A JOURNEY THROUGH THE FIE BOOKSHELF—1971-2000

Edwin C. Jones, Jr.1

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. The paper will also be an attempt to study the impact of the conference on engineering education over the last 30 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.

Index terms • FIE History, Conference History.

THE EARLY YEARS

In 1971, the IEEE Education Society had been in existence for 14 years, and the IEEE Transactions on Education had become established as a refereed journal for engineering education papers, the only one in the USA. The US economy was in a recession, engineering enrollments had dropped precipitously, and the IEEE Education Society (then called a Group) was in debt. Its survival was in question. The IEEE Board of Directors had given the Society a limited time to turn around. The Society needed ideas, which soon came.

Warren B. Boast, Head of Electrical Engineering at Iowa State University, became President (then called Chairman) of the Society in 1970. Dr. Boast, with Luke Noggle of Westinghouse Electric, and Benjamin Dasher [1], of the Georgia Institute of Technology, proposed a new conference, calling it the Frontiers in Education. Professor Dasher organized the conference, which was held in Atlanta in April 1971. Approximately 100 people attended the six sessions and heard 34 papers. The journey we call FIE had begun with its first step. Starting a conference at the time seems, in retrospect, to have been risky, but the conference met a need that was apparent to the three founders and to those who attended. Early on, the conference name was the theme, but more recently explicit themes have been stated for each conference. The titles of the six sessions 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?

Roy Mattson, Head of Electrical Engineering at the University of Arizona, was the general manager for the second conference, held in Tucson in April 1972. Meanwhile, Dr. Dasher had passed away, and the conference dedicated the plenary session to him by calling it the Dasher Memorial Session. The conference grew to eight sessions and four workshops, now a nearly standard feature of all FIEs. All were pleasantly surprised to have a lot of participation from members of the Educational Research and Methods Division (ERM) of the American Society for Engineering Education (ASEE). The conference remembers Dr. Dasher by naming the award for the outstanding conference paper for him. The first award was given in 1974.

In 1973, at Purdue University, the ERM officially became a co-sponsor of FIE, a cooperation that continues and get stronger each year. This nearly doubled the size of the conference by any measure, and broadened the coverage to all of engineering education. All found that engineering educators in all branches of engineering have much in common. The ERM Division strengthened the sessions on learning theories, evaluation, and pedagogy.

In 1974, the young conference crossed the Atlantic to London, to an outstanding conference hosted by the IEEE Education Society Chapter in London and the University College of the University of London. 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 a substantial amount of money. Both sponsors tightened their belts, secured the backing of their respective Boards of Directors, and put together following conferences that, because of their high quality and thus good attendance, earned enough of a surplus to repay the deficit and support the organizations.

THE MIDDLE YEARS

Between 1975 and 1995, the conference grew steadily by any measure—attendance, numbers of papers, proceedings pages. More important, the quality, stature, and recognition improved. Much of this resulted from the Proceedings edited by Joe Biedenbach and Larry Grayson. This change resulted from steady hard work by many people. Papers were refereed before presentation. Poster sessions and “Works in Progress” sessions were added. Keynote speakers with

1 Department of Electrical and Computer Engineering, Iowa State University, Ames, IA 50011, n2eci@iastate.edu
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national and international stature attended and made stimulating plenary presentations. Georgia Tech, site of the first conference, also hosted the 25th anniversary conference, in Atlanta.

**COMPUTER SOCIETY CO-SPORNSHOP**

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 the computer 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. The 1995 conference was one of the first anywhere to issue its Proceedings on CDs. A table given as an appendix lists all of the conference sites along with the number of papers and total pages in the Proceedings [2].

**SIGNIFICANT EVENTS**

By 1992, the NSF coalitions were making important contributions to engineering education, and the conference organizers worked with the NSF to present this work at FIE. Dissemination of the work was critical to the NSF, and FIE was able to provide a venue in which good presentations reached a lot of people who were in position to implement the ideas. The FIE/NSF relationship has continued to be 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 1990 conference, which was the second trip to Europe, was a wonderful trip to Vienna and Budapest. No one who attended will ever forget the hospitality of IGIP, the Internationale Gesellschaft für Ingenieurpädagogik, the opportunity to meet engineering educators Europe and beyond, the trip down the Danube River by ship in near-flood conditions, and the cultural experiences in both Budapest and Vienna. Many took a side trip to Yugoslavia.

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.

One of the interesting discussions over the years concerned “what conditions in the conference site are needed.” In recent years, the conference has generally been held in a metropolitan center that is relatively easy to get to and that combines cultural and recreational opportunities with the chance to learn more about engineering education. Those who attend make many new friends in the sessions, but they cement the relations during the social events.

**ISSUES AND PROBLEMS**

Problems are solved or simply go away, totally superseded by developments. Issues, on the other hand, stay, and change slowly, if they change at all. Some of the issues that have been a part of nearly every FIE include:

a. Educational technology
b. Appropriate uses of computers
c. Continuing education
d. Distance education
e. The future of the university
f. Evaluation of teaching/learning and the faculty reward structure
g. Learning theories and techniques
h. Motivation
i. Student issues—quality, grading and evaluation, recruiting and retention, underrepresented groups
j. Curricular issues
k. Teaching of engineering design
l. Accreditation
m. Resources

One issue that was important in the 1970s, but not now, is the proposal that engineering programs should be reconstituted as professional programs. This topic was a major focus in 1977, with a panel presenting persuasive arguments on many aspects of the issue. Closely related is the five-year baccalaureate program, a question that is basically dormant now, but could re-emerge.

**EDUCATIONAL TECHNOLOGY AND COMPUTERS**

1. The overhead projector has given way to video projectors and presentation software.
2. Slide rules, once the hallmark of the engineer, gave way to calculators, which are now so sophisticated that they are really small computers. In 1984, one author said of the “AT” personal computer, based on the 80286 processor, that “it shows promise.” Never was such a modest prediction so accurate.
3. Laboratories are still important, but are now so enmeshed with computers that the dividing line is hard to draw. Some of the early papers discussed questions about whether or not a computer could ever replace a laboratory—or whether simulation has a role in experimental education. Today, we hear papers and see demonstrations on the control of experimental equipment over the web.
4. The issue of learning to use information sources has changed from using the campus library, indices, periodicals, and interlibrary loans to a search on the World Wide Web, and this search is now in its infancy.
5. Electronic books are beginning to appear. How will we use them effectively? Will they replace the textbook? If so, when? Or will this be another supplement?
6. In 1973, a plenary session was devoted to 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 were different, but paved...
We expect technological advances to save time, but this rarely happens. Instead, standards rise because the technology opens new possibilities, and new accomplishments are not only possible, but expected. As examples, slide rule accuracy is no longer satisfactory—engineers expect more. Faculty expect students to “word-process” their papers. Audiences expect presentations to use sophisticated software and hardware, with audio and video that enhance the printed pages.

CONTINUING EDUCATION OR LIFELONG LEARNING, DISTANCE EDUCATION, AND THE FUTURE OF THE UNIVERSITY.

7. 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 activities.

8. The term “distance education” refers to any situation in which the students and the faculty are separated either in time or space. 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 give 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.

9. 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.

Continuing education has evolved into lifelong learning. 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.

EVALUATION AND IMPROVEMENT OF TEACHING AND LEARNING, AND THE FACULTY REWARD STRUCTURE.

10. An important issue is that of finding appropriate ways to evaluate the overall teaching 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 effective include carefully designed classroom visits, student surveys, faculty portfolio reviews, and peer review of research efforts by the faculty interested in these questions.

11. Evaluation without improvement is of dubious value. The studies of learning theory, of motivational techniques, of retention, of presentation methods, and the evaluations of the processes have given many faculty who want to improve their teaching guidance that has been effective. More research into improvement is likely to be a central focus of future conferences.

12. 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.

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.

LEARNING THEORIES, TECHNIQUES, AND MOTIVATION.

13. In the early days of FIE, we heard many papers on the subject of programmed self-instruction (PSI), sometimes called mastery learning or self-paced learning. A principal assumption of PSI is the idea that all students should be able to master a given subject matter, though some might take a lot more time than others. PSI worked well with PLATO and TICCIT, as well as 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 the faculty encouraged or discouraged it. Much research was devoted to trying to answer the question of whether or not students retained the material a month, six months, or years later. Scholars never convincingly showed that mastery learning led to greater permanence than conventional methods, which tend to be time-limited rather than time-unlimited.

14. 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.

15. Cooperative learning formalizes the natural and informal interactions of students giving students tools with which to work together. Students are encouraged to work together, and when all of the members of a group learn well, all receive extra tangible in addition to the satisfaction of learning well.

16. An important set of activities through the first 30 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.

17. 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 in the modern university, many faculty are finding that they are more effective when they mix techniques and use methods that take advantage of the variety of learning styles that our students have. The faculty have also that cooperative learning is an effective technique for achieving 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.**

18. The conference began in a period of economic recession, and when potential students believed that the engineering profession held no future for them. Papers in this period addressed recruiting of highly qualified students and showing them that not only is engineering itself is 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 thirty years. In the peaks, we had papers on enrollment management, how to choose the most qualified students, and how to ensure their progress.

19. 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 these conferences have addressed these issues.

20. The 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 clear need to improve efficiency without any sort of compromise with quality. The issue is equally critical during low enrollment periods, for different reasons. Immediately the question becomes one of resource allocation, and it 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.

21. Faculty development, mentoring, promotion and tenure issues occupy a lot more time and require a lot more resources than 30 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. This is 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 we might maintain our technological competence, mentor and be mentored, improve our teaching and service, and have a complete life.

**STUDENT ISSUES.**

22. Many 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 origin campus, but have been hard to replicate.

23. Retention is another important issue, all students but especially of underrepresented student groups. This subject has been the subject of much research.

24. Evaluation of student work is another difficult task, and engineering education scholars have presented the results of their research designed to improve the process.

It is no accident that the new accreditation criteria now being implemented 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.

**CURRICULAR ISSUES.**

25. As has been said so often, design is the “hallmark of the engineer.” Design is the process that distinguishes us from other professions. We have put a lot of effort into teaching our students to design, and many authors have shared the results of their research at FIE.

26. 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.

The curriculum is still the most visible part of a program. Potential students ask—what courses must I take? They still have not learned to ask—what are the goals, outcomes, and objectives? Future FIEs will continue to have a lot of discussion of curriculum design questions.

**ACCREDITATION ISSUES.**

27. 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.

28. 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.”

29. 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].

All of these changes had and continue to have major effects on engineering education, for accreditation is critical to offering a program that will attract qualified students. It takes time to build support. Over the years many sessions were devoted to accreditation issues, both criteria and processes. FIE has thus had a major role in the development of the new accreditation methods. This point is especially true with EC2000, as many authors have presented papers on outcomes assessment and on their interactions with ABET.

**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. It most definitely is not a destination. The journey has been unpredictable, but it has been interesting and challenging. Very 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. A table showing the conference sites follows.

Fortunately new travelers have joined the journey. The new travelers have really 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 [8] 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 thirtieth FIE takes place in a time of important developments in engineering education. Probably the most significant is the World Wide Web, as the web will give us new opportunities and challenges, and will raise 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.

**REFERENCES AND ENDNOTES**

[1] The author is aware that many others contributed, but has to make a decision as to whom to mention explicitly. Never will it be possible to name everyone.


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