

Continuing the Journey Through the FIE Bookshelf— 1971-2005

Edwin C. Jones, Jr.
University Professor Emeritus, Iowa State University
Ames, IA 50011 n2ecj@iastate.edu

Abstract - In 1971, about 100 engineering educators from industry and academia gathered in Atlanta for the first Frontiers in Education (FIE) conference. Its leaders had a vision, and moved creatively to implement the vision. The journey through the conferences, which we call FIE, is worth documenting, as the conference has become a premier and often-imitated conference. Some educators have been involved right from the beginning and continue. Others have disembarked, but many new contributors have joined. This paper will document some data and will also be an attempt to study the impact of the conference on engineering and computing education over the last 35 years. What issues have been resolved? What new issues have emerged? What issues continue? What might emerge in the future? Of necessity it will contain personal observations. The paper is an update of a similarly named paper published at the 2000 FIE.

Index terms • Engineering Education, FIE History

EARLY YEARS 1971-1975

In 1971, the IEEE Education Society had existed for 14 years, and the *IEEE Transactions on Education* had become the first (and then only) refereed journal for engineering education papers in the USA. The US economy was in recession, engineering enrollments had dropped precipitously, and the Society (then called a Group) was in debt. Would it survive? The IEEE Board of Directors gave the Society a limited time to recover. It needed ideas, which came from three far-sighted people who also implemented their ideas.

These people were Warren B. Boast, of Iowa State University, who became President (then called Chairman) of the Society in 1970, Luke Noggle of Westinghouse Electric, and Benjamin Dasher [1], of the Georgia Institute of Technology, who proposed a new conference, called *Frontiers in Education*. Professor Dasher organized the conference, held in Atlanta in April 1971. Approximately 100 people attended the six sessions and heard 34 papers, the first step of the FIE journey. Starting a conference at the time must have seemed risky, but the conference met a need apparent to the three founders and the early attendees. Early on, the conference name was the theme, but more recently each conference has had its own theme. The six session titles speak volumes about the initial conference. They are:

1. You Can't Fire Me, I Have Tenure!

2. Mark Hopkins Has a Few New Logs
3. Cradle to Grave
4. Money, Money, Money
5. Today's Dinosaurs
6. Will the Computer Really Replace the Laboratory?

Tucson was the site for FIE 1972, with Roy Mattson, University of Arizona, as general manager. Meanwhile, Dr. Dasher had passed away, and the conference dedicated the plenary session to him. The conference had eight sessions and four workshops, now a standard feature of all FIEs. Many members of the Educational Research and Methods Division (ERM) of the American Society for Engineering Education (ASEE) submitted papers, and really added to the conference. FIE remembers Dr. Dasher by naming the award for the outstanding conference paper for him.

In 1973, at Purdue University, the ERM officially became a co-sponsor of FIE. This doubled the size of the conference by any measure, and broadened coverage to all of engineering education. The ERM Division strengthened the sessions on learning theories, evaluation, and pedagogy. A leader in ERM at that time was Helen L Plants, of West Virginia University, for whom the workshop award is named.

In 1974, the IEEE Education Society Chapter in London and the University College of the University of London hosted FIE. The reception in the Guild Hall, the opportunity to learn from engineering educators across Europe, and the new Open University were conference highlights. The conference lost money. Both sponsors tightened their belts, secured the backing of their respective Boards of Directors, and put together following conferences that, because of high quality and good attendance, soon repaid the debt and earned the support of the organizations.

SELECTED EVENTS, GROWING YEARS 1975-1995

Between 1975 and 1995, the conference grew in attendance, numbers of papers, and proceedings pages. More important, the quality, stature, and recognition improved steadily. Much of this change resulted from the *Proceedings* edited by Joe Biedenbach and Larry Grayson, who set a high standard for others to follow. The conference added poster sessions, "works in progress," and a rigorous refereeing process. Keynote speakers with national and international stature made stimulating plenary presentations.

The 1979 conference was held in Niagara Falls—on the Canadian side. This was in many ways the first conference held in a conference center rather than on a campus. The attendees appreciated the scenic and cultural opportunities that augmented the conference. It set the stage for a discussion, held later, about what sorts of venue are the best for FIE.

The 1990 conference, our second trip to Europe, was a wonderful trip to Vienna and Budapest. Who can forget the hospitality of IGIP, the Internationale Gesellschaft für Ingenieurpädagogik, the opportunity to meet engineering educators from Europe and beyond, the trip down the Danube River by ship in near-flood conditions, and cultural experiences in Budapest, Vienna, and Yugoslavia?

By 1992, the NSF coalitions were making important contributions to engineering education, and conference organizers worked with NSF to present this work at FIE. Dissemination of the engineering education research was critical to NSF, and FIE provided a venue in which good presentations reached a lot of people who were in position to implement the ideas. The FIE/NSF relationship continues as a major part of the conference, and the conference organizers believe that NSF presenters come to FIE knowing that their audience will take the ideas back to their own institutions.

The conference developed a “steering committee”, composed of past general managers and others. They are responsible for choosing the conference site and leadership. Their wise decisions are an important factor in conference success. Since 1992, the conference has generally been held in a metropolitan center combining cultural and recreational opportunities with the chance to learn more about engineering education. Attendees make new friends in the sessions as they cement the relations during the social events.

CONFERENCE MATURES, 1995-2005

In 1995, the IEEE Computer Society joined as a third co-sponsor. The Computer Society brought new resources to the conference, and because of the importance of computing both in engineering education and the practice of engineering, the presence of the Computer Society attracted many new people, new ideas, and a variety of new types of session.

One of the most important activities of the Computer Society, with ACM, the Association for Computing Machinery, is the development of model curricula for computing in all of its aspects. Progress reports have been a regular feature of FIE in the last 10 years, which gives the model curricula wider exposure, a major factor in the improvement of computing education.

Georgia Tech hosted the 25th anniversary conference, in Atlanta. The 1995 conference was one of the first anywhere to issue its Proceedings on CDs. Tables on the conference web site list all of the conference sites along with other data [3].

In 1997 in Pittsburgh, the New Faculty Forum started. Supporting faculty at the beginning of their careers is important, and these people give new ideas and challenge us in important ways. Russ Meier, an early award recipient, has made this phase of the conference vital. The recipients come

from around the world. They are young engineering educators. They present papers that are reviewed “blindly,” i.e. they are reviewed along with other papers and accepted on their overall merit, not simply because the authors are young. These people have really enhanced the conference.

A slow but certainly discernable change through this period has been the improvement in quality by any measure—acceptance rate, citations, presentation quality, audience interest. Leaders in engineering education from around the world attend and contribute.

ISSUES AND PROBLEMS

Any attempt to choose the important issues addressed by FIE has the risk of the writer’s perception, and the items mentioned appear to the author to be among the most significant. Problems are solved or simply go away, totally superseded by developments. Issues, on the other hand, stay, and change slowly, if at all. Some of the issues that have been a part of nearly every conference.

- Appropriate uses of computers
- Continuing education
- Distance education
- Laboratory education
- The future of the university
- Engineering college structures and organization
- Evaluation of teaching/learning and the faculty reward structure
- Learning theories, techniques, and motivation
- Student issues—quality, grading and evaluation, recruiting and retention, underrepresented groups
- Curricular issues
- Teaching of engineering design
- Accreditation
- Resources
- every FIE include:
- Educational technology

An interesting feature of these issues is that the answers often change over time. People, circumstances, and the educational environment change, so it is logical and expected that the answers change as well. FIE has shown these changes.

EDUCATIONAL TECHNOLOGY AND COMPUTERS

Engineers and engineering educators not only create technology, they use it—in ways to improve student learning.

- The overhead projector has given way to video projectors and presentation software. FIE papers taught us how to use the new equipment. Five years ago we brought backup slides to conferences. No more.
- The chalkboard and chalk, while still present, have largely been replaced by various types of “capture software”, a great advantage to the student who has to choose between taking notes and listening to the instructor.

- Slide rules, once the hallmark of the engineer, gave way to calculators and then to the “laptop,” now a common presence in the classroom, and again FIE is showing us how to take advantage of the new opportunities to enhance learning.
- Laboratories are still important, but are now so enmeshed with computers that the dividing line is hard to draw. Early papers discussed whether or not a computer could ever replace a laboratory—or whether simulation even has a role in experimental education. Today, we hear papers and see demonstrations on the control of experimental equipment over the web. An important laboratory study was reported in [4].
- The issue of learning to use information sources has expanded from using the campus library, indices, periodicals, and interlibrary loans to include the World Wide Web. What a change this is!
- In 1973, a plenary session considered two early forms of computer-based instruction, TICCIT and PLATO. Both were pioneering efforts, well “ahead of their time,” especially considering the hardware capabilities. The two systems differed, but paved the way for future research in computer-enhanced instruction and systems now being deployed for web-based courses and distance education.
- We expect technological advances to save time, but it rarely happens. Instead, standards rise as the technology opens new possibilities, and new accomplishments move quickly from “possible” to “expected.” As examples, slide rule accuracy is no longer satisfactory—engineers expect more. Faculty expect students to “word-process” their papers. Audiences expect presenters to use sophisticated software and hardware to enhance the printed pages.

LIFELONG LEARNING AND DISTANCE EDUCATION

Engineering educators have long valued their contacts with industrial practitioners, for they realize that they gain while contributing. Teaching classes, both credit class and degree programs, and non-credit workshops (short courses) has been an important aspect of industrial contact. The engineers who take these classes are good students, and really challenge the faculty. FIE conferences regularly feature presentations on delivery methods, motivational techniques, subject matter, and instructional design for such lifelong learning activity.

- The term “distance education” refers to any situation in which the students and the faculty are separated either in time or space, or both. Distance education technology is at the simplest a system for delivery of education, but the term itself is likely to disappear, because the methods for instruction with geographical separation are often found to be effective on campus. Authors at FIE have reported their successes in distance education and have

convincingly shown that the techniques actually enhance instruction and learning on and off of the campus. They free the instructor from routine activities, and give the instructor additional time for higher level activities and also for more interactions with the students, albeit not always “face-to-face” interactions. This is another example of rising expectations and possibilities.

A few authors have predicted the demise of the university, but more have argued that the future of the university has never appeared brighter than it does today. The university will change, but the need for a university will not change. The demands on the university will increase.

In the 1990s, pressure from the public, from the national studies of engineering education, [5, 6, 7] and from industry forced the university to reduce the number of credit hours required for degrees. Papers presented at FIE showed the ways to reduce the credits, maintain essential studies, and help educate engineers who are capable of lifelong learning.

THE FACULTY REWARD STRUCTURE

Students, not surprisingly, find great difficulty in understanding why popular faculty are not promoted. But the same students admire faculty who are scholars.

- One benefit of the FIE conferences is that engineering faculty who have an interest in engineering education as a profession now have a venue in which to have their efforts peer-reviewed, knowing that good scholarship will be recognized, and that many institutions will reward their work.
- As our goal has become that of creating a learning environment, not simply being a “good teacher,” an important issue is that of finding appropriate ways to evaluate the overall effectiveness of the faculty. At FIE, many scholars have reported on their research at various types of institution. These studies are not limited to North America. Methods found to be informative include carefully designed classroom visits, student surveys, faculty portfolio reviews, and peer review of research efforts by the faculty interested in these questions.
- Evaluation without improvement is of dubious value. Studies of learning theory, motivational techniques, retention, presentation methods, and the evaluations of the processes have given guidance to faculty who want to improve their teaching. More research into improvement will be a central focus of future conferences.
- The conference itself has developed a reputation for careful review of the papers offered for presentation. The standards are comparable with those of technical conferences. New promotion and tenure criteria at many universities recognize the value of scholarship

in education. The new criteria encourage such scholarship while requiring that it be subjected to rigorous peer review. Some of the new criteria are based on the landmark book by Boyer [8]. Promotion dossiers now include references to papers presented at FIE.

LEARNING THEORIES, TECHNIQUES, AND MOTIVATION

Many educators believe that students today are very different from those of even a few years ago, and quite different from those in the classroom when FIE was launched. Yet, on graduation, they go on to their life’s work, and amaze us all with their creativity, hard work, and accomplishments. Why is this true?

- In the early days of FIE, we heard papers on the subject of programmed self-instruction (PSI), often called mastery or self-paced learning. PSI assumes that all students should be able to master a given subject matter, though some might take more time than others. PSI worked well with PLATO and TICCIT, and with print media. Students worked on an idea until they had mastered it, as determined by examinations. In principle, students worked alone, though students have always cooperated whether or not the faculty encouraged it. Much research was devoted to answering the question of whether or not students retained the material a month, six months, or years later. Scholars never convincingly showed that time-unlimited mastery learning led to greater permanence than time-limited conventional methods.
- In recent conferences, presentations on learning theories and techniques have concentrated on active learning and cooperative learning. Active learning is based on the well-established principle that students learn more and more quickly when they are fully involved with the subject matter. In active learning, students discover for themselves much of the underlying structure of the subject, and consult faculty or listen to lectures for short periods to get past especially difficult transitions. Active learning research shows that students retain more knowledge than students who primarily learn by conventional lecture methods.
- Cooperative learning formalizes the natural and informal interactions of students giving students tools with which to work together. Students work together with encouragement, and when all of the members of a group learn well, all receive extra tangible rewards in addition to the satisfaction of learning well.
- An important set of activities through the first 35 years was a sequence of papers and workshops on topics such as Piagetan learning theory, learning styles, e.g. the Briggs-Meyers analysis and the Kolb theories. We learned that students and faculty frequently have different learning styles, and this realization suddenly showed many of us why our

teaching techniques lacked the effectiveness we wanted, even when we went into the classroom having mastered the subject and prepared well.

- Over the years, engineering education scholars have taught us to write educational objectives, not satisfying ourselves with vague goal statements. We are learning now to do outcomes assessment.

The motivation for much of this study was the desire of engineering educators to, somehow, “do better.” Many believed that the conventional lecture method had become anachronistic in a technologically sophisticated age, and that students were better equipped to use other, more effective techniques. Though the lecture method is far from gone, many faculty members are finding that they are more effective when they mix techniques and use methods that take advantage of the various learning styles of our students. The faculty have also learned that cooperative learning leads to the achievement of active learning. Another important benefit of cooperative learning is that it helps students learn to work together, and nearly all of us hear the message from industry that graduates must be able to work on teams from their first day on the job.

ENROLLMENT CYCLES AND FACULTY ISSUES

Enrollment in our programs has varied substantially over the years, responding to many forces including economic considerations. Often this leads to enrollment cycles that are not in phase with the economic cycles.

- The conference began in a period of economic recession, when potential students believed that the engineering profession held no future. Papers addressed recruiting and retention of highly qualified students and showing them that not only is engineering itself a most-rewarding career, it also provides an outstanding foundation, indeed a truly liberal education for all. Enrollment has risen and fallen several times over the 35 years. In the peaks, we had papers on enrollment management, how to choose the most qualified students, and how to ensure their progress. In the valleys, we studied recruiting and retention.
- We have seen cycles alternating between shortages of faculty candidates and a rich supply of highly qualified applicants. Some of this phenomenon is tied to the enrollment cycle, but much of it is tied to other demographic factors. When large numbers of faculty of about the same age begin their careers together, they tend to retire at about the same time. Papers at FIE have addressed these issues.
- Techniques for faculty productivity determination have evolved slightly, but are still crude. A number of authors have given thought-provoking presentations and workshops on this issue, but whether the authors are faculty or administrators, no clear consensus has emerged. The issue is critical during periods of high enrollment, when classes are large and there is a need to improve efficiency

without any compromise with quality. The issue is equally critical during low enrollment periods, for different reasons. The question becomes one of resource allocation, and is complicated by the fact that there may be a hiatus in faculty hiring, with effects decades later. Student cycles are short; faculty cycles are long.

- Faculty development, mentoring, promotion and tenure issues occupy a lot more time and require a lot more resources than 35 years ago. Many authors have addressed these issues, which arise because of enrollment cycles, resource issues, public and political issues, and the ever-increasing pace of technological change.

These issues will remain at the forefront of every FIE for many years to come, still a fertile area for research in engineering education. Students, educational leaders, funding agencies—everyone expects a lot from the faculty, and there is yet a need for carefully designed experimentation on how to maintain technological competence, mentor and be mentored, improve teaching and service, and have a complete life.

CURRICULAR ISSUES

The curriculum is still the most visible part of a program. Students ask—what courses must I take? They need to ask—what are the goals, outcomes, and objectives? Future FIEs will have a lot of discussion of curriculum design questions.

- As has been said so often, design is the “hallmark of the engineer.” Design distinguishes us from other professions. We have put a lot of effort into designing design-learning environments, and many authors have shared the results of their research at FIE.
- The problems of reducing credits required for graduation has been mentioned. The tendency to simply increase the content per hour has been resisted, in part because FIE authors showed us how to achieve this goal.

ACCREDITATION ISSUES

Virtually all engineering educators in the USA agree that accreditation is vital, and yet they frequently have much concern with the time and effort accreditation visits require. Internationally, ABET is emulated, and ABET now grants “substantial equivalence” to many programs around the world [9].

- When the conference began, the accreditation criteria and processes were changing. ABET (then ECPD, the Engineer’s Council for Professional Development) instituted the due process system. Program criteria soon followed.
- In the 1980s, educators expressed a lot of concern with “bean-counting” in the accreditation process. The first major step in reducing this concern was to

modify the “science-design” criteria by introducing the “topics criteria.”

- In the 1990s, the concern remained that accreditation focused its attention on the process of education, not the results or outcomes. The result is well known—the new criteria commonly called EC2000 [9], but now accurately called the Engineering Accreditation Criteria. Similar criteria have been developed by the Technology Accreditation Commission and by the Computing Accrediting Commission.
- At FIE, many authors presented their responses to the new criteria, and many “best practices” emerged.

The new criteria, which apply the engineering design process to engineering, computing, and engineering technology education, have greatly changed our educational systems by introducing greater accountability, greater flexibility, and greater opportunities for institutions to describe their strengths and the opportunities they provide for students. Papers presented at FIE have had a major impact on accreditation.

STUDENT ISSUES

It is no accident that the new accreditation criteria start with students. Students—their selection, advising, mentoring, learning opportunities—are absolutely critical to implementation of a successful engineering education program. Much opportunity for research still exists, and many of the questions are largely unanswered.

- Important papers on various student issues have been a part of every FIE. We have tried to find new ways to raise the attractiveness and accessibility of the profession to students in groups underrepresented in our student population. Some of the techniques have been effective on the origination campus, but hard to replicate.
- Retention, especially of underrepresented student groups, has been the subject of much research.
- Evaluation of student work is another difficult task, and engineering education scholars have presented the results of their research designed to improve the process.

AWARDS

FIE regularly recognizes people who have given a lot to the conference. The Dasher Outstanding Paper Award honors Benjamin Dasher, Georgia Tech, one of the founders. The Helen L Plants Workshop and Special Events Award honors Helen Plants, West Virginia University, who had a major role in the addition of ERM to FIE. The Ronald J. Schmitz Award honors Ron Schmitz, South Dakota School of Mines and Technology, who gave generously of his ability to organize all aspects of a conference, and who passed away all too early.

CONCLUSIONS

This conference began in a troubled time for engineering in general, and engineering education in particular. The conference may be compared with a journey, not a destination. The journey has been unpredictable, but it has been interesting and challenging. A few of the early participants are still active—most of the early travelers have disembarked to pursue other challenges, or are no longer with us.

Fortunately new travelers have joined the journey. The new travelers have enriched the journey, challenging their predecessors, and setting examples for future travelers.

How is engineering education different because of FIE? The hallmark of the engineer is design, using the term broadly. The hallmark of academia today is scholarship. Boyer [9] defined scholarship as we use the term today. His monumental work clarified the ideas many of us were trying to present for many years.

FIE has brought together engineering as a profession and scholarship. FIE has given faculty an outlet for having the scholarship in their professional academic work and in their engineering evaluated by their peers. FIE has given those agencies that support improvement in engineering education an outlet that they are convinced people who make a difference will attend. These agencies test their ideas, keeping those with merit, discarding the others.

The 35th FIE takes place in a time of important developments in engineering education. Probably the most significant is the World Wide Web, as the web gives us new opportunities and challenges, and raises expectations to greater heights. The academy will continue to change and will continue to serve society. FIE will serve the academy and the profession by providing a time and place for scholars to gather, to share ideas, to evaluate ideas, to keep the effective and reject the ineffective results, and to support future generations in their endeavors. This paper is part of a set of papers intended to document some of this progress [10, 11, 12].

REFERENCES AND ENDNOTES

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