the graduate and undergraduate levels, we may have barely scratched the surface of possibilities that would arise from nontraditional programs that offer students the option of cutting across disciplinary lines (for example, biophysics and medical physics).

Earning a physics degree is not like earning a barber's license, which is useful only inside a barber shop. "Being a physicist" is an outlook on life that is backed by a powerful array of skills and ways of thinking that one can creatively apply in a vast range of callings. Hidden within the present crisis may be a golden opportunity both to produce stronger physics departments and to develop multiple career channels for those trained as physicists.

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I am one of those holders of "newly minted PhDs" to whom Edward M. Dickson (January 1994, page 13) seems to address his comments. After having read his letter, I find that he misses the point entirely. It is not the recent recipients of PhDs who do not realize their worth in nontraditional fields; rather, it is the nontraditional fields that do not realize the worth of a physics education.

It is true that the examples Dickson cites are inspirations to all who are looking for employment outside physics. Be that as it may, when was the last time anyone saw a job listing that read: "Position: Personnel manager. Three years' experience or a physics degree required." That example may sound a little too tongue in cheek, but I think it makes the point.

While it is true that being a physicist does involve the development of problem-solving techniques that are nearly universal in their applicability, I have found that the management skills required to complete a PhD are of equal or greater use in nontraditional fields. The pursuit and successful completion of a PhD requires the management of time and resources. While the product, knowledge and understanding, is often not tangible, it is presented to a competitive market, the funding agencies. If one's product isn't competitive, poof, there goes the funding!

One also has to manage a research budget. What equipment to buy, what to make in house and what to scavenge or borrow are all very important. Time management is also crucial. Scheduling work for the support shops often requires large lead times. And to top it all off, the more senior graduate students have the dubious honor of training the younger students so that the cycle can repeat itself into eternity!

I think that Dickson and I agree on all these points. But he has made the error of criticizing the new PhDs for not stressing these skills in the pursuit of jobs. There has to be an ear at least willing to listen, and those are few and far between.

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I enjoyed reading Leo Kadanoff's timely Reference Frame column "Greats" (April 1994, page 9) but was surprised to find he omitted teaching in his discussion of professions pursued by physics-major alumni. Though the number of physics majors who have become teachers is small, I believe they have played and can play a very important role in our nation. In the recent past we have tended to view such people as failures, because pre-college teachers need only an undergraduate degree and we tend to view undergraduate physics as a prelude to graduate study.

Kadanoff's column suggests another view. His description of the benefits of an undergraduate physics education eloquently shows how valuable such an education is for teachers. He begins by saying, "I think that we physicists have a lot to offer to many different kinds of people who wish to become educated." Among those people are children—all of whom wish to be educated. Kadanoff also states, "Physics teaches some concepts that should be part of the knowledge of every human." Physics can be taught in grades K–12 and should be. New materials are being developed for hands-on science for grades K–12, of which a very significant portion is physics. Teachers who know physics are in short supply. When physics-major alumni become teachers, they teach other teachers as well as the children and are very valuable, particularly in schools where the new materials are in use.

The physics department at the University of California at Los Angeles encourages physics majors who do not wish to go on to graduate school to become teachers. We are in the process of establishing a joint program with the UCLA School of Education to enable physics majors to enter the school system as full-time teachers on graduation and then take further education courses to become fully credentialed a year after graduation. The program is new but already attracting students.

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LLNL Ion-Trap Exp't's Austrian Apparatus

In our article on the electron-beam ion trap (October, page 27) we discussed work on electron emission induced by the impact on clean metal surfaces of very highly charged ions from a trap. We should have mentioned that these experiments at Lawrence Livermore National Laboratory were conducted using a method devised and an apparatus constructed by scientists at the Technical University of Vienna, Austria.[1]

Reference

1. F. Aumayr *et al.*, Phys. Rev. Lett. **71**, 1943 (1993). H. Kurz *et al.*, Phys. Rev. A **49**, 4693 (1994).

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Is *Fundamentals of Physics* Too Violent?

While teaching a freshman physics course at Princeton University, I noted a disturbing trend toward the use of violent examples and images in the course's textbook, *Fundamentals of Physics*, by David Halliday, Robert Resnick and Jearl Walker (fourth edition, Wiley, 1993). Previous editions, such as the third, published in 1988, have long been standard at colleges and universities around the world, including at Princeton.

In the preface to the fourth edition, the authors explain how they "have devoted considerable attention to illustrating real-world applications of physics topics." To this end, they state, "the features of each chapter were carefully planned to motivate students." Among the new features is the use of full color for diagrams and most of the photographs, as well as a "puzzler" at the beginning of each chapter "describing a curious phenomenon that is intended to entice a student." The puzzlers, the authors claim, "are carefully linked to the physics of the associated chapters, and the memorable photographs of the puzzlers have been chosen in order that the relevant physics also be memorable."

Many of the new, glossy, full-color photographs and associated text in the fourth edition of *Fundamentals of Physics* are indeed memorable, but are they in fact how I want my students to remember their first college-level physics course?

The first sentence in the chapter on electromagnetic oscillations reads, "On June 30, 1956, a United Airlines DC-4

and a TWA Constellation collided over the Grand Canyon; everyone aboard both airplanes was killed." In the third edition, the same chapter begins with the sentence "The radar beams that make modern air travel possible are generated in the electromagnetic oscillator of a ground-based radar transmitter."

The chapter on current and resistance in the fourth edition opens with a photograph of the fiery, catastrophic explosion of the zeppelin Hindenburg. In the third edition, a photo of the levitation of a magnet above a disk of superconducting material is presented.

In the fourth edition, the capacitance chapter opens with a glossy color photograph of a half-naked, unconscious young man lying on the pavement with tubes in his mouth and electrodes taped to his chest and shoulders. The capacitance chapter in the third edition begins with a photograph of a laser used in fusion research.

In the fourth edition, the opening of the chapter on Maxwell's equations shows war-ravaged England after it was bombed by Nazis in World War II. In the third edition, the chapter starts with a photo of a smiling woman wearing a Maxwell's equations sweatshirt.

The chapter on mechanical oscillations in the new edition begins with a sentence about how the 1989 earthquake in Oakland "cause[d] extensive damage and kill[ed] 67 people," accompanied by a photograph of a devastated freeway and chaos caused by a major car and truck accident. In the third edition, the collapse of the Tacoma Narrows bridge in 1940 is described, an event that led to no injuries or fatalities.

The chapter on collisions in the fourth edition begins with a photograph of a man breaking concrete slabs with his hand, with the caption "Ronald McNair, a physicist and one of the astronauts killed in the explosion of the Challenger space shuttle, was a black belt in karate." A picture of a tennis ball hitting a racket opens the collisions chapter in the third edition.

The fourth edition's chapter on waves opens with a close-up photograph of a scorpion and a description of how it "turns toward the beetle and dashes to its location to kill and eat it." The third edition's waves chapter opens with a picture of a surfer and the caption "Hanging ten off the California coast!"

One of the most gruesome inclusions in the fourth edition, absent in the third, is in the chapter on fluids. There the story of the asphyxiation of 1700 people from a rush of carbon dioxide from Lake Nyos in Cameroon in 1986 is told, accompanied by a photograph of some five dozen asphyxiated hogs. This is meant to illustrate Ar-

chimedes' principle. Also new to the fourth edition, in the questions section of the fluids chapter, is one problem that discusses a 1985 plane crash that "killed 136 of the 167 people on board." The question is accompanied by an otherwise useless color photograph of wreckage.

There are many other examples in the fourth edition in which a photograph or description of some physical phenomenon in the third edition has been deemed too uninteresting for freshman physics students and has been replaced by a more "memorable" image of some sort of act of violence involving injury or death. A quick browse through all the chapters reveals a new trend in the presentation of the fourth edition: The words "danger," "injury," "lethal," "die," "death" and various forms of "kill" appear some 20 times in the short puzzlers at the start of the chapters.

The authors and publisher of *Fundamentals of Physics* clearly made a decisive change of philosophy in presenting the material in the fourth edition. There is no doubt they were aware of what they were doing, having "carefully planned" the "features of each chapter." But why have they made this change? The authors state that in illustrating their view of the "real world," they intend to "provide long-term reinforcement of the associated physics."

I cannot help but question the judgment behind their decisions. It is certainly true that today's freshmen, by the time they reach college, have been inundated with countless images of horrific violence from newspapers, television and film, and may even associate such images with "entertainment." But is this really the direction in which the teaching of physics should be moving in the 1990s? What does it say about our society if physics professors assume the best way to present physics to students is not to use the inherent, natural interest of the subject matter itself, material replete with elegant equations, beautiful concepts and surprising, counterintuitive effects like magnetic levitation, but rather to show photographs of destruction and death?

Another point worth making regards a separate but no less important issue. Physicists at universities have puzzled for years over why there are so few female physics majors. It may well be the case that the more violent images shown in the fourth edition of *Fundamentals of Physics* would serve to repel young women (as well as sensitive young men) from the subject matter.

If professors planning introductory courses at universities either do not notice this trend or are not made aware of it, sales of the fourth edition will remain steady, and rival publishers may follow suit. This would be a genuine shame; centuries of devoted intellectual scientific effort would be presented to the next generation of scientists in the same way that daily tabloid news is presented to the mass population, catering to the basest of human emotions. I believe physics, being a fundamental science and rich intellectual pursuit, especially as presented at an institution of higher learning, deserves better.

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WALKER REPLIES: For the fourth edition of *Fundamentals of Physics*, I looked for examples that are interesting and instructive. As many of us have seen as teachers, it is impossible for a student to learn from a physics textbook if the student does not even bother to read the textbook. From what teachers and the publisher tell me, students *are* reading the fourth edition of *Fundamentals*.

I agree with Victoria Kaspi that violence in itself is incompatible with teaching physics. However, I do not think anything is wrong with historical accounts in which physics played a role and which incidentally involved danger or harm. After all, if physics is supposed to be about the real world, then putting a few examples of reality among thousands of problems about things like frictionless planes and massless pulleys seems acceptable, even useful.

When I wrote the examples cited by Kaspi, I took care to write in the factual, journalistic style of *Science News* and the editorial pages of *Nature*. In fact, half of the cited examples came from those two journals. (The other half came from other science journals or from historical records.)

Here, I shall comment on just one cited example: As reported in *Nature* and *Science News*, when Lake Nyos suddenly spilled carbon dioxide down a mountainside, killing many people, the gas erupted from the water because it was lighter than water, and then it descended the mountainside because it was heavier than air. The event was most tragic and horrible, but it was also interesting and instructive. In fact, Lake Nyos is again being discussed in *Nature*, because another eruption of carbon dioxide could happen at any time. That the same physics might lead to the same tragedy is important.

Finally, I hope that the apparent gender stereotyping in Kaspi's letter is due to an accidental choice of words. So do the women at Wiley (my publish-

er) who helped develop, edit and produce the book, and so does my wife (a former science major), who helped select the examples cited by Kaspi.

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Research Counts for Small-College Jobs Too

As the provost of a small liberal arts college, I have hired over 50 faculty members since 1990. Thirty-seven of these new hires arrived immediately upon completion of their PhDs or at the end of short postdoctoral appointments. Of these 37, 23 were hired for tenure-track positions, the remainder being temporary hires to replace faculty on leave.

Letters of recommendation from faculty at their graduate institutions constitute one of the most important sources of information about new PhD scientists and mathematicians applying for tenure-track openings at small liberal arts colleges. Search committees and provosts rely heavily on these letters during the initial screening of candidates. All too often letters of recommendation lack the information desired when hiring faculty at a small liberal arts college. This is particularly true when hiring science and mathematics faculty on a small campus that demands both research and teaching.

My experience has been that the majority of letters of recommendation for candidates in the sciences and mathematics extol the candidate's teaching expertise, with nary a mention of research expertise. Such a letter leaves me wondering whether the author does not think highly of the candidate's research abilities or thinks that our college only cares about teaching.

In fact, my college, like many other small colleges, is looking for faculty who can mount appropriate research programs that involve undergraduates. Hence I need to know about a candidate's research expertise and whether or not the recommender believes the candidate can mount a successful independent research program for undergraduates. I also need to know what teaching experiences the candidate has had and how successful they have been. Thus I write to remind those who write letters of recommendation to include assessments of both teaching and research experience and promise. Doing so will improve your graduate students' dossiers substantially.

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Is Lorenz's Butterfly Kelvin's Mosquito?

I was interested in seeing the "editor's note" (December, page 85) referring to Ray Bradbury's time-travel story "A Sound of Thunder" as reminiscent of the so-called butterfly effect in chaos theory. I discuss this tale in some detail in my book *Time Machines* (AIP Press, 1993), where I also point out that Lord Kelvin is a much earlier source for this idea (predating the 1911 story by Arthur Schnitzler mentioned by Peter Navé in the letter preceding the editor's note). In a letter to *Nature* (3 July 1902, page 223), Hiram S. Maxim, the inventor of the machine gun, wrote, "The grandest words ever uttered by any man on this planet were spoken by Lord Kelvin when he said that if all the matter in the Universe were reduced to its ultimate atoms and equally divided through all space, the disturbance caused by the beating of the wing of one mosquito would bring about everything that we find in the material Universe today."

The butterfly effect should be known as the mosquito effect!

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Correction

February, page 25—Michael Harreld and Daniel J. Valentino of UCLA provided the photo. Reference 19 will report on this work.
February, page 27—"Maximum velocity" should label the longest arrow in the velocity profile; "Minimum velocity" the shortest arrow. Wall stress should not have been indicated. ■

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