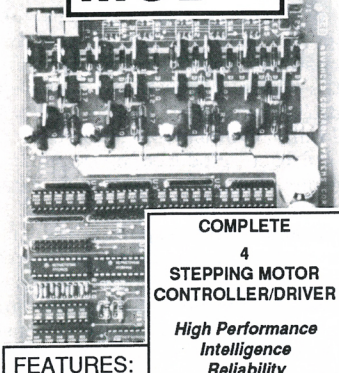


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For information write to:

Prof. B. Di Bartolo, Department of Physics, Boston College, Chestnut Hill, MA 02167, USA; Tel. (617) 552-3575.

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made during the cold war years. Nevertheless, one cannot help but notice that weapons research has found a comfortable niche in the world of government funding. During times of war, new technologies are needed, while times of peace bring the need for someone to clean up the mess.

Hanford should remind us all that scientists can never be totally objective observers; we are destined to leave our marks wherever we go. Thus it behooves us to consider carefully where to direct our talents and efforts, perhaps even placing "unscientific" factors such as politics and morality over job security.

SEAN C. KENNAN

5/92

University of Hawaii, Manoa

Global Warming and Atmospheric Altimetry

The consensus of the scientific community about global warming developed after painstaking compilation of long-term measurements of surface temperatures at a wide range of locations. This statistical approach, although valid, allows some well-meaning and responsible scientists to express reservations about the magnitude of the warming and its ultimate impact on the Earth's climate. Unfortunately, some politicians have seized on that slight doubt and used it to block, whenever and wherever possible, progress toward correction of the problem. One potential way of overcoming this obstacle is to explain and prove global warming in such simple terms that even the most politically motivated Luddite would understand.

The simplest approach is to consider the entire atmosphere as a single system and apply the ideal-gas law,

$$PV = nRT$$

to it. An appropriate way to proceed is then to examine each term and to look for any evidence indicating drastic change.

▷ T is the absolute temperature. If it is rising, there must be a corresponding change in another element of the equation.

▷ R is a constant. It will not change.
▷ n is the number of moles of the gas and is proportional to the number of molecules in the gas. When a carbon atom is burned to produce carbon dioxide, a molecule of diatomic oxygen is consumed. Thus combustion and animal metabolism, the two major sources of carbon dioxide, are neither creating nor destroying gas molecules.

▷ P is the absolute pressure. Atmospheric pressure results from the

Earth's gravity. There will be no massive change here.

▷ V is the volume of the atmosphere. If the atmosphere is warming, there should be a corresponding increase in the volume, as the only constraint is gravity. One place to look for such an increase is in space satellite orbit data.

At the time of the Hubble Space Telescope launch, 24 April 1990, NASA mentioned in its announcements that the telescope's designed lifetime of 15 years would be reduced to 5 years because the atmosphere had expanded. Within days, that comment was deleted from the announcements. As this was long before the system was tested, the decision could not have been due to any concern for the subsequent imaging problems.

The NASA reports, if unclassified, should be available to anyone who has the access to the agency's database. Various researchers who have been monitoring surface temperatures will be able to corroborate their own measurements. Thus, with this macroscopic "yardstick" we will finally have a basis for agreement not only on whether global warming exists but also as to the magnitude of the effect. It makes sense that a global effect should be measured on a global scale. The "altitude" of the atmosphere is such a global measure.

JOHN G. KEPROS

3/92

Sunnyvale, California

Is the 'Feynman Effect' a Misnomer?

In his Opinion column "The Feynman Effect and the Boon Docs" (January 1992, page 67) Albert A. Bartlett called our attention to the phenomenon of "directing one's teaching toward colleagues when one is supposed to be focusing on freshmen" and its effect on national scientific literacy. I know not the extent to which the two are correlated; however, to label the former the Feynman effect is grossly inaccurate and totally inappropriate.

As an undergraduate (1959-63) and graduate student (1963-66) at Caltech I witnessed firsthand Richard P. Feynman's extraordinary ability to discuss anything with anyone in his or her own technical language. In all of my seven years there I never witnessed Feynman, or for that matter any other professor, "teaching to his colleagues," nor did anyone ever complain of this.

Bartlett bases his definition of the effect on a passage from David L. Goodstein's article in the special issue

LETTERS

of PHYSICS TODAY devoted to Feynman (February 1989, page 70). Goodstein's account differs dramatically from my own experiences during the period 1961-63. First off, Feynman always knew exactly who were the undergraduates, the graduates, the post-docs and the faculty in any lecture hall. This was partly the result of his being a regular lecturer for many years at the undergraduates' weekly Physics X club. Second, the material not only was prepared at the freshman level, but really was for the freshmen. (See, for example, Feynman's preface to *The Feynman Lectures in Physics*.) As a junior I helped some of those freshmen with their physics homework. While their difficulties were similar to those I had seen freshmen encounter the previous year, their level of interest and understanding was higher. The same was true the following year, when they were sophomores, except that now some wanted to dig even deeper. There was no mention of alarming drops in attendance or anything of the kind. Most of the faculty and graduates who did attend were probably connected with the course. (Also, at that time at least, faculty only rarely attended Feynman's graduate courses.) Goodstein's arrival at Caltech one year after the departure of the class of 1965 may render this part of his account somewhat interpretive.

It is certainly true that one of Feynman's remarkable features was always to try to view the world from the perspective of quantum mechanics. Nonetheless he was a great admirer of all intellectual achievements. For example, he praised Sadi Carnot highly for his discovery of the second law of thermodynamics prior to the discovery of the first law. Even the most cursory glance at *The Feynman Lectures* reveals that the excitement of 18th- and 19th-century physics was not put aside in favor of that of the 20th century.

The Feynman Lectures were a natural continuation of MIT's Physical Sciences Study Committee (PSSC) curriculum for high school physics, and they were used for years in all types of colleges and universities with excellent results. At Caltech they were the culmination of a period of transition from the physics textbooks of Robert Millikan, Duane Roller and Earnest Watson. Special relativity at the junior level, for example, was introduced into the first-year curriculum in my freshman year. Quantum mechanics had been the topic of third-term sophomore physics for several years. Many of

the more sophisticated approaches in the *Lectures* were already being taught. But Feynman added many more of his own and (along with Robert Leighton and Matthew Sands) did the hard job of putting it all together into a coherent whole.

Richard P. Feynman was indeed one of the all-time great teachers of physics. But it was very much not a result of "teaching toward colleagues," in the sense implied by Bartlett.

KARVEL K. THORNER
NEC Research Institute
Princeton, New Jersey

2/92

Albert A. Bartlett's Opinion column prompts two opinions of my own. I was one among many in Richard Feynman's audience during the academic years 1961-62 and 1962-63. I was a postdoc in physics at the time (the very phenomenon to which Bartlett alludes). So I was more advanced than the intended audience of brilliant Caltech freshmen, although not by as much as one normally supposes. My late wife even worked with Matthew Sands and Bob Leighton on the editing of *The Feynman Lectures*. The lectures were a major event in the lives of many of us.

My two opinions are these:

▷ The quote from David Goodstein is accurate. The freshmen did slowly drop away.

▷ But it is unfair to Feynman or his noble project to define a deplorable tendency among teachers as "the Feynman effect," as Bartlett has done without adequate thought.

Feynman knew who his audience was, but neither he nor the Ford Foundation (which supported the preparation of the lectures for publication) nor anyone else knew whether the intended audience could profit from the intense insights that it would receive.

DONALD D. CLAYTON
Clemson University
Clemson, South Carolina

1/92

As a physician-biophysicist and long-term admirer of Richard Feynman, I must respond to Albert A. Bartlett's "The Feynman Effect and the Boon Docs."

The published volumes of the Feynman lectures were hailed by physicists worldwide as a magnificent mid-20th-century synthesis of the subject matter of physics. How does that Feynman effect relate to the complexification of virtually every other aspect of life, including the maldistribution of physicians (that is, the lack of rural doctors, or "boon docs," that Bartlett links to his Feynman effect),

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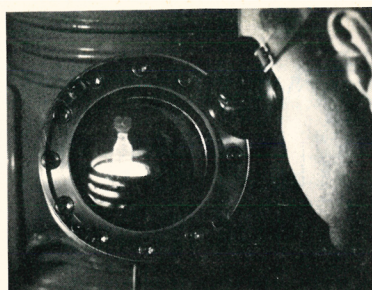
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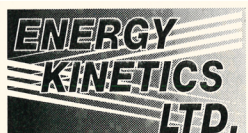
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as the century closes out? In medicine we lack a Feynman to locate the center of gravity in the vast mass of knowledge and technology cast upon newly trained physicians. They therefore tend to lack the confidence to take on the responsibility of the entire field of medicine, and the wisdom of how to train them to do so is a very scarce commodity. At each turn, the initiate's slightest oversight is judged by the standards of the narrow subspecialist. So, as in other fields, the new physician seeks refuge in narrowness and the proximity of an army of similar narrow experts to cover his or her rear end. Sound familiar? Of course the reality is a bit more complicated, and the specialty of family practice was created to answer just this problem. The reasons it has not succeeded in doing so are only compounded by the complications I have just described.

Though it was probably not intended, Bartlett has managed to disparage the memory of one of the great figures of 20th-century physics. The supreme irony is that he couldn't have singled out a less appropriate person as the cause of a social phenomenon for which there is no one to blame.

ARTHUR L. GROPPER
Glendale, California

2/92

I have just been reading the Opinion column by Albert A. Bartlett and wish to make further comment.

I agree with Bartlett that in physics the student must be thoroughly familiar with such "elements of classical physics" as the conservation of momentum and energy in both linear and rotational form and with the laws of Newton, Gauss, Faraday, Ampère and so on to begin to *understand* the more advanced work. One way to safely bring many of the advanced topics in is to have a two-year general physics course. Another way is to strengthen physics in the secondary and elementary schools.

Twenty years ago, when the dropout rate began rising from about 10% to more than 30% in my general physics classes, I began trying different approaches. One of the most successful means of keeping students was to include discussions of everyday applications of the material. The most common comment after I did that was that the course "came alive." Students could see a reason, other than college requirements, for taking the course. I also included some humor and many demonstrations in my lectures. Outside assignments included "Where have you seen this principle applied?" questions. During the last ten years the dropout rate in

my classes has fallen to about 10%, and my students' performance in their advanced classes has improved. This approach takes effort and time away from research, but I feel strongly that it is well worth it.

DONALD E. SHULT
2/92 University of Nebraska at Omaha

Regarding Albert A. Bartlett's Opinion column "The Feynman Effect and the Boon Docs": *Amen!*

G. V. BLESSING
National Institute of Standards
and Technology
3/92 Gaithersburg, Maryland

Biographical Bait for Budding Bardeens

The April issue of *PHYSICS TODAY*, devoted to the life and accomplishments of my friend and graduate school bowling partner John Bardeen, served to remind me that I meant to write you. When John died it was hardly mentioned on national TV, but when Sammy Davis Jr died at least two networks devoted hourlong special programs to his life. Our society is in real trouble when the highest pay and the greatest honors go to the entertainers and gladiators.

Since we physicists talk frequently about attracting the talented to science I would like to propose something that might help. The American Physical Society and American Chemical Society could help our young people understand the importance of science and the challenge of a scientific career by a program such as the following: Prepare news releases on the careers and accomplishments of outstanding scientists as they approach the end of their lives. Tell the news media that this information is available and that it will be furnished immediately when one of them dies. Put a little pressure on news reporters to use the information by reminding them that they are always talking about improving education.

The only person to win two Nobel Prizes in the same field and the coinventor of the device that changed the world would, I believe, have been someone TV would have featured if the information had been immediately available.

R. ROBERT BRATTAIN
5/92 Monterey, California

Correction

September, page 23—In figure 1, receiver sites are indicated by red, not black, circles. ■