shooting at. But there is a common ground here, without doubt. Or, to put it another way, logicians have too long smarted under the comment that they are not engaged in laboratory science although they purport to be illuminating it. I would respond to that comment with another: Although scientists very often are forced to analyze arguments and concepts in the course of their daily work, very few of them ever receive any formal training for doing this. Whether or not the history of science would have been written differently had this not been the case I cannot say. Here I only want to stress the fact that mastery of the techniques of science and the techniques of logic requires experience and study and that logicians of science have perceived the need for both techniques, whereas practicing scientists, although they very often undertake both, are usually trained in only one.

In short, the logic of science has been sundered from science and from the training of scientists. This comes from viewing them as independent undertakings, requiring different criteria and different skills. I am suggesting here that the deep connections between these two undertakings make them natural conceptual allies in the context of our general intellectual development.

It is not my purpose to explore the ways in which practicing scientists and practicing logicians of science can actually achieve an effective liaison, for the ultimate benefit of both. Senior scientists and junior university presidents seem to be confident that they possess the answer. But that the *doing* of science and the *thinking about* science are different disciplines which cannot be fused together but which nonetheless are interdependent—this is the intellectual symbiosis I have sought to delineate. Fusion of the two would result in a formless pulp and serious science or serious logic of science would suffer. But complete cleavage of the two would ultimately result in the death of each.

NEWS AND COMMENT

Manpower Race: Panel Offers Proposal To Turn Out More Scientists, Engineers

In its efforts to steer young people into careers in science and engineering, the Soviet Union holds an important advantage over this country.

The Soviets can tell any talented student that if he wants a higher education, it will have to be in engineering or the sciences. For vast numbers of students this is not an unpalatable choice by any means, and through this combination of push and natural inclination, the Soviets outproduce this country three to one in engineers; if teachers are included, they are also ahead nearly two to one in what are loosely called the sciences. And they have achieved these results with a total higher-education enrollment that is smaller than this country's.

It can be argued that the Soviets need more engineers to accomplish tasks that we accomplished years ago. And there is also the likelihood that a careful examination of quality would reduce the significance of the disparity, but in the context of East-West competition, the manpower race cannot be brushed aside. Accordingly, last January, the President announced that he had asked his science advisers and the National Academy of Sciences to recommend steps to increase this country's output of engineers and scientists, a goal that is not at all easy to achieve under the Western tradition of students deciding what careers to follow.

The first report to result from that request was issued last week ("Meeting manpower needs in science and technology, Report No. 1." A report of the President's Science Advisory Committee. U.S. Government Printing Office, Washington 25, D.C. 20¢). Briefly, the report proposes that the most effective first step would be to make certain that high-quality facilities are available and that financial problems do not discourage qualified undergraduates from full-time graduate study in engineering mathematics, or the physical sciences (EMP). The proprosal, in a sense, is a modest one, since financial assistance in these graduate fields is already fairly extensive (last year, 40,000 of the 56,000 full-time graduate students in these fields were receiving "full-scale" support—stipends of several thousand dollars a year, plus their educational expenses). But, at the same time, the proposal would openly establish the principle that since the federal government, directly and through contracts, is the main "consumer" of EMP manpower, it should assume responsibility for education in these fields.

By bits and scraps, through a variety of fellowship and training grant programs, the government has already moved a good way toward this role, most markedly in the life sciences. But the report, which was endorsed by the President, recommends that the nation, with the federal government taking the lead, now go all the way in EMP support; that *all* full-time EMP graduate education costs, to the student as well as to the institutions, be fully financed through a "National Program" in which the federal government would be main source of funds.

To this extent, the proposal steps out onto new ground, but in terms of the numbers of students it would bring into graduate school and the numbers of degree holders it would produce, it is deliberately aimed low, apparently in deference to the often-overlooked fact that the whole issue of scientific and engineering manpower is an enormously complex one that is beset by many pat assertions and surprisingly little reliable information.

It is obvious that in many fields, especially those related to the space effort, the present pool of specialized manpower is running low in spots, and the situation is likely to become even more critical as the nation's technical commitments increase. But the measure of inadequacy involves a good deal of guesswork, since, despite the widespread alarm over manpower shortages, no comprehensive and reliable study has yet been made. At best, there can be no firm answer to the question of what do we have and what will we need, but in this statistics-rich age the

dearth of good numbers on manpower remains a constant marvel. (The President, in ordering the study, stressed the need for haste and directed that his advisers work with "available studies and other pertinent information.") Some of the best work in the field has been performed by the Bureau of Labor Statistics for the National Science Foundation, but even the Bureau's works are studded with warnings of uncertainty. And the National Academy, which was asked by the President last January to make a study of the use of existing trained manpower, has yet to get the study under way. Once started, the NAS study is expected to take 18 months to 2 years to complete.

The study released last week was prepared by a panel headed by Edwin G. Gilliland, professor of chemical engineering at Massachusetts Institute of Technology, and its recommendations are aimed at quickly producing more EMP graduate degree holders with the least disruption in the generally uncharted field of scientific education and manpower, and without any sacrifice in quality. It is also aimed at achieving this goal in a fashion that will involve the least possible opposition within Congress, simply by expanding a variety of programs which have already received Congressional approval, rather than by asking Congress to approve new programs.

The goals set by the report are the enrollment of 30,000 first year EMP graduate students in 1964, an increase of about 8000 over what is now expected, and the award of 7500 EMP doctorates by 1970, which is actually a relatively small increase over what is expected to happen under present arrangements. The numbers projected under current programs are characteristically uncertain, but in any case they justify the report's claim of modesty. (The Office of Education now forsees 5500 EMP doctorates by 1970, while NSF puts the figure at 6100; however, if the present ratio of EMP baccalaureates to Ph.D's continues, the 1965 crop of bachelor degree holders should yield 8640 Ph.D's by 1970, all of which demonstrates that until more reliable studies are available, guessing will have to be a large component in any manpower projections.)

Regardless of what would happen under existing arrangements, the report points out that a lot more qualified students would undertake EMP graduate study and complete their doctorates faster if financial problems were eliminated or rendered less acute. And it offers the argument that the goals it establishes can be achieved "by drawing students solely from those who are expected to have received baccalaureates in EMP" and "without diversion of bright people from other fields."

It does not offer any detail, however, on the question of whether full support for EMP graduate studies might not cause EMP undergraduates to steer away from less affluent graduate fields. The now substantial support available for EMP graduate studies appears, in fact, to have had this effect already, especially in medical education, which is becoming increasingly concerned over the drop in the average grade levels of applicants. This drop appears to have been caused by a variety of factors, but it is considered significant that it has coincided with a large increase in federal funds for graduate science studies, while there are no federal funds for medical students, and other sources of assistance are relatively limited.

The report states: "Predictably, there will be enough students with expressed interest in engineering, mathematics, and physical sciences to fulfill the proposed goals. But the number of students who will obtain advanced degrees will be affected by the Nation's ability to overcome present barriers to graduate education—limitations in student support, numbers of faculty, and educational facilities.

"Faced with a choice between a starting salary above $7000 and a very much smaller stipend with graduate study, many highly qualified college graduates in EMP, especially those with family responsibilities and those who incurred debts as undergraduates, decide they cannot afford to select graduate education. And many who do undertake it must extend their study over extra years by combining part-time study with part-time jobs, deferring their availability for full-time professional work.

"Stipends for graduate study," the report concludes, "must be of sufficient number and size to attract more students into advanced training, and to allow more of them to undertake full-time instead of part-time graduate study, with a correspondingly shortened interval to obtain a Ph.D."

Therefore, the report proposes, the goal of a National Program in graduate EMP should be "adequate financial support for all full-time graduate students; funds to cover the full costs (to the institution) of graduate education in EMP; funds for physical facilities and equipment used; and funds for developing new centers of educational excellence in EMP."

Under existing arrangements, it points out, the nation, through a variety of sources, is expected to spend $580 million for EMP graduate education in 1964. To provide 22,000 graduate students with one year of training in fiscal 1964, and to raise this to 30,000 by 1970, along with the production of 7500 Ph.D.s in that year, it recommends that spending increase to $660 million by 1966, $710 million by 1968, and $760 million by 1970. "A substantial portion of this cost," the report states, "is expected to be funded by already established sources of support, both federal and nonfederal. But a sizable increment will be needed in fiscal 1964 to assure the necessary jump in enrollments."

The "sizable increment" is not specified, but under budgetary proposals now being prepared it is expected to be somewhere around $150 million. If presented in one lump, this figure would very likely cause Congress to take time for reflection, but since educational activities are strewn among a variety of congressional committees, it will only be necessary to ask each committee to add a bit more to programs it has already accepted. This is something to which the committees have not been adverse in the past, and there is no reason to expect that they will rebel against this bite-size approach.

In addition to stepping around the question of precisely how much more federal money should be devoted to EMP training, the report also avoids being specific on the size of the stipends which are expected to draw more students into full-time graduate study. At present, federally supported stipends vary widely, with some running as high as $4500 a year, plus a dependency allowance. Persons associated with the preparation of the report say that no particular figure was decided upon but it was thought that something below $4500 and above the present average of about $2500 would be reasonable.

Support, according to the proposal, would be provided to enable all qualified students to complete one year of graduate training; this would be followed by renewable annual grants, for up to 3 years, for students in doctoral programs, with the intention of en-

couraging students to obtain their doctorates four years after they receive their undergraduate degrees.

The report also suggests training grants—funds assigned to the institutions for award to students they have selected—should be emphasized as the device for channeling increased funds into EMP. The virtue of this method, it is argued, is that it will enable some of the less prestigeful, but still worthy institutions to attract students who might be inclined to go elsewhere if they receive support directly. And it further recommends that allowances to the universities to cover "true cost of education" should be raised above the $2500 per student now provided by the National Science Foundation and the Office of Education under the National Defense Education Act. Again, no figure is set forth, but the report notes that figures provided by the universities place their average costs at $3380 per fellow in the physical sciences and mathematics and $4020 in engineering.

To assure that adequate facilities will be available for the proposed increased enrollments, the report recommends the "strengthening" and wider geographic distribution of "educational centers of excellence," which it defines as "an entire institution, a department, a group of faculty, or one distinguished man." To help achieve this goal, it proposes that when other sources of funds are not available, insistence on 50-50 matching of funds for construction "be relaxed to enable the Federal government to contribute as much of the funds for a needed facility as may be necessary."

The report acknowledges that it is concerned with only a relatively small slice of the overall manpower situation. It notes, for example, that the production of highly trained graduates in EMP is a process with roots that run through all levels of the nation's educational system; and it also points out that the manner in which EMP graduates are utilized is probably as significant to the nation's needs as the number that are turned out.

However, as a short order recipe for achieving a quick, though modest increase in EMP graduates, the report has considerable merit. It is politically palatable, it is aimed at producing the increase with the least possible disruption for other specialized fields, and it could be readily integrated into existing patterns of federal support.

—D. S. GREENBERG

Cooperation in Space: U.S.—U.S.S.R. Accord Caps Year of Modest Gain

The carefully worked out agreement between the United States and the Soviet Union to cooperate in certain "peaceful uses of outer space" is regarded as a definite step ahead in international space cooperation, but is most unlikely to throw together American and Russian space scientists and engineers in the laboratory or at the launch site.

Formal announcement came early this month of agreements negotiated last spring by the two nations to cooperate in three fields: establishment of a global weather satellite system, mapping of the earth's magnetic field, and experiments with communication satellites. Working parties from the two countries will meet to plan the three projects and arrange exchanges of data, but the cooperation contemplated can be characterized more accurately as coordination than as a joint venture.

A summary of the agreement (Release No. 62-257) may be obtained from the National Aeronautics and Space Administration, Office of Public Information, 400 Maryland Ave., SW, Washington 25, D.C.

Quite understandably, however, this agreement between the only two satellite launching powers in the world is being closely examined for political significance. The decision by the Soviets and the United States to announce the agreement jointly in the United Nations and to request that the text be circulated as a U.N. document gave the news a certain cachet which probably added to the enthusiasm of the smaller nations, who like to see this kind of accord given an international aspect.

The U.S.–Soviet agreement is, in fact, a bilateral one negotiated outside the U.N. and quite similar in its essentials to cooperative arrangements for space experimentation worked out by the United States with a number of other nations, including Britain, Canada, and Japan.

Origins of the new space agreement can be traced back to faint beginnings in President Kennedy's disposition to discuss cooperation in space with the Russians, expressed in both his Inaugural address and his first State of the Union message. The Soviet Union, however, did not take the President up on his very general invitation until after Colonel Glenn's orbital flight, which may well have been regarded by the Russians as marking United States accession to full membership in the space club.

Khrushchev in his letter of congratulation on the Glenn flight, suggested that the U.S. and the U.S.S.R. might pool efforts to explore outer space. With diplomatic reflexes working at a speed that hinted anticipation, the President responded affirmatively in one day, and the United States followed up two weeks later with a list of proposals for possible projects.

Talks were held in New York in March, and delegations met again in Geneva for 10 days of talks which ended 8 June with the sending off of firm proposals to the Soviet Foreign Ministry and our State Department for approval. Chief negotiators were Hugh L. Dryden, deputy administrator of the National Aeronautics and Space Administration, for the United States and Academician A. A. Blagonravov of the Soviet Academy of Science for the Russians. The fact that Soviet scientists handled the negotiations virtually without interference from foreign-office officials led some American observers to believe that the agreement represented a victory for Russian scientists, who have been pressing for more contacts with scientists of other nations.

In August the State Department said the U.S. government had no objections. The crisis in the Caribbean in October may have delayed Soviet action on the proposals, but it appears that the only real effect was on timing.

On the basis of past performance the Russians are expected to carry out their part of the bargain. Ameri-