

THE CHANGING ROLE OF ACADEMIA

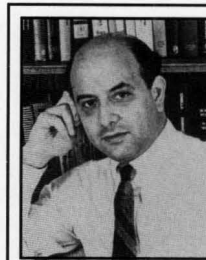
JULIO M. OTTINO
Northwestern University
Evanston, IL 60208-3120

Academia is in turmoil. Higher education in the United States has never been static, but it is now undergoing rapid transformations, seemingly with no overall plan, seeking a purpose, pulled in many directions by forces that did not even exist a decade ago. Academia is now accountable to media pressure, to alumni, and to government. There are concerns about teaching, tuition costs and allocation of funding, weights given to graduate and undergraduate education and research, scientific misconduct, and in general about the perceived mismatch between academia's wants and society's needs. Critical reports have appeared in major newspapers and on television: a *Chicago Tribune* article on teaching at the University of Illinois at Urbana; a *20/20* report on teaching at Berkeley. A decade ago it would have been unthinkable to conceive of a book like *ProfScam*.^[1]

The pressures are irreversible and will not go away. U.S. industry has been forced to deal with both globalization and environmental concerns, and environmental issues will not be reset as they were in the 1950s. Similarly, what is now expected of academia is quite different from what was expected in the 1960s and 1970s. Only the institutions that are able to adapt will survive.

There is a wide gap between myth and the reality of academic life. For this, academics have no one to blame but themselves, since any attempt to communicate ideas to the general public is usually looked upon with suspicion. The result is public ignorance as to how leading science evolves, the prevailing wisdom being that science somehow moves in rectilinear fashion to immutable truths.

Contrary to popular belief, there is now renewed attention being paid to undergraduate education in many institutions. My own institution, McCormick,



Julio M. Ottino is Walter P. Murphy Professor and Chairman, ChE Department, Northwestern University. He received his PhD degree from the University of Minnesota and his undergraduate degree from the University of La Plata, Argentina. His research interests are in mixing and chaos, pattern formation—aggregation, breakup, and dispersion—and mixing of immiscible and complex fluids. He is the author of *The Kinematics of Mixing: Stretching, Chaos, and Transport* (Cambridge University Press, 1989).

is a good example: there are financial incentives for good teaching, such as rotating endowed chairs; 80% of the full professors teach at least one undergraduate course a year; and it is impossible to buy time from teaching. The public at large, however, has little idea of how professors spend their time.

Inside and outside forces are taking their toll, particularly on young academics who are expected to be all things to all people—great researchers, effective fundraisers, inspirational teachers. Recent statistics are not encouraging: 53% of academics under forty year of age report that "my job is a source of considerable personal strain."^[2]

Many institutions are trying to redefine their missions. An ever-increasing stream of speeches and reports (many originating from captains of industry) are telling academics what to do, how to teach, how to manage their institutions, how to view research, and how to re-examine the rationale for the support of research. Some of this advice is well intended, but naive—and copying models of industrial success and applying things like TQM will help only up to a certain point. In the same way that industry cannot conduct research as if it were a university, university research cannot be managed in an industrial mode. There is just so much that can be left to serendipity^[3] but tight organization will undoubtedly kill creativity.

Changes do not come without pain. Nevertheless, it is indisputable that in order for academia to remain productive, changes must be made and a new vision of scholarship must be advanced. To echo the

words of Thomas Kuhn, a paradigm shift is in the air. As to what the new paradigm will be—that is hard to predict. What rationale will colleges and universities use to redefine their mission? Will things evolve to a unique model of success? Will expectations regarding faculty performance be uniform across institutions? *Scholarship Reconsidered*^[2] offers one of the best reasoned views of how this paradigm might look and what considerations should be important when judging alternatives. In the following paragraphs I will quote freely from this work, adding a few interjections of my own and restricting the remarks to research universities.

Universities have been too narrow in defining the boundaries of acceptable behavior, especially when contrasted to the historical record of academia's changing mission. The main thesis of this report is that it is essential to broaden our definition of scholarship.

The current, dominant, picture is that to be a scholar is to be a researcher. This was not always so and, in fact, this view is of rather recent vintage. Explicitly, or implicitly, the mission of academia has changed throughout the years, evolving and transforming itself from teaching to service to research. The colonial college, patterned after British traditions, took a view of collegiate life that was almost monastic. Teaching was a calling. The goal of Harvard College in 1636 was to "advance Learning and perpetuate to Posterity." The student was the center of attention, and tutoring was the preferred mode of teaching. This stage lasted for almost two hundred years, until service was added to the role.

This transformation did not happen overnight. Institutions gradually took an increased interest in serving business and economic posterity. Rensselaer Polytechnic Institute was founded in 1824 with the premise that "the United States needs railroad-builders, bridge-builders, builders of all kinds." The practical side of higher learning appeared loud and clear in the Land Grant College Act of 1862 and the Hatch Act of 1887. By 1903, the presidents of Stanford and Harvard would declare that the entire university movement "is toward reality and practicality," and that "at the bottom, most of the American institutions of higher education are filled with the modern democratic spirit of serviceableness." The first president of Cornell saw graduates "pouring into the legislatures, staffing newspapers, and penetrating the municipal and county boards of America." Academia saw itself as a major force in shaping society. There was a conviction that higher education had a moral mission to fulfill.

Where was research throughout this period? Certainly not within university walls. In fact, it took quite some time before research found a hospitable home within academia. The first advanced degree obtained by an American goes back to early 19th-century Germany, and it took another fifty years for the first PhD degree to be awarded in the United States (Yale, 1861—followed by Pennsylvania, Harvard, Columbia, and Princeton). Things moved quickly after that, however. The University of Chicago, founded in 1891, made the PhD degree the pinnacle of its academic program. In fact, within four years of its founding, its president declared that "promotions in rank and salary would depend chiefly upon research productivity."

Then, two World Wars and the Depression set the stage for a dramatic all-inclusive change, particularly in the way that research was to be supported by government.

The most quoted document involving interaction between government and academia, *Science: The Endless Frontier*—a report written for President Roosevelt at the end of World War II by Vannevar Bush of MIT, and eventually delivered to President Truman—provided a blueprint that guided research right up to the present day. Its implicit idea was one of "societal return": that the societal return obtained by government investment would be greater than that produced by the same private investment.^[4] Agencies such as the National Science Foundation were created, and money started to pour into the halls of academia. By some measures this has served us well. Since 1945 United States scientists have received 56% of the Nobel Prizes in Physics, 60% in Medicine, and 42% in Chemistry.

The societal return concept does not work well in a world-integrated economy; in fact the very idea of only one country having the monopoly in education is questionable and universities would do well to think in broader terms. Nevertheless a firmly ingrained consequence of operating under this paradigm for the last half century is that academic success (indeed, scholarship) has been associated with research, and research, in turn, exclusively with discovery. This might have been a narrow viewpoint, but its appeal was unparalleled. All universities tried to fit into the mode and faculty were judged primarily as researchers; after all, there was money to be garnered from successful academic enterprises.

Scholarship goes beyond research, however. By and large, only one type of scholarship is routinely acknowledged—the Scholarship of Discovery. Based

Continued on page 175.

suggesting that problems of interest to chemical engineers are fertile ground for the use of stochastics. Also, the students doing critiques of manuscripts for projects often found that much well-respected work can be greatly improved by someone with a working knowledge of stochastics.

In summary, I can write with a high probability of certainty that any chemical engineering faculty using stochastic modeling in research will find that introducing colleagues and graduate students to these techniques can be very fruitful.

REFERENCES

1. Einstein, H.A., "Probability, Statistical and Stochastic Solutions," in *Stochastic Hydraulics: Proceedings of the First International Symposium on Stochastic Hydraulics*, edited by Chao-Lin Chiu, University of Pittsburgh, School of Engineering Publication Series, Pittsburgh, PA, p 10 (1971)
2. Gardiner, C.W., *Handbook of Stochastic Methods for Physics, Chemistry and the Natural Sciences*, 2nd ed., Springer-Verlag, Berlin (1985)
3. van Kampen, N.G., *Stochastic Processes in Physics and Chemistry*, 2nd ed., Amsterdam, North Holland (1992)
4. Honerkamp, J., *Stochastische dynamische Systeme*, VCH, Weinheim (1990)
5. Kloeden, P.E., and E. Platen, *Numerical Solution of Stochastic Differential Equations*, Springer-Verlag, Berlin (1992)
6. Knuth, D., *The Art of Programming: Vol. II. Seminumerical Algorithms*, 2nd ed., Addison-Wesley, Reading, MA, Ch. 3 (1981)
7. Press, W.H., S.A. Teukolsky, W.T. Vetterling, and B.P. Flannery, *Numerical Recipes*, 2nd ed., Cambridge University Press, Cambridge, England (1992)
8. Hayes, B., "The Wheel of Fortune," *Amer. Sci.*, **81**, 114 (1992)
9. Langevin, P., *Académie des Sciences*, **146**, 530 (1908)
10. Klimontovich, Yu L., *Physica A.*, **163**, 515 (1990)
11. Érdi, P., and J. Tóth, *Mathematical Models of Chemical Reactions: Theory and Applications of Deterministic and Stochastic Models*, Princeton University Press, Princeton, NJ (1989)
12. Stokes, C.L., and D.A. Lauffenburger, "Analysis of the Roles of Microvessel Endothelial Cell Random Motility and Chemotaxis in Angiogenesis," *J. Theor. Biol.*, **152**, 377 (1991)
13. Öttinger, H.C., *Stochastic Processes in Polymeric Fluids*, Springer Verlag, Berlin: in press
14. Laso, M., *A Stochastic Dynamic Approach to Transport Phenomena*, preprint
15. Volume **47** of *Physica D* (1991) is devoted to articles on lattice gas dynamics □

ROLE OF ACADEMIA

Continued from page 169.

on this historical record, the *Scholarship Reconsidered* report argues, however, that there are at least three other types of scholarship: Scholarship of Teaching, Scholarship of Integration, and Scholarship of Application—and that our current thinking might be too narrow to value all of them.

Scholarship of Teaching entails not only transmitting knowledge, but also transforming it and extending it as well; Scholarship of Integration is to "give meaning to isolated facts, putting them in perspective...making connections across disciplines, placing issues in a larger context, illuminating data in a revealing way, often educating nonspecialists too." This clearly points toward interdisciplinary work and drawing unexpected connections between dissimilar areas (without which some disciplines might wane and die). An acceptance of Scholarship of Application demands that we broaden our horizons as well. The usual mode is that pure is better than applied, and that things are discovered and then applied. This need not be so: new intellectual understandings can arise out of the very act of application.

The best use of the human potential already in place calls for recognition of diversity. Faculty diversity should be celebrated, not restricted, and faculty evaluation should be flexible as well as systematic—it will be increasingly more difficult to impose uniform standards on something that by its very mission should be diverse. A professor's job description is often unchanged over an entire lifetime; institutions should explore alternatives on how to sustain productivity. Creativity contracts—an arrangement where faculty define their professional goals for a three-to-five year period, possibly shifting from one principal scholarly focus to another—might offer an alternative.

It is imperative that universities become more structurally robust. Only in this way are they going to be able to deal with the pressures imposed by an ever-broadening mission. The dual mission of disseminating and transforming old knowledge while at the same time pushing the boundaries of what is known can only be fulfilled by a combination of talents and an acceptance of peaceful and profitable coexistence of various modes of scholarship. Yet, at the same time, universities cannot be all things to all people. A broader viewpoint including different models of success seems to be called for if the institutions that have served so well in the past are to withstand the pressures of the future.

REFERENCES

1. Sykes, Charles J., *ProfScam: Professors and the Demise of Higher Education*, Regnery Gateway, Washington, DC (1988)
2. Boyer, Ernest, *Scholarship Reconsidered: Priorities of the Professoriate*, Princeton: The Carnegie Foundation (1990, reprinted 1993)
3. Eliel, Ernest L., *Science and Serendipity: The Importance of Basic Research*, American Chemical Society (1993)
4. Armstrong, John A., "Research and Competitiveness: The Problems of a New Rationale," *MRS Bulletin*, **18**, 4-9 (1993) □