these were his intentions, he was successful.

Reference

1. R. P. Feynman, as told to R. Leighton, *"Surely You're Joking, Mr. Feynman!"* Norton, New York (1985), p. 52.

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Richard Feynman the teacher was shortchanged in your February 1989 special issue. His encounter with an erstwhile student is fondly remembered in this letter.

Though not the brightest among my class, I eked through Methods of Mathematical Physics as a senior electrical engineering student at Caltech in the early 1950s. Feynman taught it on alternate days with Robert Walker. It was Walker who would methodically write out his lecture material on the wall-to-wall blackboards, proceeding from left to right repeatedly as the hour passed in the old Bridge lecture room. But it was Feynman who electrified the class with his enthusiasm. Everything was clear while he lectured. Unfortunately for me, I was usually too spellbound during his classes to take anything but the most skimpy lecture notes.

Not too many years later, after I had joined the Hughes Research Laboratory, Feynman came to teach the "Feynman Lecture" series there. During one of those sessions I had the delightful experience of sharing with him the results of an ongoing experiment. We had just recorded for the first time the planar acoustic beam cross section of acoustic surface waves on an anisotropic substrate. It showed the nearly textbook beam profile of Fresnel diffraction. This had been the topic of Feynman's lecture that day, during which he led us through the derivation of optical diffraction from a slit. When I told him of my work he asked eagerly to see the results. You cannot imagine how thrilled and happy, almost childlike, he was to see the changing Fresnel ripples demonstrating the near-field diffracted beam cross section at progressively distant points from the radiating aperture. He beamed and said something like "Gee, it really works in the real world too."

This was a high point in my early career. I shall not forget the exhilaration of that encounter. It remains a source of inspiration to this day.

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4/89 *Los Angeles, California*

High School Science: Why East Beats West

I am writing to clarify some points concerning Asian high school science that appeared in the letter by Francis M. Tam (March 1989, page 156). As a product of the educational system of Hong Kong, I think I am in a position to give an insider's view of what Asian high school science really is. This, I hope, will dispel some of the myths surrounding Asian science education in general.

High school students in Hong Kong usually start "majoring" in science or humanities in form 4 (grade 9). Most of these students will continue their major into forms 6 and 7 (provided they pass the Hong Kong Certificate of Education examination). For example, a major in mathematics will take an intensive curriculum in physics, chemistry, biology, general math and additional math (including calculus) plus other, nonscience subjects during forms 4 and 5. In forms 6 and 7, the student will take physics, chemistry, pure math and applied math. The intensity of this program means that by the time students reach form 7 (pre-university year), they will have taken courses in their major subjects that are equivalent to sophomore courses at US universities, as Tam rightly pointed out. In view of this intense training, the "quantum leap" of Hong Kong science students from last place in ninth grade to first place in the senior year of high school (see PHYSICS TODAY, June 1988, page 50) in a "mere" three years is neither unimaginable nor a misrepresentation.

I wholeheartedly agree with Bassam Z. Shakhashiri when he said, "American children have just as much innate curiosity and intellectual capacity for learning about science as students in any other country" (June 1988, page 52). What puzzles me is the attempt to explain away the differences in achievement between high school science students here and abroad by yanking in philosophical and sociological differences, cultural and family influences, and so on. As far as the present issue is concerned, these factors are simply irrelevant. Knowledge of these differences may be comforting, but it will not alter the fact that, as various studies have suggested, American high school science *is* lagging behind other countries, and the gap is no less than that reported.

American high school students may receive a much broader general education than their Asian counterparts, but as a trade-off, this must also imply a reduced emphasis on science as a specialization. After all, high school students are (still) human beings, and it's unfair to expect them to excel in all subjects. The American philosophy of education advocates the complete education of an individual rather than early specialization. This in itself is a very respectable goal, as long as there's an understanding of the above-mentioned trade-off. I am quite confident that American high school students would score high in a test of general education. As far as science is concerned, however, we already have the facts.

To close this letter, I would like to give a piece of advice to the educators of this country: It's time to decide which way the American intellect should steer itself, toward general encyclopedic knowledge or toward specialization. In view of the keen competition from abroad, it is unrealistic to try to embrace both these aims: Better to keep one than lose both!

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Balancing the Branches of Physics

The 1988 survey of physics department chairs by the APS Committee on Opportunities, or COP (February 1989, page 101), indicates that there is a need for more experimentalists in condensed matter and in atomic, molecular and optical physics, and that there is an abundance of high-energy theorists. Any COP that tries to separate the good guys from the bad guys probably deserves a medal for courage, but also should expect to be used for target practice.

So let me commend the heroes of this survey who are suggesting that there is a demand for useful physics. If we want to work, maybe we should do something that other people find useful.

On the other hand, I don't believe that a healthy balance in science is determined by job demand alone. There are areas of physics that, for historically sensible reasons, have been bypassed or ignored but that can contribute in a vital way to vigorous science. Atomic physics, for example, offers pictures and concepts used in other areas including not only physics and materials science but also chemistry and a little biology. As an atomic theorist who has worked in other fields, I would like to make note of the beauty of the many problems in atomic physics that have clean and elegant solutions and that, at the same time, are useful. But atomic and molecular theory is not well represented in our top 20 institutions, as is documented in the 1987 Armstrong report to the National Academy of Sciences on the state of theoretical atomic, molecular and optical sciences in the United States. And we are few in number: The Armstrong report cites 1 theorist to every 6 experimentalists in atomic, molecular and optical physics, compared with a ratio of 1:2 in all fields of physics. This will, of course, change. A new position approved at Harvard and the Smithsonian Center for Astrophysics is a beginning. But a more detailed follow-up to the 1988 COP survey would also help.

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2/89

Can One Rely on the PI for Quality Control?

In the May 1988 issue (page 78) Louis J. Lanzerotti and Jeffrey D. Rosendhal wrote about issues facing the US space research program. They suggested that significant cost savings would result from reducing quality requirements and delegating responsibility to the highly motivated principal investigators.

As part of university contract administration functions, the Office of Naval Research maintains Engineering Support Offices. These have provided quality assurance monitoring and assistance on many delegated NASA instrument contracts. We support cost saving efforts, but have a different view of the quality and reliability situation.

There is no question that the principal investigator will be highly motivated to have a productive flight. A great body of knowledge on what is needed to produce a quality product has been developed over many years by universities, industry, the Department of Defense, NASA and others. We have found, however, that PIs not previously involved in space research efforts are not familiar with the detailed methods of quality assurance for flight hardware and software. The processes of this discipline were certainly not taught in our physics classes!

The quality requirements imposed by NASA and actually met by most universities are simply not extensive, especially when compared with those imposed on DOD contracts with industry. We find also that the amount spent on quality is not directly related to the quality of the produced instrument. What seems to be most important is the emphasis and support for a