James Flanagan

Underlying Constants

This column invites comment on career experience in the interest of broadening the perspectives of young, developing engineers in our field. There are of course as many viewpoints as the number of invitees. But there may be underlying constants. As one who has had opportunity to contribute to and lead research in signal processing, both in industry and in academia, I can provide yet another perspective. Hopefully some of the constants will emerge.

Research Leadership

Foremost, there is no substitute for personal credibility built upon personal accomplishment, knowledge, and familiarity with the field. As in most team endeavors, "leading by example" is an effective mode. Respect accrues to the leader who asks nothing of subordinates that he or she has not done, or will not do again, many times over, if needed.

Team effort requires organization, authority, and accountability. But invariably multiple heads are better than a single one, so engendering a hospitable climate for listening (to varied opinions) is crucial. Great caution is needed to avoid squashing initiative. Deflating original thinking is deadly, and "my way or else" has no place, even though the leader has the responsibility for the final judgment.

Creating appreciation for a group climate that subordinates individual interest to that of the total enterprise is a great asset. This does not mean that there can't be individual "stars" and substantial gradations of excellence across individual performance; in fact, both are desired. But all participants should feel the stimulation and benefit from every individual success.

While discharging the responsibility and accountability for research programs and the investment of resources, research leaders bear another prime responsibility—developing to the fullest the talents and abilities of their associates. Mentoring junior or less-experienced colleagues is central to individual professional growth, and eventually to the health of the total research organization. This includes leadership training and development of management depth. The best condition usually is to have "a capable person in front of you and one behind you." Quality staffing also embraces recruiting—and the supervisor who continually seeks candidates "smarter than I am" generally builds an elite and effective group and is rewarded for it.

Commitment

Doggedness and commitment are critical in serious research, as every Ph.D candidate knows. But they are useful career attributes as well. Did you ever come to work saying "OK, this is absolutely the last day I'm going to try to solve this problem," only to repeat the process the next day. If you ever went home without being continually troubled, wondering "What am I missing? Where is the key?" your commitment may be lacking. "Eureka moments" are not frequent—but they do occur, and they reward dogged determination. My boss at Bell Labs, John Pierce, used to remark "How wonderful it is to understand something!" (He also had comparable remarks for when you brought him a dubious result—"Yes, you know there are more things known than are true." Or, "Anything not worth doing is not worth doing well!") There are times when you must cut losses and move on—but only after you have invested greater effort than you originally thought needed.

The author of the article in this issue has provided a long leadership in speech processing, spanning a career in industrial research at AT&T Bell Labs to a more recent role in academia. Dr. Flanagan compares the research environments and motivations in a company and a university. His comments encompass technical leadership, education, professional development, industry-university interaction, and public responsibility. He advises young students to seek broad exposure and acquire solid fundamental tools for future success.

—Arye Nehorai

Educational Preparation

There is the human tendency to follow and cling to those areas about which one knows the most. But the purpose of technical education is to broadly expose science and its fron-

tiers. Specialization, both in advanced degrees and in research careers, is necessary. But in a fast-changing world the ability to adapt to and address emerging opportunities is highly desirable. There is no substitute for acquiring the fundamental knowledge tools that support versatility. There is similarly no substitute for continued career-long self-study that builds breadth. Early and life-long participation in technical society conferences and journal publications not only educates but forms connectivity with the global community.

Industry-University Interaction

Following a 30-year career in industrial research and research management, I joined a university to teach, supervise thesis research, and head a grant-supported research center devoted to industry and university cooperation. Somewhat later I was asked to take additional duties in the university administration. For the past decade I have been able to compare the research environments of the industry I knew with that of the university. The differences are stark. The research "drivers" are quite disparate. By its nature, industry is mission driven and is being forced to become more product oriented each day. In contrast, in its most pristine form, university research is inquiry driven, with original knowledge creation a central focus. Both activities are necessary and admirable, but too loosely coupled to realize the greatest mutual benefit. On the one hand, industry needs frontier knowledge to protect its future competitiveness. On the other, university should create knowledge that has the greatest probabilility of advancing quality of life and train the next-generation skilled work force to prosecute those opportunities. Each needs the support and understanding of the other.

The practicalities are that industry often seeks university help in product-like development (which usually is poorly done and gets embroiled in intellectual property rights). And the university—far from pristine and quality-of-life motivated—commits mainly to research prescribed by those agencies which have large amounts of grant funding to supply. (Happily, so far, we have a federal establishment that largely recognizes the societal benefit of risky, long-range research and overtly stimulates it.) The granting agencies therefore have enormous influence on research directions because university research "follows the money." The remaining point is that, given this condition, industry that is being forced to ever-shorter horizons in its internal work would do well to achieve greater leverage from the federal investment in university research and even contribute more constructively to the design of federal programs and their university implementations. (My university is typical, with industry sponsorship of only about 7% of our external contract research, whereas federal funding accounts for more than 50%.) Industry participation can be accomplished through more personal interaction and hard-money investment and through a willingness to come away with nonexclusive, royalty-free rights as opposed to laboriously negotiated exclusive ownership of intellectual property. Typically industry seems to overvalue the latter in the precompetitive university environment. It seems to undervalue cultivation of highly promising candidates for employment and internships, the potential for influencing curricula important to a skilled workforce, and the usefulness of a "neutral ground" (in academia) on which to meet competitors for nonproprietary information exchange and professional networking.

Large Team Effort

Large problems often require organized effort and shared resources. This is a familiar situation in industry and is readily accommodated. It is somewhat more difficult to confront in academe. The professor, scratching to win tenure or promotion, is loath to serve as subordinate to a principal investigator who may be a rival. A university failing in many instances is the lack of formal policy for apportionment of credit in collaborative large-team effort. In some cases, this is being remedied and joint work incentivized more. It is certainly important as funding agencies move toward large, cooperative grants. Industry participation in such large efforts offers opportunity for additional incentives, which might be crafted by the funding agency or by the proposers. Still, there likely will always be academics who prefer the single autonomous, independent "Herr Professor" model with a few selected students worshipping at the feet—and this is not bad.

"Missionary" Work

As practicing researchers who are daily close to our work, we easily forget how important public understanding of science is to our society and to scientific progress. Our government leaders and our industry managers are sensitive to public impressions, as is the attraction of high school students towards scientific careers. As responsible professionals, we should recognize an implied "overhead" on our work—namely, telling the broad community what we are doing and why. How many of us give talks to the local Rotary Club, or other business groups, or visit science classes in high schools? (In one talk I gave to a Rotary Club, unknown to me, there was a congressman in the audience who afterwards introduced himself as a member of an appropriations committee that I recognized as important to science funding—you never know!) Periodic devotion to public education and appreciation is a responsibility we should all shoulder.

The Constants

While a young student, gain broad exposure to ascertain individual talents and preferences. Acquire solid fundamental tools that insure versatility, the ability to adapt to societal and scientific shifts, and the capability for sustained career-long self-education.

Where is the future? I have no crystal ball more insightful than my peers. But in the coming decade or so, there will be plenty of research action in "bio," "nano," and "info"!

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