letters

Balancing US–Japan technology flow

Although I am no expert in technology transfer or drawing up balance sheets, I would like to take issue with William C. Norris's editorial (February, page 168), because I believe it failed to mention some significant aspects of the problem.

Norris states that "the Japanese send their best graduate students to the US to obtain PhDs. The US provides financial as well as intellectual support for many of them." The latter statement is certainly true, for which I am profoundly grateful. However, there is another side to the story.

In the field I do know about—elementary particle physics—in which Japan was in a good position to do basic research, the United States has "picked up" at least Michio Kaku, Toichiro Kinoshita, Yoichiro Nambu, Susumo Okubo, Sadao Oneda, Bunji Sakita, Jun J. Sakurai, Hiroshi Suura, Mahiko Suzuki, Yukio Tomozawa and presumably others I must incur the wrath of.

There are good historical reasons for this "brain drain": the devastation of postwar Japan, and the creation of the United States as a nation of immigrants. Also, it is quite possible that by staying in the States, the above physicists and others have added more to the world's fund of knowledge.

Nevertheless, I think one gets a distorted view of US–Japanese relations (or for that matter US–European or US–Third World relations) if one includes only the support the United States provides to students abroad, but omits the influx of talent that has remained in the States.

Even if we ignore the brain drain issue, my personal experience suggests that both countries would be poorer off if the United States decided to cut of support.

Norris also states that "Japan is not performing its fair share of the basic research that adds to the world's store of knowledge, yet Japan has virtually unlimited access to US research." Unfortunately, he does not give any basis for this judgment, nor any criterion for fairness. As for my own field, I do not think the first half is true at all. There is now an electron–positron machine running in Tsukuba, which is certainly an expensive chunk of equipment. (See PHYSICS TODAY, January 1987, page 21.)

Finally, I should perhaps mention that manuscripts for all major Japanese physics journals (including the *Japanese Journal of Applied Physics*) are written directly in English, so that they are immediately accessible to a wide audience.

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4/87

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Coming from such a quintessential good guy of US science and technology, William Norris's suggestions about evening out the technological information flow with Japan were both important and instructive because of what they revealed about US perceptions in international dealings. Basically, after 40 years of world hegemony we tackle all problems with the approach: Why don't they do it our way, with our values, our standards? Given that attitude, we naturally become much more concerned about fixing "their" problems to conform to our (obviously correct) solutions! This kind of thing worked, in a manner of speaking, while the US was a kind of Supreme Power. It is no longer helpful in a world where the Soviets have established military parity of a sort, where Japan's economic ascendancy only increases every year and where many other countries are serious economic rivals. I submit it would have been more valuable to talk about our own responsibilities for our system.

While calling attention to one or two failures of US companies, Norris would like the Japanese to follow the US model in several major technology policy issues:

▶ They should do more "basic" research. Why? I would have thought it clear that we, seeing their success in technology, should change to do less of whatever we are doing now, because

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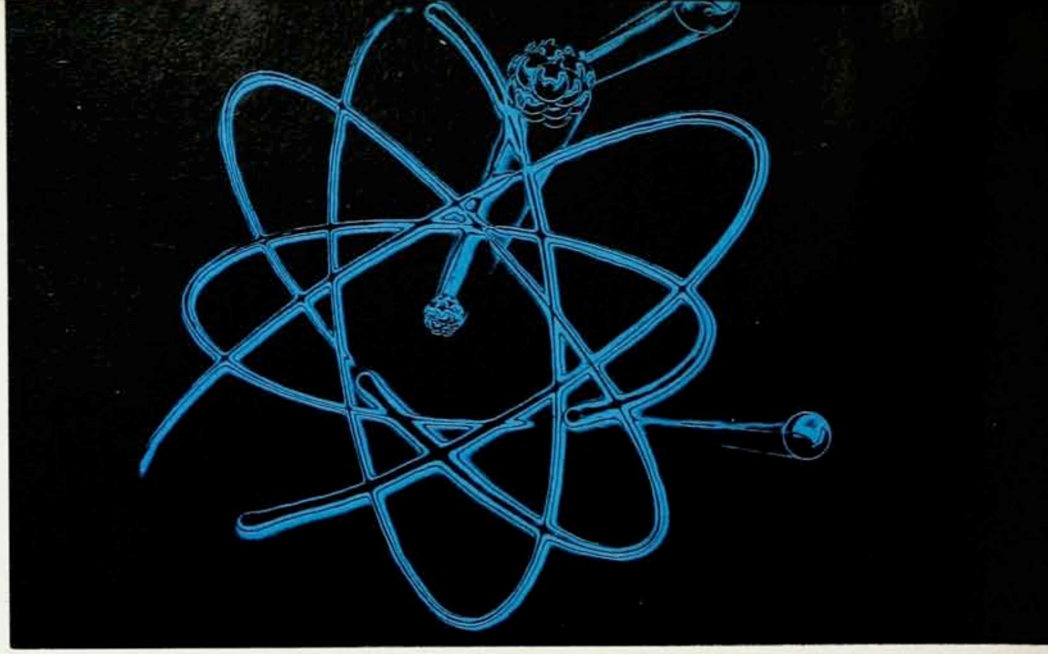

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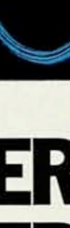

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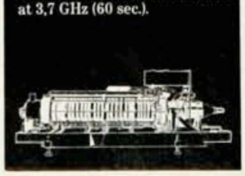

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U.S.A.: DOVER Tel. (1-201) 328 1400 TWX 710987 7901 that surely is not succeeding.

▶ Gaining access to Japanese science and technology is, as Norris acknowledges, rendered difficult by "cultural and linguistic barriers." But surely it is our responsibility, not that of the Japanese, to have our students learn their language and study their culture.

▶ Japan is also to be held financially accountable for sending its students overseas. Norris sees US universities as being "owed" $10 000 per foreign student. On the other hand, the UN and others argue that the US is "stealing" the best brains from abroad and that the US should pay those countries for all the earlier education "contained" in these emigrés. Certainly our graduate schools and many industries would be in disarray without foreign students. In any case surely the appropriate education of US citizens for the new global market is our responsibility, not a matter for handouts from foreign governments. How little the US science and technology community cares about the human factor of investing in education, as compared with their obsessive concern for increasing the budgets for whatever is labeled "basic" research, is dramatically illustrated on page 67 of the February 1987 issue of PHYSICS TODAY. The figure shows that the US university community reduced its relative commitment to science education by a factor of 10–20-fold while its total budget was rising by a factor of 10–20-fold. It strikes me as preposterous that the industrial research community should not strongly urge the US university power structure to put another $100–200 million into all kinds of innovative education and training, including fellowships to Japan, instead of continuing a monotonous and obviously unsuccessful simpleminded expansion of research budgets alone.

Another amazing argument often brought up about Japanese R&D—though not by Norris—is that the Japanese are not carrying their "fair share" of the defense burden. Perhaps they think they are; what's more they may be right. We can do something about our share—lower it—but we choose not to because of totally fantastic hype about spinoffs from defense.

Finally, I believe that Japan has indeed started to contribute in a major way to US technology by showing us what cost-effective basic research really means and how a well-integrated research system works. In the materials field within the last year or two we have observed two major research areas opened up by Japanese work. In growth of metastable diamond films Nobuo Setaka, S. Matsumoto and their colleagues at the National Institute for Research on Inorganic Materials have developed the potential of the discoveries by Boris V. Derjaguin, D. V. Fedoseev and B. V. Spitsyn in Moscow. I "harvested" this Japanese basic science and brought it back to create a diamond fever among US companies. Likewise the new high-temperature ceramic oxide superconductors made their way to the US from Switzerland by way of the University of Tokyo and the announcement by Japanese colleagues at the Materials Research Society meeting in Boston in December 1986.

Since it is well established that good science almost always results from advances in technology, the Japanese are most certainly contributing to the health of "basic" science in the future. That, I submit, is more than adequate justification for them not to fix something that ain't broke. I wish one could say that about most US science and technology policy. Here a crippled President is trying to salvage his reputation by attaching himself to more basic-science "magic" (including a Super Collider). Norris identified an important problem. But in an era when huge sums of money for research are being so generously thrown around (albeit only in proposed budgets) it is surely a little incongruous for Americans to appeal to policymakers in Tokyo and not in Washington to fix the problem.

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In the February issue of PHYSICS TODAY, I found an editorial contribution by William C. Norris on equalizing US–Japan technology flow in which it is claimed that "Japan is not performing its fair share of the basic research that adds to the world's store of knowledge." It is also claimed that Japanese "government laboratories and cooperative projects involving the government and private companies carry out a significant part of Japan's meager basic research." I feel strongly that these and other statements of the article should not remain uncontradicted by the evidence.

I have just spent five months in Japan as a guest of the Institute of Laser Engineering of Osaka University, and I have toured laboratories mostly in the Tokyo area and at Nagoya. (This is of course only a small fraction of Japan's universities and institutes.) I was highly impressed with the range and quality of the

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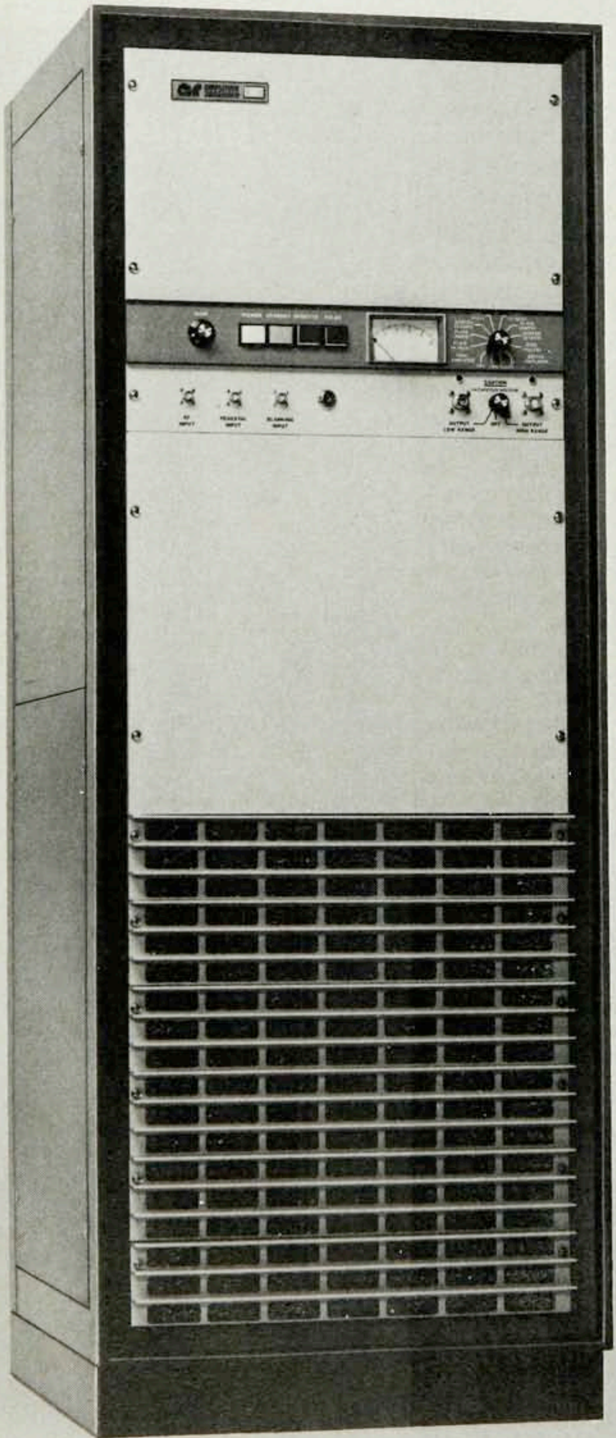

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research and the information freely communicated to me. Admittedly, my interests are limited to thermonuclear fusion, accelerators and lasers, and although I visited Japan's space research center I did not do so as a well-qualified specialist. Nevertheless I hope that you will find my comments worthwhile.

At a time when research in fusion has been cut back in the US, Japan is holding the torch. At the ILE in Osaka pioneering work in inertial fusion is going on with the help of a superb 50-kJ glass laser. The work is very basic and of an extremely high standard. To the extent that similar work is done in the US, it has been directed toward SDI and away from energy research, and security restrictions have not only almost stopped the flow of information to the scientific community at large but also forbidden research elsewhere. The work at Nagoya on magnetic fusion is at least as basic as the much reduced US effort, and more broadly based. Seeing that this work is of crucial importance to humanity, we must be glad that it is carried out on a large scale in Japan.

This year the Japanese have hosted two large international meetings on magnetic fusion alone. The Japanese publish physics journals in English and freely communicate their results. Perusing them, I find that the Japanese work creatively on practically every subject pursued in the West, not least in the field of solid-state materials.

I imagine that Japanese companies keep their manufacturing methods to themselves, but so, I presume, do US companies.

The Institute of Space and Astronautical Science at Mombuso [the Japanese Ministry of Education] has engineered a wide range of rockets and run many space missions, without major mishap as far as I know. I could see that everything there is done with great care and minute attention to detail. I was shown a film of a successful mission to Halley's comet and I am sure the results are well known. I have before me three pages of a publication of the institute describing international cooperation with various countries, including projects with NASA and the European Space Agency.

At Nagoya I met a team of US scientists from General Atomics who are spending several years on collaborative projects in Japan. They benefit from superior installations, and I am told that similar arrangements would be open to other firms.

In university research the graduate students contribute a very large share of the effort. Perhaps Norris underestimates the contribution of the 7000 dedicated Japanese graduate students to US science when he asks for a cash contribution from their government. I am sure that academic teachers other than myself would agree with my assessment.

I think that my contact with the work at the ILE has revealed to me the secret of the Japanese success: dedication to the job.

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3/87

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In response to William C. Norris's editorial, I would like to quote a passage from *The Japanese Mind*, by Robert C. Christopher (Simon and Schuster, 1983):

> By setting up the Japanese trade balance as a kind of straw man, successive US Administrations have distracted public attention from our real problems and enabled Americans to take refuge in the notion that their problems are primarily the creation of "unfair" foreigners. In particular, Washington's myopia has made it possible for US businessmen and labor unions to wrap themselves in the cloak of national interest and whip up support for protectionism. This, of course, simply diminishes the incentive for the mismanaged industries to come to grips with their own shortcomings. In short, a vicious circle has been created by the high-handedness—sometimes conscious but more often unconscious—with which the US has become accustomed to treat Japan. And the only way to cure this destructive situation is for the US to begin to treat Japan with at least the same respect that it accords to substantially less dynamic allies such as France and Britain.

I can recall a local example: A Japanese–American firm was excluded from joining a consortium for conducting research in microelectronics, but a British and a Canadian subsidiary were admitted without the slightest protest.

There is no denying that we need reciprocity (within reason) to help eliminate the imbalance in technology flow. But I still find some of what Norris said in his editorial politically opportunistic. Let's focus on American ingenuity. We have enough talent and resources to beat the Japanese in their backyards. What we need is new lead-

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ership with a vision, not inflammatory rhetoric.

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Declining SATs pose a threat

Robert Beck Clark's editorial (June 1986, page 144) notes that only 0.33% of students taking the SAT exams intend to major in physics. Clark notes that although this number is "woefully small," the future physics majors rank first in median math aptitude and a photo-finish second on the verbal test.

In view of the not surprising news that physics majors are recruited from the very top-scoring students on the SAT exams, it is pertinent to call attention to what has been happening to the number of top scorers in recent years. It is well known that there have been declines in average SAT scores, but the data on the high-scorers are much less discussed.

The number of students whose scores on the verbal test are in the 700–800 range show a stunning decline[1] since 1967: from 2.3% of those taking the exams down to 0.83% in 1982. The decline in top math scorers has been somewhat less severe, but of the same order of magnitude. While the declines seem now to be bottoming out, what we see over the past 20 years is a cumulative loss of about half of the top scorers that we had in 1967!

Not only are the top scorers the ones who are more likely to major in physics, but they fill key positions in every niche of American economic life that requires distinctive intellectual ability. Thus the loss that has occurred must eventually be felt in leading positions in all fields of intellectually demanding endeavor. This is a very sobering thought, but it is one to which we have hardly paid any attention at all.

It is significant of at least part of the problem that those who would concern themselves with the decline in the high-scorers can expect to face criticism as "elitists." In short, we seem to be caught up in the pursuit of mediocrity that Alexis de Toqueville warned us a hundred and fifty years ago might be the Achilles heel of democracy.

The fact is that those who scorn "elitism" scorn democracy in its essential sense of giving all citizens the opportunities to develop to the best of their abilities and, by so doing, to make the greatest contribution to the general welfare. Only the most benighted among us equate democracy with mediocrity. And it is high time that we recognized what has been happening to the ranks of our intellectual elite, and take strong measures to recoup our losses of the last 20 years. One measure that is already being taken is the creation of special secondary schools for the talented. But we need more of them, and it would be singularly helpful if there were a model school in the Washington, DC, area to serve as an inspiration for model secondary schools all over the country.

Reference

1. R. Jackson, *An Examination of Declining Numbers of High-Scoring SAT Candidates*, Educational Testing Service, Princeton, N. J. (October 1976). Annual reports of the College Board, New York.

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What's best for space science?

From my perspective in the private sector, a commentary on Irwin Goodwin's interesting news story on NASA in the September 1986 issue (page 37).

First a couple of nits:

▶ Goodwin's assertion that the Uranus results prove "without question that humans can explore the Solar System at no risk to themselves" is just not so. Robots are extremely cost effective in investigating simple systems where our initial ignorance is profound. They are much less useful in dealing with complex systems; for example, the results from the Apollo missions could not have been obtained with robots.[1] Dealing with complex systems requires extremely high-order pattern recognition, which is far beyond the present capabilities of robots.

▶ Goodwin's aside about "Reagan's pet space station" is off the mark. The Soviet Union has been flying space stations for over a dozen years. To believe that it has devoted such long-term effort to a program of little scientific or technical value is preposterous. To believe that the United States cannot respond to this effort without severe economic and political consequences is dangerously naive.

More generally, space scientists should beware of presenting their studies as something that "should" be done. Furthermore, protests from scientists to the effect that "we've devoted our careers to these studies and deserve to finish them" will carry little conviction with the public. There are legions of folk out there who can no longer make a living at their chosen careers—steel and auto workers, farmers and so on—despite years of investment in training.

As Milton Friedman asked some years ago, why *should* the public support science? (Especially in tight economic times!) The short answer is that a society that supports science prospers, and indeed, science traditionally has been sold on just this basis.

However, scientific research is occasionally justified as a "cultural" endeavor that *per se* demands support, and this seems implicit in Goodwin's story. Such a reason may be valid for making a career choice, but not for spending public funds. This notion is further weakened by the fact that most research is intelligible only to other specialists, a remoteness exacerbated by many scientists' suspicion of popularization. Indeed, scientists who do try to reach a wider audience typically come in for criticism.

This whole approach makes the scientific community seem a particularly naive special interest: "We need this funding because we want to do this work; besides, we've invested years in our careers to this point. However, don't ask us to justify the project on any cost–benefits basis; it's merely of cultural value. But the results will be intelligible to only a few specialists, and furthermore, although we resent any attempts by others to explain them to a wider audience, we can't be bothered to do so ourselves." To the extent that the public who is picking up the tab perceives such attitudes, science funding will suffer. Indeed, inchoate resentment of "big science" by the public probably had as much as anything to do with the decline of space science during the 1970s.

Academic scientists traditionally bristle at suggestions that their research should be cost effective. How, after all, can one quantify the value of results one doesn't know yet? Certainly there is much truth in this view, and with the severe damage excessive short-term thinking has done to US business (as noted below), one would not want to inflict such thinking on academic science too.

Nonetheless, public-supported research should support the public interest. Virtually all basic research has had long-term payoffs, and it is those payoffs that justify—indeed compel—the public sector investment. With the currently fashionable concern about the necessity of "long-term thinking" to restore US technological leadership, space science (and other basic research) could enjoy a much more favorable political climate. But space science needs to be put into a general context of basic research as representing vital, long-term national interests.

To be sure, the aerospace companies and NASA are also not blameless for the present state of space science. The