student works in private industry or government while attending graduate school, are rare and often are discouraged by the department or the employer.

Graduation usually improves finances, yet physicists must now face a new array of problems. Unstable business and government policies have contributed to the image of the scientist or engineer as the "migrant worker" of the professional field. Proprietary employment agreements place severe restrictions on the mobility of technical workers. A number of companies with strong research images are now "pimping" their technical staffs for government contracts at $180 000 per man-year rather than using these staffs to create new products and jobs. Most of these policies are aimed at fostering short-term corporate profitability rather than at improving our industrial and scientific position with respect to the rest of the world.

Unlike the Institute of Electrical and Electronics Engineers, the American Bar Association or the American Medical Association, The American Physical Society has long been dormant in trying to improve the quality of its members' lives. Too often the society has promoted physics rather than physicists. This, I believe, has led to the large decrease in the number of American graduate students and the subsequent decline in American technological preeminence.

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THE EXECUTIVE SECRETARY OF APS REPLIES: The American Physical Society exists to "advance and diffuse the knowledge of physics" and has carried out that purpose primarily by publishing journals and holding meetings. Since the 1970s, however, APS has recognized that providing support for the education, training and careers of physicists is a necessary and appropriate aspect of its mission. APS and the American Institute of Physics have undertaken several low-key activities useful to physics graduate students and to physicists seeking employment.

AIP's education and employment statistics division obtains and provides data on graduate programs and on physics as a profession, and regularly reports the findings. Working with this AIP division, the APS committee on opportunities recently completed a survey of physics department chairs. Data have been extracted from the survey's results on the availability of both jobs and candidates in the subfields of physics. A report on the survey will appear in a future issue of the *Bulletin of The American Physical Society*. AIP's career placement service, which is available to APS members free of charge at meetings and at AIP's New York headquarters, offers job listings, arranges interviews and provides individual counseling.

Efforts on behalf of women and minorities in physics, prizes and scholarships, and the matching membership program are other examples of what APS does for individual physicists.

Unlike APS, organizations such as IEEE and the AMA have the same tax status as a trade union (501-C6 status). Because they exist primarily for the benefit of their members, these organizations can provide "quality of life" services that APS is not permitted to offer and for which APS does not have the resources. The APS council has periodically considered and debated the benefits to physics and physicists of changing its IRS status, but has always overwhelmingly rejected such a move. Among the effects of such a change would be a sizable increase in APS membership dues, because tax-free status would be forfeited and more income would be needed to support existing services. APS values its identity as a public-interest organization, and expects to continue in its role as a promoter of physics.

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Where the Academic Elite Meet to Inbreed

On 26 October 1987, *US News and World Report* published a list of the top colleges and universities in the United States.[1] This ranking of the so-called "best" created a mild furor in academic circles.[2] Once again the issue of the validity of ranking faculty, academic programs, and colleges and universities emerged.

In the November 1983 edition of *Changing Times* a listing of the most highly regarded doctoral programs in 32 academic disciplines was presented.[3] These rankings were based on a five-volume study published by the National Academy Press.[4] Entitled "An Assessment of Research-Doctorate Programs in the United States," this study reviewed 2700 PhD programs in 32 disciplines ranging from anthropology to zoology.

In the ratings reported by *Changing Times* two key measures of repu-

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tation from the National Academy study were combined: The first, "faculty quality," assessed how professors around the country rated their peers in the same discipline; the second, "program quality," assessed how well the faculty thought each program educated research scholars and scientists. *Changing Times* combined these two measures and derived a ranking of the top 10% of the programs in each discipline. For physics *Changing Times* listed the top 12 departments based on scores derived from the National Academy study. If one goes by the assumptions of the *Changing Times* article, the 12 schools with the highest combined scores represented the "academic elite" in physics, the 12 "best" programs in the country.

Given the subjective nature of the evaluation process that produced the National Academy ratings, I decided to examine the composition of the faculties of the top 12. I suspected that these departments would be substantially linked to one another by hiring one another's graduates, and hence enhancing one another's reputations. I also expected that among the academic elite there would be a high degree of academic "inbreeding"—the hiring of graduates from one's own program.[5]

I used the American Institute of Physics report *1986–1987 Graduate Programs in Physics, Astronomy and Related Fields*[6] as the basis for my analysis. It soon became obvious that there were numerous interrelationships among departments in terms of where the faculty had received their doctoral degrees. The table presented on this page lists the top-ranked departments and indicates the percentages of full-time faculty members who received their doctoral degrees from one of the "elite" departments on the list (which includes those who received their degrees from the same departments where they are currently on the faculty).

As can be seen in the table, in all of the top-ranked departments a substantial proportion of the faculty had received their PhDs from a member of the "academic elite." MIT had the highest percentage of holders of degrees from the top-ranked departments (83.0%), and the State University of New York, Stony Brook, had the lowest (49.2%). At most of the schools anywhere from two-thirds to three-quarters of the faculty had graduated from one of the prestigious programs.

The table also addresses academic inbreeding among the top-ranked physics programs. Bernard Berelson[7] and Theodore Caplow and Reece J. McGee[8] have demonstrated that a high degree of inbreeding among elite schools is not accidental. According to both studies, if elite programs are to maintain their prestige, they cannot hire a large number of PhDs from lower-ranked departments, and this would include PhDs from upwardly mobile "middlemen" programs whose elite credentials have yet to be established. George R. Gross in his study of sociology departments found that the higher the prestige of a department, the greater the proportion of "homegrown" graduate faculty.[9] With some modifications, David Shichor's study[10] confirmed Gross's findings. Shichor found the relation between departmental inbreeding and the prestige of a department in sociology to be curvilinear, with the highest- and lowest-ranking departments having the highest rates of inbreeding, while midlevel departments were found to have the lowest rates. Not surprisingly, my inbreeding findings for physics programs were almost identical to those for sociology.

As can be seen, the school with the largest percentage of its own graduates on its full-time physics faculty was MIT (39.8%). Princeton University also had a rather large percentage of its own graduates on its physics staff (31.9%). Stony Brook had not hired any of its own graduates.

I also determined the number of PhDs produced at each department who were on the full-time faculty of one of the elite departments in 1986. These numbers also are presented in the table. Berkeley had 73 of its graduates in faculty positions at elite physics departments. MIT and Harvard followed with 64 and 63, respectively. Stony Brook and the Stanford applied physics program had the least, with 3 each.

'Inbreeding' among top-ranked physics departments

Rank	Department	N	Percentage Elite[1]	Percentage Own[2]	Number produced[3]
1	Harvard	41	73.2	24.4	63
2	Caltech	49	67.3	12.2	36
2	Cornell	49	71.4	14.3	28
2	Princeton	47	74.5	31.9	59
3	MIT	88	83.0	39.8	64
4	Berkeley	79	73.4	29.1	73
5	Stanford (physics)	23	60.9	17.4	27
6	Chicago	47	66.0	8.5	29
7	Stanford (applied)	12	75.0	25.0	3
8	Illinois	93	60.2	4.3	12
9	Columbia	29	58.6	20.7	24
10	SUNY, Stony Brook	61	49.2	0.0	3
Totals		618			421

[1]Percentage of faculty who received PhDs from one of the 12 top-ranked programs.
[2]Percentage of faculty who received PhDs from the program in which they are now employed.
[3]Number of PhD recipients from the program who were on the faculty of one of the top-ranked programs in 1986.

I think that graduate departments in physics (or in any discipline) must rely to a large extent upon their reputations to attract highly qualified faculty and graduate students to participate in their programs. The 12 physics graduate programs that were top ranked in the 1981 National Academy study are undoubtedly strong programs. I certainly do not wish to argue that they are not. However, the data suggest that a number of subjective factors influence the procedure by which academic departments are ranked. Primarily, I contend that a rather small group of institutions (12 in this case) tend consciously or unconsciously to enhance one another's reputations by hiring one another's graduates. The study cited by *Changing Times* used two measures of reputation to establish its list of the "best" graduate departments: how professors rated their peers in the same discipline, and how well the faculty thought each program educated research scholars and scientists. These criteria are vitally linked; when elite faculty are asked to rate their peers at other schools, they are, to a large extent, rating their former professors or students.[5] There are a total of 618 full-time faculty in the physics elite, and 421 of them (68.1%) graduated from one of these distinguished programs. Clearly it is in their best interest to rank their alma maters highly.

Ultimately, I think it should be asked, Are the 12 highest-ranked programs indeed the best PhD programs in physics, or do they comprise an "academic elite" with a large number of faculty members in the discipline and an obvious interest in perpetuating the present ranking sys-

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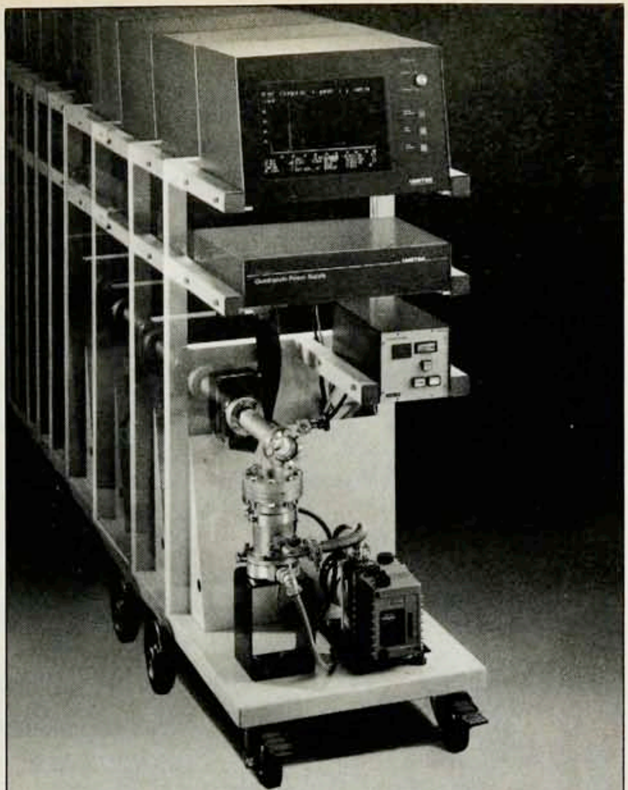

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tem? The data suggest that the latter is true. Two final comments seem in order. First, I contend that because of their subjectivity, current ranking systems are a detriment to the discipline. They may impede professional mobility, reward status over achievement and result in programs of lesser renown being bypassed, even though they may merit as high or higher recognition than do those of the elite. Second, I believe that current, subjective ranking systems incorporate serious distortions and misrepresentations. Because they have the potential to do as much harm as good, I recommend that as they are presently constituted, subjective systems of departmental ranking should be routinely ignored.

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8/88

Corrections

November, page 17—In the news story about ultrahigh-energy cosmic gammas, the photo credit on page 17 should have referred to the University of Athens-Columbia-Purdue-University of Wisconsin collaboration. On page 20 the rest-mass limit on the particles from Hercules X-1 should have been stated to be $\frac{1}{20}$ the *neutron* mass. The journal in reference 7 (page 21) should have been *Physical Review B*.

October, page 20—In the penultimate paragraph of the news story about *CP* violation experiments, the upper limit on ε'/ε should have been given as 1×10^{-2}. ■