coeducational liberal arts colleges also tend to be consistent with the results of these earlier studies, with some exceptions. For example, in one earlier study (*12*), attendance at a technological institution was found to enhance the student's mathematical aptitude, but attendance at a coeducational liberal arts college failed to have this effect. Conversely, attendance at a coeducational liberal arts college tended to increase the student's motivation to obtain the Ph.D., but this was not true of attendance at a technological institution (*5*). In the study of Ph.D. "productivity" (*4*), both the technological institutions and the coeducational liberal arts colleges tended to produce more Ph.D.'s than had been expected, though these trends were not statistically significant.

At this time, interpretation of these findings is difficult and at best speculative. For example, the men's colleges of the Northeast are characterized by prestige, affluence, and a high "enterprising" orientation; this combination may result in an environment which discourages the student from pursuing the highly specialized and technical training required in most scientific fields. Some of the findings in a recent study (*13*) suggest that attendance at these colleges tends to encourage the pursuit of careers in the "enterprising" category.

The results for the female students suggest that the effects of colleges on the student's motivation to pursue a career in science are not the same for women as for men. It is difficult to say why the affluence of a college should discourage women of high aptitude from pursuing scientific careers. (Ordinarily one would expect to find that attendance at an institution with highly trained faculty, students of high aptitude, and financial resources would tend to encourage the pursuit of scientific or scholarly careers.) In any case, since this finding has no parallel in previous research, it seems desirable to determine whether it can be replicated in independent samples.

Summary

The effects of different college characteristics on the student's motivation to pursue a career in science were examined in a 4-year longitudinal study of high-aptitude students attending 82 undergraduate institutions. The male student's motivation to pursue a career in science appeared to be positively influenced by attendance at a technological institution or a coeducational liberal arts college and to be negatively influenced by attendance at one of the men's colleges in the Northeast. The female student's motivation to pursue a career in science appeared to be negatively affected by the affluence of the institution attended. The student's decision to pursue a career in science at graduation from college appeared to be much more dependent on his characteristics as an entering freshman than on the characteristics of the college he attended.

References and Notes

1. This study is a part of the research program of the National Merit Scholarship Corporation and was supported by a grant from the National Science Foundation. Portions of this article were presented as a lecture at the meeting of the Midwestern Psychological Association held in Chicago in 1963.
2. R. H. Knapp and H. B. Goodrich, *Origins of American Scientists* (Univ. of Chicago Press, Chicago, 1952); R. H. Knapp and J. J. Greenbaum, *The Younger American Scholar: His Collegiate Origins* (Univ. of Chicago Press, Chicago, 1953); *Research and Teaching in the Liberal Arts College: A Report of the Wooster Conference* (College of Wooster, Wooster, Ohio, 1959).
3. J. L. Holland, *Science* **126**, 433 (1957); A. W. Astin, *J. Educ. Psychol.* **52**, 173 (1961); ——— and J. L. Holland, *Coll. and Univ.* **37**, 113 (1962).
4. A. W. Astin, *Science* **136**, 129 (1962).
5. ———, *J. Educ. Psychol.* **54**, 63 (1963).
6. ———, unpublished manuscript.
7. ———, *J. Educ. Psychol.* **53**, 224 (1962).
8. ——— and J. L. Holland, *ibid.* **52**, 308 (1961); A. W. Astin, *ibid.*, in press.
9. In this category are Amherst, Dartmouth, Harvard, Princeton, Wesleyan, Williams, and Yale.
10. In this category are California, Case, Georgia, Illinois, and Massachusetts institutes of technology and Auburn, Rensselaer, and Rice.
11. In this category are Antioch, Carleton, Grinnell, Oberlin, Pomona, Reed, and Swarthmore.
12. R. C. Nichols, unpublished manuscript.
13. A. W. Astin, unpublished manuscript.

News and Comment

Science and Government: A Survey of Some of the Major Elements in Growing, Troubled Relationship

If an observer gets away from the forest floor and gains enough altitude for a broad look at what science and government are doing to each other in this country, a number of large and interesting contours stand out.

First of all, with the exception of military defense and closely associated areas, scientific research turns out to be more heavily dependent on federal money than probably any other nationwide activity. Science and government have been in partnerships of various sorts since the early days of the Republic, but, as far as the division of financing goes, the postwar years have seen the federal government become the overwhelmingly dominant partner. The shift in the relationship is perhaps best illuminated by recalling the letter Einstein wrote to Roosevelt, in 1939, to alert him to the explosive potential of the atom. The letter, written at a time when the federal government was contributing less than $75 million a year to the sciences, suggested that funds for atomic research might be obtained from "private persons who are willing to make contributions for this cause, and perhaps also by obtaining the cooperation of industrial laboratories which have the necessary equipment."

There was no suggestion that the government finance the work, for the simple reason that the federal government had not yet become the principal source of support for the sciences. Figures for the period are not complete, but it appears that research-and-development expenditures by private industrial firms were in excess of the government's spending. Today, of course, the situation is markedly changed, and even if military research and development

is excluded, federal spending under the label of R&D exceeds the amount spent by industry and other nongovernmental sources.

In the fiscal year that has just ended, support for R&D, from all sources, totaled some $16 billion. Of this amount, the government provided about $12.2 billion. In the present fiscal year the government's share is expected to rise to $14.9 billion, continuing a trend that has produced annual increases of from 10 to 35 percent since 1956.

Along with this affluence there has come a general willingness on the part of political leaders to take the word of scientific leaders on how national resources should be allocated for scientific purposes. The political leaders do not automatically swallow each suggestion, but it is probably fair to say that if half a dozen of the nation's elder statesmen of science should put their influence behind any scientific venture that is not patently absurd, the Congress and the Executive would tag along.

Thus, it cannot be argued that money problems are plaguing American science today. There are spots here and there where additional funds would be extremely useful, but these are now the object of well-organized surveillance, and improved support in these areas can be confidently expected fairly soon. The problems afflicting science and government are far more subtle than mere money. Basically, they stem from the fact that in the U.S. the two areas had become incredibly intertwined before anyone quite realized what was happening, and, in large part, the tensions and stresses that are now becoming increasingly painful arise from an effort to define the reciprocal responsibilities and relate the relationship to the traditional political process. All this must be viewed against the fact that the American people and their political leaders have come to accept and demand a flourishing scientific establishment, for everything from better missiles to better cancer drugs, from cleaner rivers to faster commercial transport planes. And despite gloomy forecasts from persons who have been stunned to find some Congressmen suddenly turned skeptical toward scientists, the only rational forecast in the political-scientific relationship is that the federal investment in science is going to continue to grow, probably at the rate of about 15 percent a year, for a long, long time. It is now about 2.5 percent of the gross national product, compared with about 0.65 percent when Einstein wrote to Roosevelt, and some administration planners feel that it will reach 3 percent before serious pressures develop for a reduced rate of growth.

It appears safe to assume that the money will be there for the continued support and growth of science. But there is little certainty about the circumstances that will govern its use, and there is even less certainty about the willingness of Congress to accept the view that science is a superstructure built on education; that it is ruinous to continue the present policy of nourishing the top with ample funds while the supporting base is deep in poverty. Congress has been slowly—but very slowly—yielding in this regard, with the result, for example, that the National Science Foundation (NSF) is carrying out large summer training programs aimed at improving the competence of high school science and foreign language teachers. But such efforts represent no more than an occasional splash over the dike, and they usually are achieved only in areas that bear a readily visible relation to national security requirements.

Congress Aroused

Attempts to move from specific to general support for education, even for science education at the graduate level, can generally be counted upon to rouse the ire of Congress. Such was the case last week when members of a Senate appropriations subcommittee expressed doubts about enlarging NSF's program of general support grants for institutions where NSF-supported research is conducted. The program, which is intended to overcome financial imbalances that may result from emphasis on scientific research, is seeking $18 million this year, compared with $8.4 million last year. The committee will probably arrive at a figure somewhere in between, but several members, reflecting a prevalent congressional attitude, were clearly uphappy about putting money into education without specifically earmarking it. This attitude arises from a variety of factors—among them fiscal conservatism, fear of federal control, and failure to resolve the church-state issue—which result in Congress still standing as a massive barrier to comprehensive federal aid for education. Its readiness to support graduate science programs is based on the government's long-standing reliance on universities for mission-oriented research. Out of this tradition has come a willingness to support basic research and training at the graduate level. But below the graduate level the Congress has shown little inclination to give money away for education. While it is possible today for a dull graduate student to receive a generous federal fellowship, a bright undergraduate finds little federal assistance available outside of low-interest loans. This situation continues to prevail in the face of the fact that, if only tacitly, Congress has come to accept the principle that, since the federal government is the major consumer of scientific manpower, it has a responsibility to assure the supply. Thus, Congress has generally given its assent to proposals for large-scale expansion of graduate fellowship programs. The final verdict is not yet in, but it appears likely that the current session will in large part go along with administration proposals for a still further enlargement of fellowship support. Whether this can go very far without expanded support to enlarge and improve the undergraduate base is a serious question. But the congressional approach is by its very nature a piecemeal, fragmented one (mainly because the committee system spreads jurisdiction all over Capitol Hill, with little reference to the organization of science and education in the real world), and it is not inconceivable that Congress will continue to bloat the graduate levels with fellowships and other forms of support while the lower levels of education continue to suffer.

The situation is altogether different at the executive level, where substantial progress has been made in recent years to develop a comprehensive approach to the government's relations with science. The effort actually began in World War II, but it died out at the end of that conflict and was revived only after Sputnik demonstrated the need for a continuing, high-quality scientific advisory service within the President's official family. That service is now embodied in several separate but closely connected executive organizations, which, without receiving very much attention, have come to exercise a great deal of power over federal support for science. The power is by no means unchallenged, and the extent of it is difficult to determine, since it is not exercised at public meetings. But

the White House Office of Science and Technology, in cooperation with the President's Science Advisory Committee and the Federal Council on Science and Technology, has become a coordinating point and a clearing house for federal relations with science. Virtually all proposals involving federal support of scientific activities pass through these channels en route to the Bureau of the Budget. Where it is felt that there are gaps in existing programs, the advisory bodies exercise the power of initiative. For example, the fellowship proposals that have been incorporated into the federal budget originated with a PSAC panel that was called together to examine future supply and demand for scientific manpower; the question of which federal agency is responsible for what in monitoring radioactive fallout was adjudicated at the White House advisory level; similarly, the burgeoning oceanography program, with its multi-agency participation, has been subjected to scrutiny by these advisers. Sometimes the issues are trivial, and sometimes they are of major significance; sometimes the White House influence is decisive, and sometimes it has no visible effect, as was the case when the Office of Science and Technology argued for employing an earth rather than a lunar orbit technique in NASA's moon-landing program. OST contended that, since the military potential for space appears to be in the near-earth regions, an earth orbit in the lunar program would help develop techniques that could be adapted for military purposes. That was the "big picture" approach to management of scientific resources. NASA simply argued that it's cheaper and faster to employ a lunar orbit. Ultimately NASA won.

Well-established agencies, with close ties to Capitol Hill, are not always inclined to share the "big picture" approach of the White House. Nevertheless, on a broad range of issues, from fish flour to the supersonic transport, the executive branch has taken effective steps to make certain that left and right hands are in close communication as they shape scientific policy. However, Congress, for a variety of real and manufactured reasons, has not remotely begun to move in the same direction. Its apparatus for dealing with science is pretty much unchanged from the days when the federal R&D budget would not have covered the electric bill at Oak Ridge.

Perhaps the most significant thing about the federal involvement with science is that, with few exceptions, the government has reached into the scientific community for advice on what to support and how to support it. The result is that, until recently, the scientific community—through a grand complex of advisory bodies—has written the rule book, particularly on the now controversial issue of accountability for research funds. However, as the science budget has grown, so has congressional concern over whether the country is getting what it's paying for. It isn't enough for the scientific community to answer that research is essentially an uncertain, unavoidably wasteful process that defies the cost-accounting techniques developed for nuts-and-bolts contractors. The Congress is unhappy—hence the current dispute over NIH's accounting practices—and, in matters of this sort, it is able to turn its unhappiness into concrete regulations. In the matter of education and other facets of science, the easy course for the scientific community is to wail and moan about congressional inadequacy for judging these issues. The difficult, but more productive, course would be for the scientific community to collect its evidence and state its case. Fortunately, the National Academy of Sciences, through its Committee on Science and Public Policy, is moving in this direction. If it fulfills its aspirations, both science and government are likely to be better off for its efforts.—D. S. GREENBERG

Civil Defense: Make Haste Slowly Is Watchword of Current Strategy on Fallout Shelter Program

The sight of a dozen congressmen changing their minds on the basis of evidence is a newsworthy event in itself, and when the subject at hand is one as riddled with technical uncertainties and political difficulties as civil defense, the event is more notable still. The unanimous decision of a House Armed Services subcommittee to support the Administration's request for an expanded fallout shelter program is remarkable in many ways, for 6 weeks ago, when the subcommittee opened its hearings, prospects for the program looked exceedingly dim.

Part of the negative atmosphere in which the hearings opened was planned. Because the proposed program would involve the government for the first time in the actual construction of fallout shelters in buildings that would require modification to provide them (the present program is limited to marking and stocking spaces in buildings that offer suitable shelter without special construction), a new authorization from Congress is needed. The Armed Services Committee and the Office of Civil Defense were agreed that civil defense had been battered about by Congress long enough without receiving much policy guidance from it, and that a broad review which candidly faced all the technical, strategic, and moral questions that the program has encountered would do much to reduce both congressional and public confusion. Accordingly, the subcommittee counsel, Philip Kelleher, became the devil's advocate, and the hearings opened with an exhaustive document detailing —with some conviction—the charges against civil defense. Kelleher's report served as the target for rebuttal by Assistant Secretary of Defense Steuart Pittman and the scores of scientific, political, religious, labor, business, and other leaders assembled to testify on behalf of the shelter program.

That far, at least, the hostility to the shelter program that appeared to dominate the early days of the hearings was planned. But it was also in part accidental, in that the hearings began at precisely the moment when the city of Portland, Oregon, chose to end its participation in the government program altogether—a move which set off a wave of speculation about grassroots alienation from policies made in Washington. And the hostility was in part instinctive, since the dozen members of the subcommittee shared with many of their fellow congressmen the feeling that civil defense was something of a boondoggle psychologically as well as, perhaps, financially.

On point after point, however, as the hearings progressed, the subcommittee found itself being persuaded that the proposed program was neither morally invidious nor psychologically damaging; that since it offered fallout, rather than blast, protection it would probably not force any changes in Soviet military strategy; and that it would not make our allies (who recently agreed in a NATO resolution that fallout protection offers reasonable opportunities for saving lives and should be encouraged) feel insecure about America's intention to protect them. Instead, the subcommittee, apparently to its own surprise, concurred