How Santa Cruz Faculty Built Itself Up

I would like to clear up a misunderstanding that occurred in connection with the report "Could a Silver Lining Lurk in Cloud of University of California Cuts?" (September 1993, page 59). A paragraph on our physics department states that "at Santa Cruz . . . the physics department is highly geared to its teaching responsibilities, drawing recruits largely from the ranks of its own graduates." While it is true that the Santa Cruz physics department built itself up largely by *promoting* young faculty from its own ranks, it is not true that it has *recruited* them primarily from the ranks of its graduate students. Only one of our former graduate students, Abe Seiden, is a faculty member in our department. Incidentally, the report mentions the recent appointment to the faculty of the University of California, San Diego, of one of our former graduate students, Kim Griest, but his last name was misspelled "Grieft."

While the statement that our physics department "is highly geared to its teaching responsibilities" is correct, Santa Cruz is also a strong research institution. For example, in a study[1] of the number of citations per published research paper in the physical sciences, UCSC ranked first in the US, followed immediately by Harvard and Princeton.

Reference

1. Science Watch, November 1990, p. 1.

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10/93

Teach Nonscience Majors 'Real World' Physics

In his Opinion column "Science Literacy at the College Level" (January 1993, page 69), F. Curtis Michel reiterates the obvious need for successful college science courses for nonscience majors and describes briefly his approach at Rice University. Although it is hard to judge from his short description of the course, I'm led to believe that it represents an approach so fundamentally different from my own textbook writing and college-level teaching (at small liberal arts colleges such as Wellesley and Swarthmore as well as large universities such as Stanford) that I'm compelled to present my alternative view.

Despite his recognition that some students may come to such courses with "outright hostility," Michel spends some (perhaps much) of his course time trying to lead students to become interested in certain topics. I know of no nonscience students who come to class with an interest in "Bragg scattering" or whether "radioactivity itself produces more radioactivity" or "the natural abundances of radioactive isotopes" or "spectral lines of mercury" or *any* of the topics Michel describes as part of his course. Nonscience students (and even physics majors) typically have no intuition concerning these topics, since few of them are amenable to direct experience. Even some of the most "obvious" ones (obvious to trained physicists), such as seeing the spectral lines of mercury, require abstract visualizing of microscopic entities.

In my optics courses for nonscience majors, I concentrate on real-world phenomena with which the students are familiar and *already* have interest. I have found this quite successful. Students don't have to be persuaded to be interested in many questions surrounding rainbows, reflections in mirrors, color, movie projection, eyeglasses and so forth. They've all watched TV, played video games and used cameras.

Paradoxically, often *more* science is conveyed when describing such real-world phenomena than the more standard ones Michel describes, because the students can concentrate on the science and explanations rather than on the raw phenomena themselves. And make no mistake about it, one can give an explanation of these phenomena as deep as one wants.

Even the experiment Michel chooses to begin his course with—"how a metal rod can be made to ring with various pure tones"—is not one students are interested in or will ever see again (though it is admittedly one that can gain attention). This experiment is, moreover, more challenging than instructors steeped in science might imagine: The students cannot even *see* the vibration of the rod. Michel thus unwittingly reinforces the misperception by nonscience students that physics is something done in a lab, divorced from everyday life.

Why not instead take a Polaroid instant photograph in lecture, project it and ask simply, "How does that work?"

Some educators will ask, "How can we consider a student literate in physics who does not know the second law of thermodynamics, special relativity, wave–particle duality, quarks, quasars, the Big Bang, chaos, . . . ?" But as Michel admits, in his course he can succeed only in "giving the students

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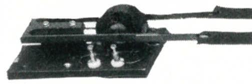

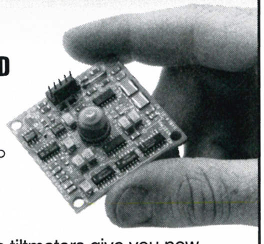

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just enough to understand" topics such as radioactivity. It is my experience that these knowledge tidbits fail to satisfy students past the final exam. Thus in my own nonscience optics courses, quantum phenomena are covered *last*—if at all!—and I feel no great loss if we don't get to them.

There is another benefit to my approach, one that addresses a problem Michel points out: keeping instructors interested in teaching courses for nonscience majors. Because the type of course I promote covers a great deal of material not in standard courses, faculty learn throughout the course too. And because these courses are rarely prerequisites for subsequent science courses, instructors can be freer to explore real-world problems of their own particular interest.

DAVID G. STORK

2/93 *Stanford, California*

MICHEL REPLIES: I certainly agree with David Stork that it is important not to try to cover everything, and certainly if one can have success being "Mr. Science" and explaining everyday phenomena, that's great—although I'm not sure that 250 Wellesley students sign up for an optics course each year. In a large required course such as the one I was describing, there is the expectation that specific topics will be covered. The idea was to enable the students to take further science courses if they wished, so we did have certain constraints on the material. Indeed, the original version of the course was taught from a list of topics that nonscience students should know, drawn up by a faculty committee; the overambitious result was described by students as like trying to drink from a fire hose.

In presenting the material we did not, of course, just give a standard first-year physics description. In the first lecture of the year I showed a rainbow colored backwards and sort of mused about whether that mistake was "important" or not. (That was *not* the whole lecture!) What I wanted to accomplish more than simply explaining this or that was to show where the explanations themselves come from. So the ringing rod was a paradigm for the scientific method: That you can't see the rod oscillate is part of the puzzle. How do you know it's oscillating, as opposed to, say, being "filled" with sounds like a tumber filled with fluid that is leaking out? If one realizes that there is a methodology for figuring out what's happening even when one can't see it happen, then later on one can more readily grasp the basis for, say, atoms. Rather than just being told there are atoms, one can understand the *everyday* evidence: shapes of crystals, boiling of water and so forth.

Another paradigm was an inexpensive handheld electronic calculator that every student had. Suppose you painted over all the buttons; how could you figure out how it worked? That's essentially our relationship with nature: We're in this world without the handbook.

The lead-in to the discussion of radioactivity was a newspaper photograph of someone picketing a store selling irradiated strawberries. The lead-in to the age of the Earth was a newspaper survey showing that something like half of college graduates thought it was 6000 years. I pointed out that this date was estimated by no less than Newton and separately by Kepler, explained how they did their estimates, and of course presented evidence to the contrary. (I'm not sure such "insensitivity" to possible religious beliefs would be "tolerated" anymore, but I managed to get away with it somehow—actually for the second time, the "no handbook" remark being unintentionally the first. Don't try this at home.)

I hardly urge that everyone follow this approach. Attempting to intrigue students is one thing; succeeding is another. Indeed I had one colleague repeatedly dismiss the course as "Feynman for nonscientists," and you certainly can't find a suitable textbook along these lines, which is a very serious drawback. Still, I'm skeptical about Stork's claimed benefit of having the "faculty learn throughout the course too," having sat in the audience with the students and heard faculty (no longer at Rice University) put forward totally erroneous explanations, which were never retracted. Also, I happen to know why you can see yourself in a department store window despite its being transparent, but I'd hate to have that everyday phenomenon brought up as a starting point to explain optics.

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3/94

Correction

August 1993, pages 66–67—The document referred to as the "Portland *Baseline Science Essays*" is correctly called the *African-American Baseline Essays* and includes only one essay on science. Hunter Adams III is the author of that essay, entitled "African and African-American Contributions to Science and Technology." ■