all, students and educators; it doesn't do the job. Donald Langenberg's statement that "today's young faculty are not living up to the old stereotype" is the single most hopeful message delivered by the panel. Now if those young faculty can only win tenure.

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The roundtable in the March issue was interesting, but repeated some off-the-mark justifications for sponsoring physics research. In particular, the notion that this country must sustain a deep and broad effort in basic research to ensure a strong economic future for ourselves really doesn't hold up under scrutiny. Consider:

▷ The British have long had a brilliant and high-achieving basic science establishment but have an absolutely dismal record of building upon British basic scientific discoveries to develop new and economically rewarding industries. British discoveries almost always are exploited in other countries. It is some kind of British cultural failure, but clearly shows that having a strong basic research effort isn't enough for achieving economic competitiveness.

▷ The Japanese have contributed very little to basic science. But the Japanese have showed (all too well) that a bright and well-educated scientific and engineering establishment can track and adopt discoveries made elsewhere and turn them into superb and extremely rewarding industrial advances. As Japan has become rich exploiting the discoveries of others, its contributions to basic science are increasing, but they still lag those of countries with longer scientific traditions.

▷ Some other countries understand the difference between the British and the Japanese models. For example, in the early 1970s the Program on Science, Technology and Society at Cornell University was graced by a visit from the French government's science adviser (I believe it was Pierre Aigrain). At that time he was advising the French government that it was important for a relatively small country like France to have more scientists per capita than the US, simply to have, in the country, the ability to access, understand and adapt scientific advances made in richer countries.

▷ Your roundtable participants discussed the rapidly evolving worldwide dissemination of scientific information on the Internet. The group seemed awed by, but generally applauded, the increased speed with which new knowledge now spreads. Unfortunately the group did not grasp that this phenomenon simply means that research advances made in the US are now even more quickly accessible to the Japanese, the French and any other astute country. Once on the Internet the US doesn't even have the modest head start once afforded by the old print dissemination channels.

If the US emulated our competitors more adroitly, we would pay more attention in real time to discoveries made elsewhere—even if reported in foreign languages. But we do not. Unless discoveries are reported in English we no longer have the ability, much less the interest, to follow them. For example, how many US scientists attend Japanese scientific meetings or read the abstracts for such meetings in their original Japanese? The Japanese get almost a year's head start on us, because it often takes that long for reports to appear in English.

In short, we need to accept that we cannot cover all bases ourselves, we need to be eager to monitor the work of others seeking economic opportunities, and we need a well-educated scientific–engineering establishment willing to do it without shame. We do not have to make all the discoveries ourselves and should stop pretending that the discoveries we make will help the US more than our economic competitors. That is simply a false notion!

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Does Top Mass Rule Out Higgs at LHC?

In my letter of January 1995 (page 73) I said that the 1994 Drell subpanel report to DOE's High Energy Physics Advisory Panel promotes CERN's Large Hadron Collider "over the physics that we Americans would normally be doing at that time." What I meant by "normal" physics is that there would be a continuation of the long series of improvement programs at Fermilab. I gave reasons for the next two improvement programs to be a doubling of the Tevatron energy followed by construction of a new "Tevatron" ring of ten times that energy.

At the time of the 1994 Drell report it was generally felt[1] that the mass of the top quark was approximately 160 GeV, based on radiation corrections to the width of the Z and assuming a Higgs mass of 300 GeV.

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(The measured width of the Z relates the top mass, the W mass and the Higgs mass—see the figure in PHYSICS TODAY, May 1995, page 19.) But now the CDF group and the D0 group at the Tevatron have mass measurements of 176 GeV and 199 GeV, respectively.[2] This means the Higgs particle mass should be higher than previously thought. For example, reference 1 used a Higgs mass of 300 GeV to predict a top mass of 165 GeV (with large errors). Reference 1 also says that a top mass of 185 GeV predicts a Higgs mass of approximately 1000 GeV. This kind of Higgs mass would be out of range of the LHC.

This new information makes it even more unlikely that the LHC could do Higgs particle physics, whereas if we let Fermilab proceed "normally" the Higgs physics would much more likely be within reach. If instead we should follow the advice of the Drell panel, an additional $400 million of the US high-energy physics budget would be diverted to the LHC, and this might interrupt the normal progress of improvement programs at Fermilab after two more upgrades.

I am not advocating any curtailment of the normal practice of US physicists using European accelerators or European physicists using Fermilab. But I am questioning an additional US contribution to the construction of an accelerator that is generally considered inferior to what Fermilab could do.

References

1. W. Hollik, in *Lepton and Photon Interactions*, AIP Conf. Proc. 302, P. Drell, D. Rubin, eds., AIP, New York (1994), p. 365.
2. CDF collaboration, Phys. Rev. Lett. **74**, 2626 (1995). D0 collaboration, *ibid.*, p. 2632.

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A MEMBER OF THE DRELL PANEL REPLIES: Jay Orear claims that the recent mass measurements of the top quark by the CDF and D0 collaborations provide evidence for a very massive Higgs particle. Orear uses this claim to bolster his idea that the funds envisaged for the Large Hadron Collider by the "Drell report" would represent a serious diversion of the US high-energy physics effort, as it is now "even more unlikely that the LHC could do Higgs particle physics." While I could comment on wider issues of the US participation in international projects and the usage of US facilities, I will merely comment on the physics.

The electroweak radiative corrections to the masses of the W and Z bosons provide a window to the Higgs within the context of the standard model of particle physics. Due to the structure of the corrections, the top quark plays an important role because it is so massive. On the other hand, one should be careful to pay attention to the size of the error bars on the top mass and to the dependence of the radiative corrections on the Higgs mass (which is logarithmic). Reasonably precise measurements of the masses of the W boson and the top quark are the two outstanding pieces of information required to use the radiative corrections to obtain a "window" on the Higgs mass. With uncertainties of roughly 50 MeV on the W mass and 5 GeV on the top quark mass, one could derive roughly a two-standard-deviation separation between Higgs masses of 100, 300 and 1000 GeV. Given that the current uncertainties are much larger (roughly 180 MeV on the W mass and 14 GeV on the top quark mass), it is unlikely that the present information would yield anything approaching this degree of certainty on the standard-model Higgs, unless the measurements lay very far outside the standard-model predictions, which is not the case. If anything, combined fits to electroweak data seem to prefer a light Higgs, but again with such large uncertainties that it would be unwise to draw any strong conclusions.

Certainly the future direction of US high-energy physics is an important subject and is worthy of discussion in these pages. Contrary to Orear's letter, however, the existing data on the top quark do not support the conclusion that the Higgs boson is very heavy and hence, at present, do not serve as a guide to the discovery potential of future accelerators.

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Impediments to a New Science Curriculum

Leon M. Lederman's Reference Frame discussion of "A New High School Science Curriculum" (April, page 11) revisits in a very convincing way concerns and possible remedies that have been on the minds of educators and science professionals for some time. With great insight he calls attention not only to the advantages of a multiyear teaching program combining physics, chemistry and biology but also to the pitfalls and practical considerations standing in the path of wide acceptance. As educators who already have trod that path, we urge that today's innovators pay heed to some of the hard-learned lessons of the past.

In the 1960s and '70s many educators were convinced that a "spiral" approach to science education, with material from several disciplines presented in a coherent and interrelated way over several years, was the most effective way to reach secondary school students having a broad range of abilities and goals.[1] By 1974, according to an unpublished study by David C. Cox at the Center for Unified Science Education at Ohio State University, at least 300 interdisciplinary science teaching programs were in place in US schools. These had a variety of formats but shared a common educational philosophy.

One of the more successful of such programs, the Portland Project, was developed under the auspices of the NSF by high school teachers, academic educators and scientists working over several years as a team led by Michael Fiasca at Portland State University.[2] The program incorporated material from traditional courses in physics, chemistry and biology to form a three-year course for 9th- through 11th-grade students. Wherever possible the project drew freely from well-tested materials developed for programs such as the Physical Science Study Committee course, Harvard Project Physics, the Chemical Bond Approach course and the Biological Sciences Curriculum Study course. Indeed, although a large amount of original materials was produced,[3] much of the program could be put in place using widely available textbook, audiovisual and laboratory resources. Even in its early stages of development this approach enjoyed wide acceptance; a 1967 survey showed that the Portland Project science curriculum was in use in 44 schools in 20 states.

Unfortunately, as with several social ventures that lost ground in the political climate of the 1970s and '80s, the Portland Project withered away in recent years. Why? Judging by the enthusiasm greeting recent initiatives such as the National Science Teachers Association's Scope, Sequence and Coordination, the basic philosophy is not without its champions. Perhaps the principal lesson to be learned is that a fundamental revamping of the ways in which we educate requires sustained support, whether it be governmental or corpo-