

fessor's performance can be compared to the top level indices and the frequency curves so that some idea of individual productivity can be obtained. □

REFERENCES

1. Griskey, R. G. *Chem. Eng. Ed.* 10 140, (1976) "Ranking Chemical Engineering Departments.
2. Cartter, A. M., "An Assessment of Quality in Graduate Education," American Council on Education, Washington, D.C. (1966).
3. Roose, K. D. and C. J. Andersen, American Council on Education, Washington, D. C. (1966).
4. Bernier, C. L., Gill, W. N. and Hunt, R. G., *Chem. Eng. Ed.* 9, 194 (1975) "Measures of Excellence of Science and Engineering Departments: A Chemical Engineering Example."
5. "Engineering College Research and Graduate Study" *Engineering Education* 65 No. 6 (1976).
6. *Directory of Graduate Research*, American Chemical Society, (1976).

REVIEWER'S COMMENTS

COMMENTS BY PROF. C. JUDSON KING

University of California, Berkeley
Berkeley, California 94720

I am sorry to see continued publication of rankings of this sort, since I feel they provide no positive or useful purpose to the chemical engineering community.

First of all, I feel that rankings of this sort are undesirable in principle. They generate results on bases that must necessarily be subject to much question. They fix numerical rankings in people's minds, without the underpinnings of the number being recognized or remembered. Criteria of excellence must necessarily be subjective, qualitative and variable. All departments should not have similar goals, and variety of emphasis should be encouraged. Variety gets lost in surveys of this sort.

Even without the "in principle" point, the criteria themselves do not seem to me to correspond to excellence, or to factors which would lead me to recommend a school to a would-be graduate student: (1) The size of the research funding does not relate to the quality of education a student will receive. In fact, big money may mean lots of paid professionals, lots of faculty administrative commitment, and a reduction of faculty attention to the students on a project. (2) Simply counting degrees says nothing about the quality of the degree or the worth of the educational experience to the student. It does not differentiate the tutorial experience in a thesis M.S. from a coursework M.S. (3) In some fields of research it is customary to write many short papers, each with small content; in other fields this is not the case. Some professors are overly prolific, publishing much the same thing repeatedly. And again, counting

papers does not relate to the quality of a student's educational experience.

Put another way, if I were to push for a substantial increase in any or all of Griskey's categories next year with our present faculty and students, I would necessarily *lower* the quality of graduate education in our department! The faculty would divert more of their time away from students into dealing with government agencies (getting money) and hiring and supervising non-students (using the money); and/or they would have less time to spend on each of their students because of higher enrollments (more degrees); and/or we would eliminate the M.S. thesis or otherwise reduce the content of degree programs (more degrees); and/or some professors would spend time away from students writing papers they shouldn't have (more publications)!

It would be better to put the whole ranking question gently to bed!

GRISKEY'S RESPONSE: The above review has, I feel, missed the point of the paper. It is not to set up a rigid ranking system. Nor is it to *force*, as he seems to think, any one professor or any department to place emphasis on grants, M.S. degrees (etc.). Instead, the paper attempts to focus attention on a subject that will be discussed regardless of our feelings about it. Furthermore, it does this in the most objective fashion possible. For these reasons, I disagree with his recommendation for non-publication.

As a side issue, I am a little concerned about his comment that "Criteria of excellence must necessarily be subjective, qualitative and variable." This type of philosophy leads ulti-

mately to personal feelings with all of their vagaries as a criterion. Such a system is, in my opinion, far worse than even a bad quantitative system (which the paper is not).

COMMENTS BY PROF. RUTHERFORD ARIS

University of Minnesota

Minneapolis, Minnesota 55455

To comment on Dr. Griskey's "objective" rating of chemical engineering departments is to incur the suspicion that one takes it seriously enough to wish to know the "rank" of one's own. However the fortunate omission of Minnesota from the new rankings and your request for comment will perhaps reduce my perusal of part II from the mortal to the venial category of sins. It is unfortunately true that there are people who, as Dr. Griskey says in his opening sentence, regard these rankings as "an important aspect of information for those in industry, government, and academia." It is to be hoped though that they inform (in the true sense of the word) their opinions by something more than quantifiable or so-called objective criteria, for these exercises in numbers are the kind of quantification that renders futile much current research in the social sciences.

In the first place I am sure no one is more aware than Dr. Griskey of the great difficulty of obtaining reliable data on which to base his calculations. Nowadays we are bombarded with so many questionnaires asking for numbers, costs, and other statistical information that it would be a fulltime occupation to answer them with the scrupulous accuracy that they seem to presume. But even if they were accurate the statistics on which the index is based are liable to considerable fluctuations. Perhaps a three or four year moving average would do something to smooth this out, but simply to take the number of PhDs reported in any one year is to invite fluctuations which are quite liable to bounce the candidates around among their rankings in a most haphazard way. Again simply counting the number of refereed publications is bound to give a very variable figure unless averaged over a suitable time period. In any case this ignores the monographs and graduate texts which are just as much an indication of the faculty's concern for graduate education as are the research publications. There have been few more influential texts than the famous Birdfoot nor any more indicative of the high level of graduate (and undergraduate) instruction at

Wisconsin, yet such texts would be completely overlooked by the publication index. Moreover since a considerable amount of effort might be diverted from research papers into the writing of such a monograph its neglect is an error of commission as well as of omission. A much more interesting and useful statistic might be compiled from the *Citation Index* for this would give some idea of how the published works of faculty were influencing the research of others. Even this would have to be compiled with great care and indeed would involve an enormous amount of work. But at least it would come closer to weighing publications rather than just counting them. Even the amount of extramural grant money has to be weighed, rather than counted, for in some places it may reflect the activities of a single individual in building up a major laboratory facility rather than any overall health of research activity in the department.

The simple fact is that no quantitative measure can do justice to educational quality. Like the true harvest of Thoreau's daily life it is "something as intangible as the tints of morning and evening." How, for example, is the ethos of the department to be calibrated. A department could have high academic standards and impose them ruthlessly without regard to the nurture of students. Another department could have equally high and productive standards but put much more effort into seeing that those of good, but less than brilliant, abilities were brought along to the highest standard of excellence that they could achieve. No index is going to reflect this. The relationship of the department to the university as a whole is also difficult to quantify. There are some departments which are very good yet set in colleges or universities of fairly dismal proportions. Even an index for the university as a whole will not do, for it ignores the nature of the relationship. We are fortunate at Minnesota in having a mathematics department with quite a few faculty who will discuss problems with engineers. In other universities the faculty of mathematics can be extremely "pure" and there be little intercourse. Clearly this kind of relationship makes for a stronger and more enviable department yet it is hard to see how it could be embodied in any numerical criterion.

In fine, Sir, I would suggest that we are a mature enough profession to put rankings behind us. As I said to a friend at Wisconsin who was on the verge of being apologetic in the face of the

Gill report, "We didn't believe the Carrter or Roos-Anderson, so why should we believe this?"

GRISKEY'S RESPONSE: This review has some good points concerning the paper, some of which already mentioned in the manuscript (see for example the sentence about the intellectual and professional growth of the graduate student). The suggestion of considering influential texts is fine except for the fact that no conclusive agreement could be reached as to what texts fall in this category. To cite my point there are some (not myself) who even question "Birdfoot" as a classic graduate text!

The *Citation Index* (C.I.) approach is one that was also suggested by Gill. This, however, has the defect that some authors conduct a "round-robin" of citing each other's work in somewhat limited areas of endeavor. Furthermore, the C. I. does not allow for situations where industrial practitioners actually use the paper for design or operational purposes. Finally, the use of refereed papers as per "Part II" is, in my opinion, a strong enough safeguard as to quality. If it is not, then we as a profession have failed in our responsibility to provide proper reviews.

I agree that there are other points that could be considered, but again how do we determine these? Generally, they must be extremely subjective which I feel is self-defeating. Incidentally, the question of the remainder of the university is a two-edged sword. A poor department in a strong university also can receive unwarranted acclaim by the reverse of guilt by association.

COMMENTS BY WARREN E. STEWART

*University of Wisconsin
Madison, Wisconsin 53706*

The strength of a chemical engineering department cannot be measured properly by such rudimentary data as staff size, enrollment, funding and graduation statistics. This claim is borne out by Griskey's calculations (CEE 1976) which show a correlation coefficient of only 0.5 to 0.73 between his productivity index and large-sample peer evaluations. Thus, his method accounts for only 25 to 53 percent of the quality variation indicated by the peer appraisals.

High productivity on the Griskey scale is neither necessary nor sufficient for a strong edu-

cational program. Indeed, use of his four productivity measures as guidelines could be harmful, since overemphasis on these goals could compromise the quality of teaching, counseling, research, and publications.

The main problem with so-called "objective" rating systems is the neglect of personal factors. In the present context these include: quality of faculty; rapport between faculty and students; breadth and depth of teaching and research programs. These factors are difficult to quantify, but they are very important to the quality of education.

COMMENTS BY WILLIAM H. CORCORAN

*California Institute of Technology
Pasadena, California 91125*

Review of this paper is difficult because I have a bias against ranking of chemical engineering departments. The four criteria used are on an annual basis and are M. S. degrees awarded per faculty member per year, doctorates awarded per faculty member per year, thousands of dollars of extramural funds per faculty per year, and refereed publications per year. The author clearly points out that neither quality undergraduate education nor public service are involved. Clearly, then there could be other elements of an index if an author so chose. Professor Griskey chose to stay with his defined criteria. Ranks were developed and presented. There can be no argument about the objectivity based upon the criteria used, but the criteria are really limited.

One of the real functions of a chemical engineering department is to prepare students for graduate work or industry, and so there cannot be any ignoring of undergraduate development. There could be difficulty in evaluating undergraduate development of the student. There clearly is difficulty in evaluating quality in the program. So all we have then, finally, is a ranking based upon some numbers and which may be rather sterile and rather fruitless. Perhaps if we think about this matter further we could stop ranking departments. Ranking clearly is effected in the intelligence network of corporations which hire students and by students themselves as they prepare for graduate school or just ask questions about undergraduate schools.

Professor Griskey's evaluation nevertheless is on sounder ground than some. A recent evaluation published in *Chemical Engineering* by a staff member of a western university uses college cata-

logs and correspondence with faculty. That process should just about bury ranking of schools, and that might be too bad because there may be some element of truth in what Professor Griskey is trying to do.

COMMENTS BY J. J. MARTIN

University of Michigan
Ann Arbor, Michigan 48109

There are many ways of ranking engineering departments. Dick Griskey has chosen to rank them on the basis of GRPI (Graduate and Research Productivity Index).

Since this is not the only basis, for one could well consider professional activities, consulting, government committees, undergraduate programs, and the like, it is necessary that his particular approach be identified early or it may be misleading. I would support publication of his paper if the title had the particular qualification of the basis of ranking by GRPI. Thus in the Introduction there should be some discussion of the total departments' activities so that the reader can see

the narrower basis of Dick's technique of ranking. With these changes I recommend you publish his paper.

COMMENTS BY DAVID HANSEN

Rensselaer Polytechnic Institute
Troy, New York 12181

I believe the manuscript "Ranking Chemical Engineering Departments Part Two" should be published as a natural follow-up to Part One. I expect it will be even more controversial and if there is ever a further sequel you should consider more carefully the value of continuing to publish this type of material. The summary statistics are useful. Personally, I believe the rankings are meaningless.

COMMENTS BY J. W. WESTWATER

University of Illinois
Urbana, Illinois 61801

This is an interesting study and should be published.

BOOK REVIEW: Biomedical

Continued from page 55.

to a weak and pedantic beginning. However, the book's greatest lack seems to me to be the absence of a precise pedagogical goal. The subject area is clear, but what is being taught about the area is not. For example, large amounts of information are presented in early parts of the book with only suggestions about how the information might be used. The review of blood rheology is not used to teach principles (cf. Bird *et. al.* Transport Phenomena) nor does it lead to clear design-style recommendations about when account must be taken of the various phenomena that are considered. (Incidentally use of the Magnus phenomenon to explain axial accumulation of erythrocytes is incorrect; the particle Reynolds numbers are too small.) The general utility of the information developed on circulatory dynamics is not established; a qualitative, and to me simplistic, discussion about how and where aneurysms develop is given. The fifteen percent of the text dealing with the human thermal system is very detailed in its treatment of previous work in physiological heat transfer but is unclear in its pedagogical intent. The subject has not received and does not

seem to deserve as large a role as it has in this book. The chapter on compartmental analysis is clearly written and contains much useful information; but still it does not, in my judgment, spend enough time on principles (e.g. the work of Danckwerts, Zierler, Shinnar, Berman) nor develop general techniques for model building, nor give an adequate appreciation of the wide application of compartmental models in modern bioscience. The step from lumped to distributed models is taken with very little specific recognition of the profound physical and mathematical differences involved. One of the most important practical aspects of compartmental analysis, the requirements that a tracer must meet, is not discussed.

The development of the theory of elementary transmembrane transport for substance passively transported down an electro-chemical gradient is very lucid (although its applicability to situations where active transport is also present should be explained) but the importance of the results is discussed neither from a physiological or engineering viewpoint. The treatment of renal transport mechanisms is also lucid (but incomplete especially with respect to the important counter-current multiplier mechanism for urine concentration).
Continued on page 91.