
- Student retention and persistence
- Teaming
- Undergraduate research experiences
- Women in CSET education
- Other (You may submit abstracts and proposals on other topics that address issues at the frontiers in CSET education.)

From your Editor

Bill Sayle
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A comment from one of the “non-renewing members of the IEEE Education Society” in a recent IEEE survey of non-renewing members: The newsletter is entirely focused, it appeared to me, on US higher education. It has little relevance to those overseas”.

While this comment was the only one of its nature in a survey of several hundred “non-renewing members” of the IEEE Education Society, it got my attention. While the focus of *The Interface* is heavily on US higher education, it is not because of deliberate discrimination against higher education in other parts of the world. If you have read this far in this November issue of *The Interface*, you undoubtedly have seen several contributions from non-USA authors. In fact, over the years, Trond Clausen, of Norway, has been a regular contributor of articles describing projects and activities in Scandinavia. Manuel Castro, of Spain, is a member of the Chapters Committee of the IEEE Education Society. And a perusal of the roster of the AdCom reveals two non-USA at-large members and several committee members from outside the USA. As a transnational society, IEEE tries to include in its leadership members from all around the world, but in practical terms this is a real challenge because of the expense of travel to the various administrative committee meetings. I welcome articles from all of our members. Electronic submission has made it much more practical than in the past for everyone to have

access to *The Interface*.

Continuing the theme of the above paragraph, I have been heavily involved in my role as Director of Undergraduate Studies at Georgia Tech Lorraine here in Metz, France, in setting up an undergraduate third- and fourth-year engineering program in concert with our French partner schools. We have operated a very successful graduate program for the past 14 years and a very successful Summer Undergraduate Program for the past seven years. Our newest challenge is make it possible for Atlanta- and Savannah-based Georgia Tech students to spend the third and/or fourth academic year(s) here in France taking all the courses they need to stay on track for graduation. Since we currently do not have traditional (translation: non-computer) instructional laboratories in our Georgia Tech Lorraine facility, we are working with our nearby French partner schools SUPELEC (electrical engineering) and ENSAM (mechanical engineering) to use their laboratories for instruction in addition to using their regular courses as courses for our students. When our students take their regular EE or ME courses (in French) that have laboratories, each of our Atlanta/Savannah-based students would be paired with a SUP-ELEC/ENSAM French student. We are calling this new undergraduate program the “International Plan”.

In keeping with Rob Reilly’s comments on the use of the word “international”, this plan features education both in the USA and in another country, where English is not the native language. It’s an exciting new program and one to which we are all looking forward to implementing.

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