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was not felt to be providing suitable services and how the Mermin and Wilson "remedy from within" for any deficiencies might have been or might be implemented.

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International agreement

I read with interest the letter of Jay S. Huebner (May 1976, page 9) suggesting that the last page of articles be incorporated in references. There lies, in my modest opinion, a much more Herculean task ahead for the AIP: international standardization. As you are well aware, there are small, but irritating and useless, differences in the way articles are referenced. For instance, British journals and SIAM journals use alphabetic reference systems, *Physica* puts the year after the volume rather than at the end of the sequence. I am sure that every editorial board has a logical justification for its choice, and who would dare to ask the Royal Society to change its archaic ways? Not me! Nevertheless, life would be easier on the author and his faithful typist if there would be an international agreement. The book publishers appear to have come to some kind of international system.

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Physics of technology

The letter "Teaching the physics of high fidelity" by Kenneth Johnson et al (November, page 9) brings attention to what is indeed a powerful and successful teaching technique. High fidelity is a fertile technological system for motivating the learning of a broad spectrum of physics topics.

But there are other systems that can also serve. In fact, one might simply offer a course titled "The Physics of Technological Systems," or more generally, "The Physics of Technology," and utilize a variety of technological devices determined by the particular student interests and career goals.

In fact, such a program and course materials already exist. The Physics of Technology program was recently developed under a grant from the NSF and is now available from the McGraw-Hill Book Company. The materials consist of a series of 27 laboratory-based modules, each centered on a technological device.

The following is a list of the modules available, along with their physics-topic emphasis:

- The Analytical Balance (measurement, errors and mechanical equilibrium)
- Automobile Collisions (momentum and energy)
- The Electric Fan (rotational motion)
- The Pile Driver (kinematics, work and energy)
- The Stroboscope (measurement of motion)
- The Torque Wrench (forces, torques and elasticity)
- Hydraulic Devices (hydraulics and equilibrium)
- The Loudspeaker (sound and wave motion)
- The Guitar (sound and wave motion)
- The Pressure Cooker (thermal properties of matter)
- The Power Transistor (temperature and heat transfer)
- The Toaster (heat and energy)
- The Cathode Ray Tube (electric fields and forces)
- The Multimeter (electrical measurement)
- The Automobile Ignition System (electricity and magnetism)
- The Solenoid (electricity and magnetism)
- The Transformer (alternating currents and the magnetic properties of matter)
- The Slide Projector (geometrical and physical optics)
- The Binoculars (geometrical and physical optics)
- The Camera (optics and photographic measurements)
- The Spectrophotometer (spectral properties of light)
- Photodetectors (interaction of light and matter)
- The Incandescent Lamp (current electricity and photometry)
- The Fluorescent Lamp (atomic physics and atomic spectra)
- The Laser (modern optics and quantum mechanics)
- The Geiger Counter (radioactivity and nuclear physics)
- The Cloud Chamber (radioactivity and supersaturated vapors)

The modules are generally divided into three sections, each section representing about one week's class and laboratory work. Thus, an instructor (or student) can select from the library of 27 modules approximately four or five to comprise a one-semester course. The modules include well developed laboratory instructions that guide the student through various experiments to determine the quantitative behavior of the technological system. The results are then used to develop the relevant physical concepts and laws that account for them. Thus, the laboratory experiences are an integral part of the learning process and are not used simply to verify statements made in a lecture.

Further, the laboratory apparatus is a familiar real-life device, not a specially made device that a student will not see anywhere else again. Contemporary measuring instrumentation (thermistors, photocells, amplifiers, oscilloscopes and so on) is used to measure the device behavior. Most of the devices can be purchased from local retailers and at a cost that is small compared to conventional laboratory equipment. Equipment kits are also available, however, from Thornton Associates (37 Beaver Street, Waltham, Mass.) for those whose purchasing procedures encourage that mode.

The Physics of Technology program was designed originally with an engineering and engineering-technology audience in mind. This accounts for the more technical nature of some of the devices employed. However, many of the modules have been found appealing to less technical audiences and have produced favorable reports comparable to those described by Johnson et al.

This general approach represents a significant alternative to the conventional teaching practice. Instead of stating general laws of physics and later showing how they operate in specific instances, this approach starts with the quantitative behavior of a specific and familiar system and uses this to develop the relevant general laws.

It also places the physical device and laboratory experience in a central role. For students in the "concrete" phase of Piagetian development, these may well be essential ingredients to the learning of physics. And it may not be a bad method for teaching physics majors either!

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Newton and de Broglie

In the year 1693 Isaac Newton suffered a personal crisis. He wrote odd letters to friends and experienced severe irritability and insomnia. Profound students of this great inventor of physical and mathematical theories have speculated that Newton's illness was purely emotional. Others have said that vitamin deficiency may have been a contributing factor.

Having studied and contemplated this uncharacteristic breakdown of Newton's it has occurred to me that he may have suffered from mercury poisoning. Newton was a lifelong alchemist. He joked that his hair turned gray prematurely as a result of working with quicksilver. He was engaged in just such work with mercury at the time of his crisis in 1693. I am making a concentrated investigation of this possibility. I would like to communicate with people concerned with the biography of Newton, and with mercury toxicity.

PHYSICS TODAY is admirable, not only for the excellence of its technical articles but also for the regular historical features, such as the reminiscences of Felix Bloch in the December issue ("Heisenberg and the early days of quantum mechanics", page 23). I would like to point out that the identification of the founder of wave mechanics is incorrect. It was not *Maurice* de Broglie, but his younger brother Louis.

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Thanks to Laurence Johnson for pointing out the error made by our staff in carrying out our usual practice of inserting the first names of people mentioned in manuscript. Maurice de Broglie (1875–1960), also a physicist, became president of the French Society of Physics and a member of the French Academy of Sciences in 1924, the year his more famous brother got his doctorate at the Sorbonne.

EDITOR

Welfare costs

The dispute about welfare costs between Carl Friedberg and Eugene Wigner (December, page 13) is explained by the fact that they do not agree on the meanings of words like "income maintenance" and "welfare." In point of fact, they are both correct.

The 30 million or so Americans over 65 years of age together with a much smaller number of the disabled, dependents of disabled, and widowed (if assumed to receive a reasonable average of $300 per month in Social Security benefits) receive quite a bit over $108 billion per year from the Social Security system, which the recipients have in the past put into the system. A recent piece in *The New York Times*, on the other hand (I don't remember the exact reference, only the bottom-line figure) states that actual welfare in the nation adds up to approximately $12 billion per year. The sum, perhaps also adding some reasonable value for unemployment insurance, gives us Wigner's $182 billion. The welfare figure alone explains why Friedberg was shocked at Wigner's figure.

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Ether drift debate

Referring to the letter by J. W. Haslett (January, page 11) let me point out that the readily available basic paper,[1] which preceded the PHYSICS TODAY letters on this subject, quoted T. S. Jaseja *et al* at some length; in fact their paper was a major basis for certain calculations. I would suggest that before denigrating your correspondents, as in the Haslett letter, it might be well to check the literature, or at least permit those who are knowledgeable on a subject to make prepublication comments, to try to prevent such irresponsible shooting from the hip.

The Michelson–Morley experiments, and others seeking to find an "ether drift," were basically attempts to establish a method for determining absolute motion of the Earth, that is lateral motion without reference to any other celestial body. This was first accomplished by E. Conklin[2] in determining the diurnal variation of the 3.5-cm electromagnetic-radiation flux. If we assume this flux to be locally isotropic, the motion of the Earth is described as being along a line defined as declination 32 degrees, right ascension 13 hours. The velocity is approximately 160 km/sec. Suggestions have been made that optical studies be done using various techniques, *with the apparatus oriented to determine the possible effects of the Earth's motion about our galactic center.* This velocity is approximately 220 km/sec.[3]

Such experimental studies are now in progress, both in the US and in Europe. An international meeting will soon examine in detail these findings, as well as the theoretical significance of this updated approach to modern physics.[4] Time (and physics) marches on!

References

1. H. C. Dudley, Nuovo Cimento **4B**, 68 (1971).
2. E. Conklin, Nature **222**, 971 (1969).
3. H. C. Dudley, Bull. Atomic Scientists, January 1975; page 47.
4. New Scientist, 23 September 1976; page 662.

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THE AUTHOR COMMENTS: From time to time, attempts are made to exhume and revitalize an ether theory. Whether help is sought from the neutrino-sea hypothesis of Steven Weinberg, as proposed by H. C. Dudley in 1971, or from a sort of continuous radiation of Conklin, as referred to by Dudley in his letter (February 1975, page 73), it appears that any ether theory in old or new dress dies easily and resurrects hard these days. This is not altogether surprising in view of the satisfactory explanations of null results of ether-drift type experiments (such as that of C. H. Townes *et al*[1]) which are offered by the theory of relativity usually attributed to Albert Einstein.

If an ether theory based on a neutrino sea or on some other consideration is to be acceptable, it will, in addition to any positive comments that it may make, have to offer satisfactory explanations for the null results that have been obtained by