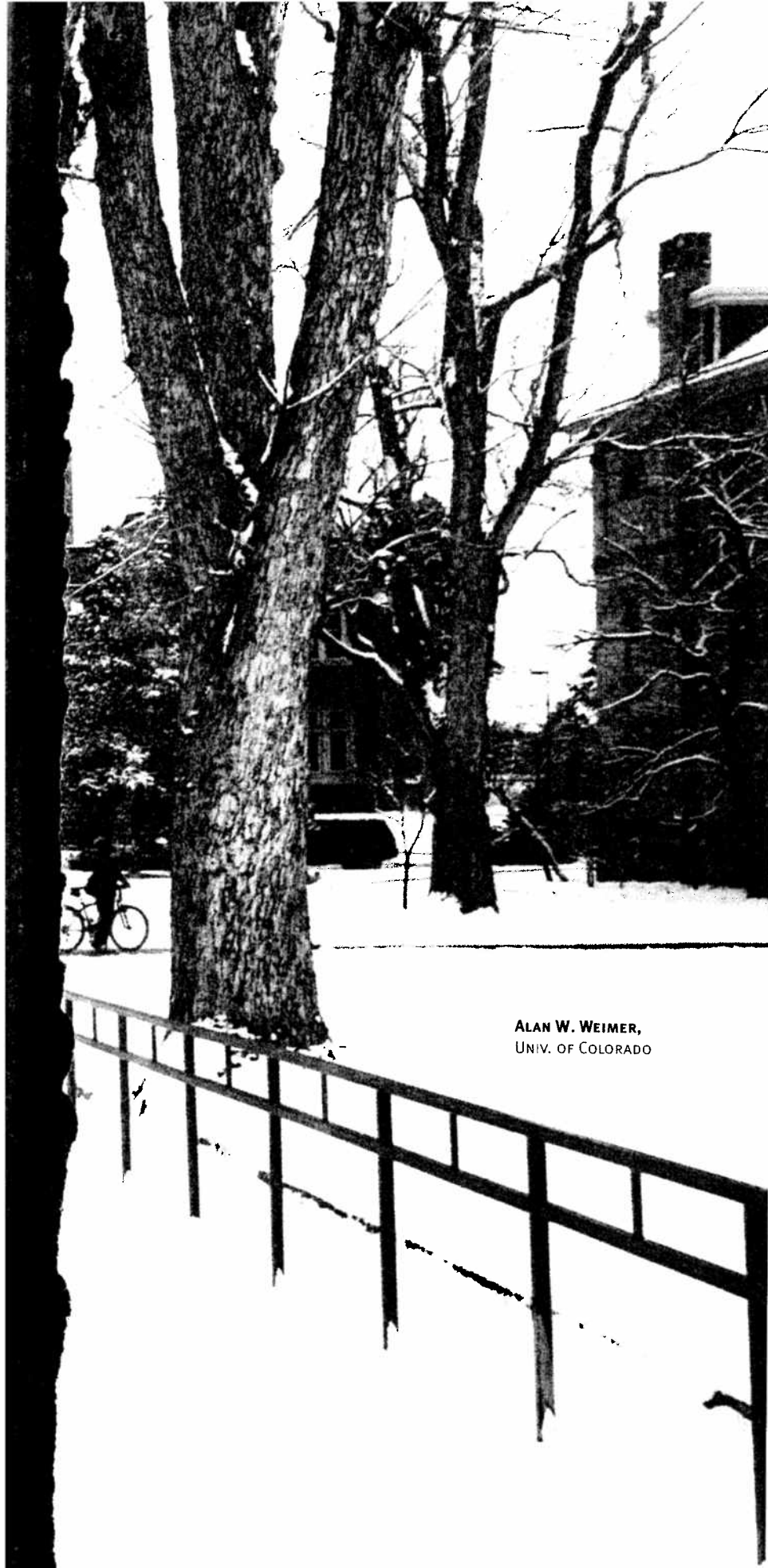


Successfully
Switch from
Industry to
Academia

**Here's what
you should
know if you're
considering
making the
transition.**

Many industrial chemical engineers wonder what it would be like to teach and conduct research as a faculty member at a major university. Likewise, many university search committees wonder what it would be like to hire an engineer from industry. The fact is that few connections have been made and so most major research universities today have chemical engineering faculties with little to no industrial experience.

There is a huge disconnect between the public perception and the reality of an academic position. This article discusses the job requirements for an academic professor, the advantages and disadvantages of industrial experience, why so few industrial engineers are given the opportunity to make the transition, and what can be done about it.



ALAN W. WEIMER,
UNIV. OF COLORADO

Academic job responsibilities

A typical faculty position at a major research university has three primary job responsibilities: teaching, 40%; research, 40%; and service, 20%. The actual weightings will vary from school to school.

As a rule (there are exceptions), no research institution hires an industrial engineer into a tenured or tenure-track faculty position just to teach capstone design. Although the ability and desire to teach the applied courses are big pluses, the new faculty member is generally hired to develop a research program.

For the faculty member to obtain tenure at a truly elite research university, the research program needs to be world-class, and the teaching ratings are basically irrelevant. At the other end of the prestige spectrum, if the professor is doing anything at all in research and getting decent teaching ratings, it's probably good enough. However, the typical major research university generally expects a new faculty member to develop a strong and independent research program and to earn good teaching ratings. These are almost always prerequisites for hiring and advancement.

The industrial engineer will only be hired into a conventional tenured or tenure-track academic position (at a major research university) if that faculty believes that he or she can obtain substantial research support. With that said, the most unfamiliar and formidable aspect for someone considering the transition into academia is that a significant part of the academic job is writing proposals to secure research funding.

Obtaining support for research

Since the ability to attract research funds is critical to the faculty hiring decision, it's important to discuss the advantages and disadvantages of industrial experience in that regard.

An overwhelming percentage of research support comes from government sources, and the decision of whether or not to fund a research proposal is based on extensive peer review. The peer reviewers are almost all academics, and the process is quite different from the industrial review process.

In industry, the peer review is almost immediate – an engineer's idea will be discussed quickly and openly within company boundaries. The academic review process is much slower, typically taking as long as nine months, and it is done confidentially.

In industry, the proposer will know his/her critics and will be able to respond directly to any criticisms; discussions will ensue and refinements to the proposal can be made quickly. In academia, the proposer will not know

who the reviewers are and will generally not be able to respond to any criticism except by rewriting and resubmitting the proposal. Often, any rewrite to address the criticisms and improve the proposal may be for naught, since a resubmitted proposal will usually (though not always) be evaluated by a different set of reviewers who have no idea of the previous criticisms.

Because academic research is generally basic rather than applied research, much of the industrial training that is directed toward process development, economics, and near-term profitability is irrelevant in the academic's quest for government agency funding. In order to receive "excellent" peer reviews, a requirement for funding, the proposal must have novelty and preliminary data indicating a high probability for success. A proposal cannot be too exploratory. It also must be extremely well-organized and well-written, and the research plan must be solid. The researcher must have a track record indicating past success and the reviewers should know the person's work.

Of course, for academic peers to be familiar with one's work, it is imperative that the industrial engineer academic "wannabe" have a publication track record in peer-reviewed research journals. This is very difficult, since industry typically has little to no reward for – and often discourages – external publications by their employees.

Even with all of these attributes, the odds of success for a proposal, on average, are between about 10% and 20%. The odds depend totally on the program and the funding agency. With some programs, the hit rate may be 50% or higher; with others, one has a better chance of winning the lottery. There is no doubt that the most frustrating aspect of an academic's job is the seemingly never-ending hunt for research support.

Experience can help in getting support ...

Some aspects of industrial experience can be beneficial to obtaining research support, such as:

- diverse industrial project experiences that provide a unique background, allowing research in an array of areas;
- project work on multidisciplinary teams that provides a first-hand understanding of the benefits of collaborating with scientists and engineers from other disciplines;
- quality project ideas resulting from work that was shelved because of some real problems that needed to be understood and solved; and
- a better understanding of what industry needs and an array of contacts that result in a better opportunity for direct industrial support and an easier partnering with industry on collaborative proposal opportunities.



A requirement for academic research success is having the flexibility to develop expertise in areas different from, but related to, one's base expertise. Rapid technological changes and limited funding opportunities are requiring researchers to expand their work into somewhat unfamiliar areas. Those academics who can respond quickly to needs in new areas and who are willing and able to carry out work in multiple areas will be more successful. Transitional academic faculty with substantial industrial experience should have a significant advantage here, since the industrial culture requires them to work in a broad range of research areas.

Most major scientific breakthroughs result from researchers in different disciplines and with different expertise working together to solve a problem. Industry understands this, and so industrial project work automatically progresses through multidisciplinary teams. Such arrangements allow engineers to learn rapidly from other engineers and scientists who have expertise in other disciplines. Such interaction provides an appreciation for the power of this type of collaboration and a framework for desirable multidisciplinary collaborative academic research.

About 95% of all industrial research projects never produce positive lasting results. Although most of these "nonsuccesses" are probably the result of a market that hasn't yet developed, many of them have technical challenges. So, an industrial researcher making the transition to academia will have a chest full of good ideas for problems that need to be solved.

It is important that any trade secret and noncompete agreement issues be resolved prior to the start of any academic research in areas where the industrial engineer previously worked. This is a very sticky subject because, just as companies take their employee confidentiality provisions seriously, universities take the academic prerogatives of their faculty equally seriously and want to ensure academic freedom and the ability to conduct research and disseminate the findings. An outstanding win-win situation is one where the former employer supports research being carried out by the transitional academic.

If anyone can attract industrial interest for direct project support or for collaborative support, it should be an academic with substantial industrial experience. Such a faculty member understands the needs of industry much better than an academic without such experience. Some of these needs include an ability to respond quickly, an appreciation for simplicity and cost/performance economic factors, and an appreciation for the value of intellectual property. Many grant opportunities require industry/university collaboration, and a faculty member with substantial industrial experience has a clear advantage in developing the needed relationships.

... Or it can hurt funding efforts

On the other hand, substantial industrial experience may be detrimental to the new academic's ability to establish a strong and independent research program. Three disadvantages of industrial experience are:

- too much industrial experience will disqualify the new academic from applying for special research restricted to researchers within five years of obtaining their PhD;
- the new academics will have to focus on convincing the peer reviewers that they are truly doing basic research and not process development; and
- the transitional academic may be seen as having a shallow understanding in a lot of areas (*i.e.*, the industrially desired problem-solving generalist).

It is essential that new academics make rapid progress in their quest for research support. Their case for tenure depends on it.

To provide unique opportunities for new faculty, major funding has been set aside specifically to help them establish their research programs. The number of these "Young Researcher Awards" available from various government agencies is impressive, and they are quite effective at helping deserving young faculty members get started.

These awards vary in their restrictions, but, in general, any new untenured faculty member within five years of receiving a PhD is eligible. The National Science Foundation Career Award is more progressive and starts the five-year clock at the time of the academic appointment, provided the new faculty member is not tenured.

Faculty search committees look favorably on those candidates eligible for this type of startup funds. Likewise, if a candidate is not eligible for these awards (*e.g.*, an industrial engineer with more than five years of experience following the PhD), the perception is that he or she may have a more difficult time starting up a research program. This is one reason (but not an overriding one) why some chemical engineering departments opt to hire a new PhD or a post-doc with one or two years of experience instead of the industrially experienced engineer.

A highly respected peer told me that if he reviews my research proposals, he will especially look to make sure I am doing basic research and not process development. His concern is that my industrial experience will tend to sway my work toward development. I appreciate his candor and recognize that I need to address this very real issue in every proposal I write. In general, industry does very little or no basic research. Thus, engineers making the transition from industry to academia will need to bear this in mind.

Another possible disadvantage for industry-to-academia wannabes is that their experience is broad, but relatively shallow. Industry today needs to research, invent, modify, develop, and implement quickly in order to keep pace with the rapidly changing markets that dominate the global economy. With the significant downsizing that has occurred in the past five to ten years, there is less time now to study problems in-depth. Hence, those engineers who can respond quickly to solve a broad range of problems are most valued within industry. Engineers who are successful in industry strive to be recognized as problem solving "generalists."

In academia, grants are awarded to academics who have in-depth knowledge in the key area of the proposed research. The broad experience base that is an advantage in industry is detrimental to the academic, if that experience base is shallow. There is not much research funding today for the academic generalist.

Teaching

Undoubtedly industrial experience can help considerably in teaching. Professors who have "walked the walk" are able to bring real-life examples into the classroom – not just related to textbook examples, but the real issues surrounding today's work environment.

In my classes, I discuss the importance of teamwork and encourage the students to do homework in groups.

I emphasize good communication skills and count grammar and spelling 10% of the report grade in the capstone design course. We require numerous oral presentations in chemical engineering laboratories and in the design course. Many students have reminded me that capstone design is not an English course. But then, I tell real-life stories of how poor communication skills have prevented people I have known from getting promotions that they may have otherwise deserved.

I discuss the importance of lifelong learning for success in today's work environment, and I encourage students to seek additional responsibilities in the workplace and always stretch themselves to a point where they feel somewhat uncomfortable as they learn new things. Feeling comfortable in a job may mean that one is not learning enough new aspects of the work.

I emphasize the importance of early investing in retirement plans. (We study the time-value of money and how the students can all be millionaires by investing early and routinely in their 401Ks and IRAs.) I emphasize the importance of working for employers that have portable pension plans. I also point out how setting down roots in a

metropolitan area can allow job switching that involves just driving somewhere else to go to work.

The students are most intrigued by the open-ended design problems I give for homework (many of which are based on my own industrial experiences) and the real-life stories I tell. It is natural for faculty with substantial industrial experience to teach these things, because we lived them. There is no substitute in the classroom for real-world experience.

The capstone design course is one where a professor with significant industrial experience can have a major impact. Because of the applied nature of this course, most faculty prefer not teaching it, and many would do a poor job. Most faculty do best teaching courses in areas where they have active research programs, and design is usually not among them. The capstone design course involves process creation, open-ended design problems that encompass numerous unit operations, costing, and profitability analysis. Since these activities are inherent in the industrial setting, an academic with industrial experience is quite at home teaching this course.

The life of a startup professor

To those who may think that a professor comes to school and teaches class three times a week and has the life of leisure in the Ivory Tower – think again! Most startup professors will work 60-h to 80-h work weeks. No one else is there to lead a class if he or she isn't prepared. Students start coming in at 9 am with questions, and faculty who assign homework need to support it with an open-door policy and time for students. It is difficult to keep the class going at a fast pace and to write those research proposals that have the 10-20% hit rate.

This schedule may last for years, until some sort of steady state is reached regarding research. Then perhaps the work time may be reduced to 50-60 h/wk, mainly because the professor can, for the most part, teach the same courses and because some proposals are improvements and resubmissions.

Summers are not free. The professor is writing research proposals and papers, generally catching up with graduate students, and doing course development work.

One saving grace is that, in academia, the individual has a lot more control and flexibility over time and generally knows what's coming. He or she can pick the 60 hours of the week to work! However, the proposal writing seems to never end.

Although the service work can be exhausting, I generally find it rewarding, as it usually involves students. I think



a lot of the service responsibilities I am assigned are the result of my colleagues believing my industrial experience has advantages in my interacting with students and telling them about the real world. I am a sophomore class advisor and the AIChE student chapter advisor, I arrange talks for the undergraduate seminar course, and I chair the shop, safety, ABET, co-op, and industrial outreach committees. These service functions, in addition to my work with the professional organizations to which I belong and my obligation to review papers and proposals being submitted for publication or support, keep me busy. I also write about 25 letters of recommendation per year for students.

To be successful in this profession, one needs to be a self-starter and have excellent time management skills. One must be able to communicate well and to have a certain patience and enjoy working with students. One needs to be resilient and must love to write (papers and proposals). One must be a good manager of people and of money.

I think being a university professor is as close as one can come to running one's own business, but without the capital investment concerns. One must be able to support graduate students with funding. Once funding is available, one needs to be able to attract good students to the projects, because the faculty member doesn't have the time to do the research, but rather accomplishes it through students as they explore and learn. The faculty member's bottom line must be black, and there is no more of that picking fittings out of community bins and not really caring or even knowing how expensive they are. You're paying.

If you're considering the transition

I have been asked numerous times what I would recommend to someone considering a similar move. The main thing to consider is that major research universities hire new faculty based on their perceived ability to develop a strong and independent research program. Hence, factors affecting this ability are crucial to hiring decisions.

To be recognized in the field by peers, you must publish in peer-reviewed research journals, present papers, help coordinate technical sessions at professional meetings, and network with academics. Publishing is extremely difficult and relatively unrewarding, since it is not necessary and is even discouraged within certain industries. However, remember the lifelong learning requirement and consider this a part of it.

The teaching element is also important. Academic departments are concerned about hiring an industrial researcher at an advanced level with no teaching experience. You can evaluate your teaching skills by teaching short courses, either in-

ternally or outside of your company, and possibly partnering with a professor who teaches evening classes locally or through a community college. Successful teaching experiences are highly valued during the academic job search. If you find that you are unhappy teaching in these situations, you will be unhappy in the academic environment.

Faculty positions are difficult to obtain, as 50 to 100 or more applications are usually submitted for each opening. The competition is fierce and often only junior-level positions are available. Someone with one or two years of postdoctoral experience at a major university or government laboratory will usually get the nod over the engineer with substantial industrial experience. The young postdoctoral candidate has the ability to seek set-aside startup support that the industrially experienced candidate may not be eligible for. Also, academics tend to hire their own (someone directly from academia) and often think it's risky to hire an industrial person (who likely has no teaching experience and is unfamiliar with the proposal writing process).

Nonetheless, an industrial candidate who has a solid publication track record and good, potentially fundable research ideas should have a reasonable opportunity to land a faculty position. Often, the best opportunities are with your own alma maters since the faculty know you. Networking is critical to obtaining an academic interview.

However, even with one or two peer-reviewed publications per year (an extremely difficult accomplishment), excellent professional service, and an outstanding industrial research record, it is common for an industrial applicant to be rejected on the first review. Remember, the perceived ability to jump-start a strong and independent research program normally outweighs a perceived ability to teach.

The disconnect between industry and academia

There is a disconnect between engineering education and the applied nature of the engineering profession. Engineering faculty, for the most part, are no longer traditional engineers – they are, generally speaking, physical scientists, and they pursue fundamentals almost to the total exclusion of applied engineering.

I believe that much of this has been brought about by the drop-off and current lack of significant academic funding by industry. Without substantial industrial support for academic research, faculty have been forced to compete with the physical sciences for nationally provided funds (e.g., from the National Science Foundation, National Institutes of Health, etc.). Engineering departments have retooled and are staffed with those capable of landing such



funding. This retooling of faculty has been a major contributor to the current disconnect between industry and academia.

Since professors in most U.S. chemical engineering departments are not experienced engineers (if they are engineers at all), they have a very difficult time teaching undergraduates how to solve the complex problems industry wants solved. In industry, there is often no time or money to really search out the fundamentals. The tools for doing so are quite different than those needed to find a workable solution quickly and affordably and then implement it in the marketplace. This is the essence of the disconnect! Industry must have people with such training. Generally, the current faculty can't supply them, so they seek to hire transitional industry-to-academia engineers to teach applied engineering to the students who otherwise may go unserved.

Industry-to-academic transitional faculty (ITATF) generally seek a balance between the fundamental and the applied in their research. Because of this, they are viewed in some circles as less capable or less "academic." The reality is, however, that all "applied" problems have important "fundamentals" that must be understood and all "fundamentals" problems have important "applied" consequences, if the work is properly carried out.

The difficulty that ITATF have is that, to be successful, they must succeed in securing national funding, just like any other new faculty member. ITATF provide an opportunity to bridge the disconnect between industry and academia. But, they need industry to support them in their quest for research success. If they are forced to seek all of their support through the same route as the physical scientist, the opportunity for them to bridge the academic/industrial disconnect is in jeopardy. It is only with a substantial influx of industrial support that university engineering departments will be able to find a balance between teaching and research, and a balance between fundamental and applied research.

Faculty service responsibilities may involve supervising students conducting outreach activities.



NSF and other funding agencies recognize this need and now have various program opportunities tied directly to academic/industrial interaction. However, this is not enough. Industry needs to be more directly supportive and involved.

A role for industry

Many articles have been published recently criticizing engineering education in America today. The main criticism revolves around the lack of industrially experienced faculty and the resulting disconnect we've discussed.

As mentioned earlier, there is no doubt that industrially experienced faculty readily emphasize teamwork, good communication, and lifelong learning in their courses – because they have lived this. This emphasis comes naturally and companies want to hire students with these skills and values.

Corporate America needs to help smooth the transition from industry to academia and to encourage chemical engineering departments to hire industrial engineers. There needs to be a mechanism for providing support that allows these faculty to develop their research programs and eventually obtain tenure.

Frequently, these individuals have made significant contributions to their companies and have professional connections that would allow supported industry/academic research projects in areas important to the companies to take place. They usually have a sense of loyalty to their former employers and are in a position to encourage their best students to consider employment with them. These types of relationships would be win-win partnerships. However, when the industrial environment becomes impersonal and short-term-profit oriented, these types of relationships don't automatically develop.

Major chemical engineering employers do support academia through matching donations of their employees and small gifts through their recruiting departments, and the like. However, none of these impacts the hiring and tenuring of industrially experienced faculty.

I highly recommend that industry consider more supported research projects with faculty, industrially sponsored endowed chairs, or startup funding to support indus-



try-to-academia engineers in the transition. Since most of the ITATF come from large Fortune 500 companies, it seems appropriate that these companies could recognize the long-term payoff of such a partnership and provide this type of support.

Industry should also assume a larger role in the undergraduate educational process. Corporate executives should encourage and promote interaction between their employees and faculty with regard to course projects and seminars. Rather than being considered low-value work, implying work that does not directly impact the bottom line, such interaction should be encouraged and used to develop an image of a caring company on campus. Most corporate executives don't seem to realize the significant impact a company's image on campus has on the firm's ability to attract and hire students.

Academia's role

Chemical engineering departments need to rededicate themselves to finding balance in their faculty. They need to reach out and take risks, and hire a few academic wannabes from industry now and then.

Once hired, these ITATF should not be forced to change the nature of their work or how they do it. It should be okay to do applied research. There are important fundamentals to be studied in all applied problems and vice versa.

More industrial money should be sought. Balance will be achieved only when engineering departments find balance in their funding.

It's important for some engineering faculty members to be traditional engineers in order for departments to achieve the balance needed between teaching and research, and the balance between applied and fundamental research. I believe that industrial support is an untapped resource. Those who understand the way industry operates will be in a position to capitalize on it. No one is better prepared for that than the ITATF.

Final thoughts

There is no substitute for industrial experience in the classroom. Academics with substantial industrial experience generally relate well to students and can excel in the teaching of applied courses like capstone design. However, the research startup phase for a new faculty member is stressful and may be difficult, so universities may be reluctant to hire industrially experienced faculty. Hence, mechanisms need to be developed to help encourage and support the transition of industrial engineers into academic roles.

The ITATF members provide a unique opportunity for chemical engineering departments to achieve more balance in their programs and to bridge the disconnect that exists between industry and academia. Universities should hire some industrially experienced faculty. Then, industry needs to play a more significant role in supporting them. The partnering of faculty with former employers and general industrial support for educational and research initiatives are powerful means for providing long-term beneficial relationships regarding hiring, a positive company image on campus, the education of future chemical engineers, and allowing basic research that companies normally don't do. The barriers inhibiting industrial support of academic research in the U.S. need to come down. These barriers may include both intellectual property agreements on the part of academia and the manner in which industry today is so focused on short-term earnings.

I want to conclude by saying that I consider my academic faculty position the best job in the world. The direct impact I have on students gives me a sense of value in my work. The greatest thanks I get are in the many thank-you notes I receive at the end of each semester. This position allows me to make a positive difference in the lives of many future chemical engineers. **CEP**

A. W. WEIMER is a professor of chemical engineering at the Univ. of Colorado (CU), Boulder (Phone: (303) 492-3759; Fax: (303) 492-4341; E-mail: alan.weimer@colorado.edu), where he leads a research program in fluid particle processing, with applications directed toward sustainable environment and advanced materials synthesis. Prior to joining the CU faculty in 1996, he was an associate research scientist with the Dow Chemical Co., where he had been employed since 1980. He received Dow's 1995 "Excellence in Science Award" for his coinvention, development, and commercialization of the rapid carbothermal reduction (RCR) process. He was awarded the first Chemical Engineering Faculty Mentor Award by the May 2000 graduating class for his "exemplary teaching, advising, participation in student functions, open-door policy, help in job placement, and time to talk to students." He holds a BS from the Univ. of Cincinnati and a PhD from the Univ. of Colorado, he is a registered professional engineer in the state of Colorado, and he is a member of AIChE, the American Association for Aerosol Research (AAAR) and the American Ceramic Society (ACerS).

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