This essay is based on the Arthur B. Guise Honors Lecture presented by Professor David Lucht on May 20, 2002.

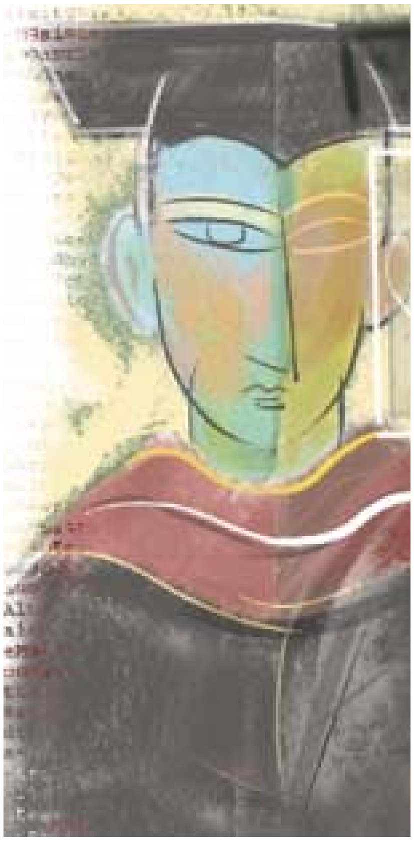
The Role of Post-Secondary Education in Advancing Fire Protection Engineering

By David A. Lucht, P.E.

The question is asked from time to time as to why so few schools offer fire protection engineering degree programs. After all, for decades the demand for FPE graduates has been exceptionally strong.. well in excess of the supply. One might think engineering schools would be eager to establish new programs where there is a recognized demand. This essay will offer some thoughts on this question and suggest some strategies for expanding the availability of degree programs worldwide.

THE FINANCIAL CRUNCH

It will come as no surprise that fiscal constraints are a major inhibitor to the startup of new degree programs. Private schools, like Worcester Polytechnic Insti-



tute (WPI), are nonprofit corporations which must be operated on a sound business footing. The income must at least equal the outgo on a continuing basis. State universities may receive subsidies from the state government, but they, too, have fiscal constraints, and the demand for resources usually exceeds the supply.

In recent decades, engineering schools have had to raise their prices (tuition) faster than the rate of inflation in order to stay even. For example, American universities have increased tuition at twice the rate of inflation over the past 10 years (75% tuition increase vs. 36% inflation). During the same decade, the median family income only increased about 10%.[1] This, along with other factors, has heavily increased the pressure for the university to provide financial aid. Over the past 20 years federal assistance has shifted from scholarship grants to loans, which place additional debt burdens on students and their families. In 1980, about 42% of federal aid was in the form of loans; in 2000, the proportion had increased to approximately 60%.[2] It's a vicious cycle.

To compound matters, the "customer base" of potential engineering students has shrunk significantly over the past 20 years. The fraction of high school graduates interested in engineering has declined from 12% of the graduating class in the early 1980s to 9% last year... a 25% drop. This is further exacerbated by the fact that the overall population of college age students declined 20% between 1981 and 2000. All of this means that the engineering schools have had to compete for a bigger piece of a smaller pie. This has caused universities to incur added costs for marketing and advertising to increase market share and fill the freshman class. This year, WPI launched a multimillion-dollar television and radio marketing campaign in order to compete for market share. This is a first-of-its-kind investment for this 137-year-old institution.

While universities have been facing increased costs and a shrinking market, it should also be noted that they do not have the same cost-cutting flexibilities as do industry and many other non-profit businesses. University professors are tenured... making it more difficult to execute layoffs, terminations, or reassignments. And most physical plant costs for classrooms, laboratories, and other support functions are fixed. Schools can't easily downsize or move to a cheaper labor market. It is difficult for university administrators to justify new investments in an entirely new academic degree program... especially in a nontraditional, little-known discipline like FPE.

SHORTAGE OF PROFESSORS

University professors are the backbone of any academic program, and it is extremely hard to find candidates who fit the profile universities normally demand when hiring new faculty.

The typical university professor has three degrees – B.S., M.S., and Ph.D. – in the discipline within which he or she is hired. A new assistant professor has typically spent 10 years studying at several universities and has conducted significant Ph.D. dissertation research under the direction of a senior expert in the field. Fire protection engineering does not have this luxury. WPI's FPE program has five fire protection engineering professors. None of them has three degrees in the FPE discipline. They all received their fundamental education in one of the founder disciplines: mechanical or civil engineering.

If one thinks about this within the context of the university culture, FPE professors are somewhat at a disadvantage. New professors in the founder disciplines begin their first faculty job with many years of academic momentum. A mechanical engineering professor, for example, has been studying mechanical engineering at the B.S., M.S., and Ph.D. level for a decade. Teaching a junior- or senior-level ME course is relatively easy... the subject matter is very familiar. The new ME professor has more time and energy to spend on preparing for tenure and promotion, while the FPE professor has the added burden of getting up on the learning curve in new fire-specific areas he or she never studied in their own undergraduate or graduate coursework. Unlike the founder disciplines, there is not a robust feeder system of faculty candidates for new positions, candidates who have completed formal undergraduate and graduate education in FPE.

SHORTAGE OF RESEARCH FUNDING

Research is of importance to engineering degree programs of all kinds for several reasons. First, part of the role of academe is to uncover and disseminate new knowledge through teaching and publication in the archival literature. Research keeps university professors on the cutting edge. And their involvement in the research community helps them bring fresh, state-of-the art information to the classroom. On the operational side of the equation, there are some more pragmatic reasons research is important. This has to do with the fiscal crunch of engineering schools in general and the issue of tenure.

Tenure is certainly a concept that distinguishes the academic institution from most other workplaces. Once a professor earns tenure, it lasts for the remainder of his or her career. Basically, a tenured professor can only be involuntarily terminated for misconduct or when the academic program is shut down. The tenure decision is basically made by a tenure committee of professors. Typically the decision comes in the professor's sixth year. If the decision is no, the professor is terminated. If the decision is yes, he or she is granted tenure.

The tenure decision is based on the candidate's record and potential for future excellence in three areas of performance: teaching, service, and scholarship. To receive tenure, the candidate must demonstrate good teaching, service to the profession, and good scholarly performance (research). A professor's research is expected to contribute to the body of knowledge as documented in scholarly journals, textbooks, and other forms of the literature.

The research or "scholarship" criterion weighs heavily in the tenure equation and can be the big challenge for any new professor in any discipline, but especially FPE. The phrase "publish or perish" is more than a slogan. It is a sober reality.

How does a professor get research accomplished? The answer to this question most often involves graduate students. Most university professors are very busy people. They are usually employed on a nine-month salary, and the academic year is very intense, with preparation for class, teaching, advising, service, and a host of other duties. Graduate students are recruited to do a bulk of the research legwork, under the supervision of the seasoned professor. And the research forms the basis for the student's thesis or dissertation.

Normally, in engineering disciplines, graduate students do not agree to work on a professor's research without remuneration. They usually receive research assistantships which cover tuition and a stipend for living expenses.

For the most part, the money for supporting graduate student tuition and stipends, and summer pay for professors doing research, is not funded by the university operating budget. Most often the funding comes from off-campus sources. Research grants and contracts also provide revenue for the university.

A typical graduate student would be paid about $30,000 a year for serving as a research assistant. This, combined with charges for the professor's time plus university overhead, brings the total cost to sponsor a graduate student to a total of $50,000 to $60,000 per year. The M.S. with thesis normally requires two years' time; the Ph.D. another three or four years.

Following this research support model, it is clear that, in addition to their teaching and research skills, professors must have entrepreneurial talent in order to secure the external funding needed to establish and operate a robust research program... skills in addition to those needed to be a good teacher and scholar. The money normally does not come from the school, it must come from outside sources. And, like everything else, there is a lot of competition for the research dollar.

FUNDING SOURCES

Research dollars come from external sources such as government or industry. Some government agencies, such as the National Science Foundation (NSF), are mandated by Congress to fund research. Other agencies, like the military services, FAA, and Department of Energy (DoE), fund research that supports their mission. And industries fund graduate students and professors who are willing to work on projects that are in the sponsor's commercial interest.

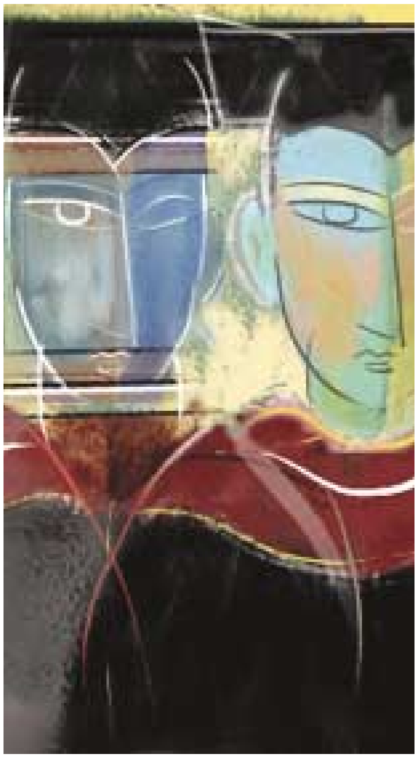
The National Science Foundation is the prime research funding source for university professors and their graduate students. The NSF budget is currently about $5 billion, with support going not only to engineering and the physical sciences but also mathematics, biology, computer and information science, geoscience, and the social and behavioral sciences. In years past, there was a fire research program at NSF. In 1973, NSF fire research funding totaled $2.2 million (which, with inflation, would be $9.6 million today). While modest in amount, this NSF program did support some important research outcomes... fire modeling to name one. Harvard Professor Howard Emmons, universally known as the father of computer fire modeling, received ongoing fire research support from NSF. During his career, Emmons produced 50 Ph.D. graduates, several dozen of whom concentrated on fire research. This program was shut down in 1973, and NSF has not had a fire research focus since.

The Emmons story is a great example of the importance of ongoing research funding. NSF support was robust enough to enable high-quality research over a long enough period of time to yield real tangible results. And the value of Harvard's output was not limited to the research results themselves. Many of Emmons' students went on to contribute lifetimes of fire safety work to society. These include noted professionals like Dr. John deRis at FM Global Research, Dr. David Evans at NIST, and Dr. Craig Beyler at Hughes Associates. There was critical mass at Harvard, a community of talented scholars who, over the years, made incremental progress toward major accomplishment. Research funding was the enabler. When Emmons retired and the funding ended, Harvard lost interest.

In 1974, the Fire Prevention and Control Act created the Center for Fire Research at the National Bureau of Standards, now the Building and Fire Research Laboratory (BFRL) at the National Institute of Standards and Technology. At that time, a $2 million fire research grant program was put in place, with the idea of continuing support of some of the former NSF-sponsored research. The fire research grant program at BFRL is now about $1.4 million (compared to $8.7 million if the original grant program had simply grown with inflation).

Other government agencies support fire research that assists them in fulfilling their specific mission-related objectives. The SFPE recently released a survey which documents federally funded research totaling some $37 million.[3] The bulk of these research expenditures goes to support the salaries of federal research staff workers, consultants, and contractors, with a smaller amount for university research grants. About 14% of the dollars go to supporting university professors and students; about 1.2% to FPE schools. Indeed much of the work is shorter-term, "contract-deliverable-oriented" and is not particularly amenable to higher-risk M.S. thesis or Ph.D. dissertation work.

In the end analysis, sources of fire research funding for university FPE professors and students are limited, which is a key factor inhibiting the startup of new programs. New programs need new professors; professors need tenure; tenure needs research papers; research



needs graduate students; graduate students need financial support from off-campus sources. A break anywhere in this chain can make for a difficult situation. The existing FPE programs must struggle and juggle to keep all these variables working in the right direction.

THE FUTURE

So far, the picture painted above could be viewed as pretty grim. The climate has not been favorable for universities to decide to create new programs in nontraditional disciplines. In fact, during the most recent decades, several established FPE degree programs were shut down. The Illinois Institute of Technology's BSFPE program was terminated in the mid-1980s. It was the flagship program, having been the first in the U.S., started in 1903. The MSc program at the University of Edinburgh was shut down during the same era. In fact, WPI president Jon Strauss proposed shutting down the WPI FPE program in 1989... it was only the protests of friends and alumni that saved the day. Dr. John Bryan, the founding FPE department head at the University of Maryland, reports similar threats during his tenure. The University of British Columbia started and terminated a program as well over the past decade.

There is little doubt the demand for FPE graduates will continue to grow. The demand has been wholesome for generations; there is no reason to believe it will not continue. The emergence of performance-based building codes in Australia, New Zealand, and the UK, as well as other countries, has been another employment driver for FPEs. In 1999, Australian fire protection engineer Peter Johnson reported, "There is now a major fire engineering consulting industry in Australia that was not evident at all in 1991."[4] The first American model performance-based building code was just released by the International Code Council (ICC) in 2001. As it is adopted into law in states, cities, and counties throughout the U.S., it, too, will be a driver for more FPEs. And the World Trade Center event has set a new context for the use of FPEs on the design teams of the future.

And so we find ourselves in this conundrum. On the one hand, FPE offers a wonderful product which is in high demand and which serves the public good. On the other hand, we see a somewhat grim picture as to the future of FPE degree programs, at least for establishment of more new programs. Yet there are reasons for optimism.

• Fire research funding may get better

Most of us have been hoping for a very, very long time that our federal government would place stronger policy-level emphasis on fire research. Hope was piqued in 1973 when, in its report to Congress, the National Commission on Fire Prevention and Control recommended that the federal fire research investment be increased by $26 million per year ($113 million in today's dollars).[5] This was to come to naught, but some renewed efforts are being seen. Hearings have been held by the House Science Committee in the wake of the World Trade Center collapse, and $16 million has been appropriated to further investigate the incident. (It is interesting to note that the SFPE Research Agenda[6] developed in 1999 did not mention structural fire protection on its list of priorities. The agenda was created during a two-day workshop involving 70 participants from all segments of fire protection practice. Priorities then were risk-based concepts, fire phenomena, human behavior, and data.)

And, prior to the September 11 disaster, on its own initiative NSF took a renewed interest in fire research. In 2001, NSF engaged the National Research Council to "develop a clearly articulated statement of research, education, and technology transfer needs for improved fire safety in the United States." A workshop was held in Washington, D.C., in April 2002; its report is expected in early 2003. It is hoped that this NRC report will add another credible focus to national fire research needs in the U.S.

• Expanding degree programs using advanced technology

There is reason for optimism about future opportunities for expanded FPE degree programs, worldwide. The future may see creation of some additional "bricks-and-mortar," on-campus programs of the type we are used to seeing, with professors lecturing to students in the on-campus classroom... programs which can produce more graduates and provide the research laboratories needed to do scholarly work and contribute to the body of knowledge. And real breakthrough opportunities are available through advanced communication technology, the same technology the for-profit industrial sector uses every day to conduct global business operations.

Today the professor does not always need to be in the same room with the student. Distance learning technology can bridge the oceans and link students in any country with professors in any other country. It is estimated that 86% of American colleges and universities will offer distance learning of one kind or another in 2002, up from 62% in 1998.[7] It has been estimated that distance learning enrollments increased from 500,000 to 2,000,000 during the same period. This approach to higher education in FPE can open up entirely new ways of thinking.

The proof of concept has already been accomplished for development and delivery of high-quality, university-level FPE courses to students continents away from the professor. WPI has been doing this since 1993 and now offers 14 full-semester courses via distance. Over one-third of WPI's FPE enrollees are practicing professionals who cannot leave their jobs and come to Worcester for instruction. The technology works well. WPI has graduated students with the MSFPE degree who have never set foot in Massachusetts. But much more can be done, especially with the younger college-age population and with interscholar cooperation.

• Talent sharing

When we open our minds to the new paradigm which allows that the professor and the students do not have to be in the same room at the same time, lots of interesting ideas can emerge. For example, WPI realized that it is possible for on-campus students to be taught by professors at other universities. Last year, UC Berkeley Professor Patrick Pagni taught a course in fire safety science for his UCB students in California and simultaneously delivered it to WPI on-campus and distance learning students. He was merely appointed as a WPI adjunct professor, and the technology took care of the rest. This was a highly successful course, bringing a specialized expert to the WPI curriculum in a way that would otherwise have been impossible.

Last year, one of WPI's distance learning students in the State of Washington wanted to take a lab course to learn how to use a specialized ignition apparatus which was available in a local laboratory. Dr. Vyto Babrauskas happened to live in the area, and he was agreeable to teaching the lab course to the student... again as a WPI adjunct professor. There are experts at universities and government/industrial fire research labs worldwide, of the caliber of Pagni and Babruaskas, who can potentially serve as specialized teachers for engineering students at any engineering school, using remote-learning strategies.

• Interuniversity networking

Over past years, the line of thinking for universities starting FPE programs has followed the path that has been familiar to WPI and all other schools, i.e., an on-campus program, with on-campus professors, staff, offices, and laboratories. But again, the distance learning paradigm can open up new lines of thinking. Does each and every FPE school need to have all the program elements, or can elements be shared? Sharing and collaboration are definite possibilities.

In 1999, WPI and the University of Costa Rica (UCR) began working together to help UCR get an FPE program started. The University of Costa Rica had approval from the university leadership, but did not have the resources to hire a cadre of FPE experts to form a complete, self-sufficient academic department. WPI worked with UCR, making WPI's distance learning courseware available to UCR professors. For example, UCR used WPI video-recorded lectures as "video textbooks" for UCR students. Over the past three years, UCR has made remarkable progress in developing and delivering FPE courses tailored to their local needs.

Another approach is underway in Korea, under a new Memorandum of Understanding with Seoul National University (SNU). There, some 18 FPE students are meeting as a class on a weekly basis to receive graduate instruction which will lead to the MSFPE degree. Courses are taught in various formats: (1) directly by WPI professors via distance learning; (2) jointly by WPI and SNU faculty; or (3) by SNU professors working in areas where they have specialized expertise, such as process safety management and industrial fire protection. The program in Seoul would not have been possible were it not for the school-to-school cooperation and distance learning technology.

• Reaching college-age students

The recruiting of young men and women into FPE is an "easy sell." For some young folks, there is an attraction to careers that make a difference, something "different." Fire protection engineering can be seen as fun and cool. But it is difficult to reach high school students, because of the large numbers and the small fraction that is even interested in engineering (less than 9%).

There are over 300 engineering schools in the U.S., with nearly 400,000 young men and women who have been "prescreened" with an interest in engineering. A surprising fraction of them really do not know what discipline they might end up choosing. They are also candidates for recruiting into FPE.

To take this a step further, the distance learning paradigm can open up new lines of thinking for this group of potential FPEs. All of these 300+ engineering schools teach the fundamentals needed by any FPE – math, physics, chemistry, statics, dynamics, fluid mechanics, thermodynamics, and heat transfer. And potentially they can gain access to FPE courses via distance learning. This is a chance to introduce them to the formal discipline of FPE while they are still undergraduate students at their home universities. For example, one young woman graduated last year from Illinois Institute of Technology with a BSCE degree and a minor in FPE. She earned FPE credits by taking several courses from WPI by distance learning, using them as transfer credits toward her IIT civil engineering degree. She has now taken a job with Rolf Jensen & Associates in Chicago. Ultimately, she has the option of going on to finish her MSFPE having already completed some of the M.S. degree requirements at WPI. ▲

David Lucht is with the Worcester Polytechnic Institute.

REFERENCES

1 "Financing Higher Education", *Journal of the New England Board of Higher Education*, Volume XVI, No. 2, Spring 2002.

2 "TRENDS in Student Aid", *The College Board*, 2000.

3 "Federal R & D for Fire Protection Engineering: A Baseline Report." Society of Fire Protection Engineers, Bethesda, MD, 2002.

4 Johnson, P.F., "Benchmarking the 1991 Conference Report: How Far Have We Come?", Proceedings of the Second Conference on Firesafety Design in the 21st Century, Worcester Polytechnic Institute, Worcester, 1999.

5 "America Burning", Report of the National Commission on Fire Prevention and Control, April, 1973.

6 A Research Agenda for Fire Protection Engineering, SFPE, Feb. 2000.

7 "Online Distance Learning for Higher Education," 1998-2002, International Data Corporation.