"Is it relevant to your own research?"

The first two questions directly gauge interest and importance. The third addresses whether *PRL* is meeting its goal of informing researchers about results outside their own fields. Reader feedback would help the editors to evaluate their referees and the review process, diminish the apparent arbitrariness felt by contributors, and focus the journal on topics of broad interest to physicists.

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2/92

Big vs Little Science: A Lesson from Alvarez

The small science–big science debate can use the wisdom of the late, great Luis W. Alvarez. Luie started in the Radiation Laboratory at Berkeley when nuclear physics was small science. His first important work, the experimental proof of K capture, was done in the days of "love and string and sealing wax."[1] His later efforts and discoveries contributed to nuclear physics' growth from small science to big science. Here is what he had to say about entering big science as it is today:[1]

"There is no way a person with my personal qualities could go into either nuclear physics or particle physics at the present time. The table of contents of the latest issue of *Physical Review Letters* lists three particle physics papers with multiple authorships. The first two papers each have 72 coauthors, taking up fifteen lines—exactly the same names, in the same order—and the third paper lists 46 coauthors. I can't believe that I could ever have derived any satisfaction from being listed as the 37th in a group of 75, or as the 337th name on the list of 500 that will soon characterize the papers coming from the large European electron–positron colliding-beam accelerator near Geneva. I once saw a cartoon over the desk of a person working in one of these huge collaborations; it showed two men chained to a trireme oar, pulling as hard as they could. One said to the other, 'If it weren't for the honor of the thing, I'd rather do something else.'

"... Most of us do physics because it's fun and because we gain a certain respect in the eyes of those who know what we've done. Both of those rewards seem to be missing in the huge collaborations that now infest the world of particle physics."

The men who have successful careers today in nuclear and particle physics are the power brokers, the managers, the administrators and the politicians of big science. Regardless of their limited technical contributions they have absolute power to approve publication of all papers from their laboratories. Luie conscientiously avoided a career as an administrator except for two years on the disastrous Materials Testing Accelerator. He said those years nearly did him in as a scientist.[1]

According to Luie,[1] only those with a herd mentality fit as willing cogs on the wheels of the bureaucratic machines of big science—among which I would count the Superconducting Super Collider, the space station, the Mars expedition and controlled (*sic*) thermonuclear power. None of these megaprograms addresses the needs of the taxpayers who are forced to support them. All four are in serious technical and engineering trouble. Aristotle warned about building pyramids that serve only the purposes of a priesthood and impoverish those who must pay for them.[2] (See my letter in PHYSICS TODAY, December 1988, page 129.)

Luie's career shows that the creative, nonconformist, inventive Alvarezes of the world in physics and other sciences could put the vast sums wasted on big engineering programs to much better use.

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2. Aristotle, *The Politics*, book V, ch. II.

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7/91

Students and Teachers Need to Face Facts

A lot has been said recently about the number and quality of American science students. Many of these discussions fail to come to grips with the facts.

There is considerable confusion between quality and popularity of courses of study. A popular course need not be of high quality. A good teacher need not be a popular one. (The fallacious nature of student opinion polls is well known.[1]) Physics is harder to teach than most other subjects. Any campus-wide comparisons can only make us look bad. Students also need to understand that education is a job, not entertainment. It is the work everyone is expected to do prior to gaining admission to paid employment.

If students can no longer learn "first year" physics in two semesters, then we should require that they take three or four semesters. If we really believe all college graduates should know some physics, then it is up to accrediting agencies to demand that physics be required of all graduates. If all the students that need science were required to take (and learn) it, credit-hour production would be increased.

Since scientific knowledge has grown over the years, it is likely that four years is no longer adequate for an undergraduate degree. This time probably needs to be increased, with the added credit-hours going to required science and math courses.

There is, however, no reason to expect that we should train as many physicists as we do, say, business majors. Nor would one expect the costs to be identical. In fact, I would argue that the most important goal of physics education would be to offer training to the one or two Einsteins who come around every couple of generations. We don't create such people; we should simply be there to serve them. Nor can we expect them to find their way to the Harvards or Princetons. History shows us they don't necessarily choose such prestigious institutions.[2] Nor can they necessarily afford them.

We also must teach *facts*. You cannot teach a person "how to think" without first providing him or her with facts to think about. In reality, you can recognize an intelligent person by the insatiable appetite for more and more facts.

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2. R. Pool, Nature **352**, 661 (1991). A. Anderson, New Scientist, 17 March 1990, p. 66.

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1/92

A New Form of Nuclear Blackmail?

Unemployed scientists and new science graduates looking for work will be interested in a report in *The Los Angeles Times* (24 January 1992, pages A1 and A10) that the Bush Administration is preparing an initiative to ensure full employment for an estimated 2000 nuclear scientists in the former Soviet Union, including US-funded jobs and positions at uni-

versities in the United States and elsewhere in the West. The plan will be carried out using part of a $400 million fund Congress has provided for dismantling the Soviet nuclear arsenal. Those scientists who prostituted themselves by working for the Soviet military establishment will be paid off lest they seek employment with those third world leaders who still dare to think that God does not live in the White House.

Thus, by the stroke of a pen, Uncle Sam will solve the economic woes of a couple of thousand Soviet scientists. Such programs never could be considered for the orders-of-magnitude-greater number of unemployed scientists and engineers in the United States. But this program at least furnishes graduate students contemplating scientific careers in an enduring economic depression with a clue on how to use the free-market-driven economy: Along with their scientific training they should pick up enough nuclear-bomb-making skills—these being none too hard to come by—so that upon graduation they can advertise their services in *The Bengazi Daily News*, *The Teheran Herald* or even *The Belgrade Politika*. If those ads do not produce dozens of job offers, they may perhaps elicit a visit from a man in a gray flannel suit with a government check. A word of caution, though: Should the supply of nuclear scientists turn out to be too large to be cheaply bought, the man in gray may carry a silencer instead.

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3/92

Corrections

May, page 69—The brochure on how to raise human rights concerns at meetings was prepared by the Committee to End the Chinese Gulag, not the APS Committee on the International Freedom of Scientists. Fang Li Zhi and Yuri Orlov are cochairmen of the former committee.

April, page 87—The price of *Quantum Mechanics on the Macintosh*, by Sigmund Brandt and Hans Dieter Dahmen (Springer-Verlag, New York, 1991), is $49.95.

January, page 71—In the review of Stan Wagon's *Mathematica in Action* (Freeman, New York, 1991), the function in the figure caption should be $r = e^{\cos\theta} - 2\cos 4\theta + \sin^5(\theta/12)$. The error in the sign of the second term was reproduced from the caption in the book. The Mathematica code on page 2 of the book does contain the correct function, however. ■