all, besides materials science I've only written a dozen papers or books each on K–12 science education, peer review, national science policy, technology and religion, and even a best-seller on human sexuality. Lack of curiosity does it every time.

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Take Physics Teaching Back to the Basics

Recent discussions in PHYSICS TODAY about the status and needs of our profession impel me to comment from the perspective of a half-century spent as a physicist–engineer in industry, academia and national laboratories.

Despite innumerable demonstrated benefits to society, modern technology is encountering increasing hostility from the press, politicians and pulpits. The news media seem kinder to astrologers, mystics, radical environmentalists, rock stars and religious fundamentalists than to scientists and engineers. Public affairs focus increasingly on issues with which very few public officials and too few news reporters are capable of dealing rationally, because they involve science and technology. The general public must have a better understanding of elementary science. To that end, society today should encourage and reward teaching more than research. Super Colliders and space stations can wait for better times; education cannot.

There is no shortage of advanced physicists today, but there is a deplorable dearth of good secondary school science teachers who can motivate students to enjoy and apply science rather than simply entertain or try to impress them with material on the frontiers of research that has little or no relevance to our daily lives. They, not more PhDs who require expensive facilities for investigating arcane phenomena, are what today's physics departments should be producing and society rewarding.

During a decade on the faculty of an engineering school, I saw how teaching suffers when the faculty member must also raise the funds not only to support his research but to pay for his graduate students and maintain his salary. Now that scientific research has lost the prestige and urgency it enjoyed when this country was on a war footing, scientists must work even harder than I had to then to raise funds for research, and their students are the losers.

Moreover, I'm disturbed about some recent trends in methods of teaching physics. I don't think one can learn basic physics at the video display terminal of a personal computer; there, one learns only how to manipulate numbers and be entertained. In my final decades as a research physicist I observed that although younger physicists were far better than I at *computing*, very few had the intuitive "feel" for phenomena that I did; they had an almost religious faith in a computer printout, even when the input data or the program was faulty. The mental concepts one receives working at an Atwood's machine, a telescope, a Foucault pendulum, an optical bench, a reactor console or a Wheatstone bridge are *fundamentally different* from those one receives modeling those same phenomena at a computer terminal. Electronic "black boxes" make possible very precise measurements, but they can't impart the understanding that one gets from using an old-fashioned galvanometer with an Ayrton shunt, nor can they always be trusted to function as advertised. The slide rule is far less precise than a 16-bit computer, but its use reminds the experimenter that he or she is usually dealing with imprecise data.

As for subject matter, today's elementary university physics course should be part of a larger general science curriculum embracing chemistry, geology and biology that is required of the general student body. It should concentrate on explaining the phenomena of everyday experience and impart the understanding needed to deal rationally with the role of technology in today's society. It should emphasize Newtonian mechanics, heat, optics and electromagnetism, then thermodynamics, atomic physics and elementary nuclear physics, because they are central to the evaluation of alternatives for energy production, of the postulated greenhouse and ozone hole effects, and of many other environmental concerns, and to deciding the proper emphasis of a space program. Quanta, quarks, quasars, the wave–particle dualism, high-energy particle physics and Big Bang cosmology are not relevant to any matters of public concern except insofar as they affect the Federal budget, and I doubt that a "theory of everything" will be applicable to anything practical. Those topics are important for only a small minority of the profession.

Finally, why must the physics profession be concerned about the ethnicity and gender of its members? It should be completely blind to color, national origin, sex and political affiliation. "Affirmative action" is discrimination! Intelligence, dedication, integrity, sense of responsibility, creative ability, attitude—those and *only* those are what should matter in a scientist. Often when confronting one of those annoying questionnaires that ask, "Are you a member of a minority?" I reply, "Yes, a minority of one!"

But I do hope that I am *not* a minority of one when it comes to these opinions!

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8/93

'Sustainable Growth' Is Insupportable

In his "Candidate's Statement," a candidate for general councillor of the American Physical Society says that "we need to limit the growth of the physics community in the USA to sustainable levels."[1]

"Sustainability" is a buzzword in today's global society, and I feel that the term is often used with no recognition of its implications. "Sustainable" implies "for a very long time." The size of a steadily growing quantity varies as e^{kt}, where k is the fractional change per unit time. For all positive values of k, this size approaches infinity when t becomes very large. Thus there is no positive value of k that can be sustained, and so the term "sustainable growth" is an oxymoron. In contrast, $k = 0$ might be sustained, and some values of k in the range $k < 0$ can be sustained.

We need to be more precise in our use of the term "sustainability." If one advocates continued growth of the physics community in the US, one should specify either the recommended value of k or the recommended way in which a desired value of k can be determined. If one advocates "sustainability," one needs to know that this limits k to values less than or equal to zero.

Reference

1. From the booklet "1994: The American Physical Society: Election of Vice-President, Vice-Chair of the Nominating Committee, and General Councillors. Biographical Information and Candidates' Statements."

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