

## European Science: Financially, Politically, It Has Trouble Too

London. With the Soviet scientific threat squeezed dry of plausibility, Americans who are displeased with the amount of federal support for research have lately taken to warning that scientific superiority may pass to Western Europe. Physicists, with their prodigious financial needs and well-developed sense of public relations, lead the pack in detecting this new spectre, but similar alarms emanate from other disciplines. What is to be made of this new entry into the already cluttered brief of arguments for generous government support of research?

Putting aside the question "So what if superiority *does* pass to Europe?," the fact is that, individually and collectively, the nations of Europe have an immensely long way to go in most fields before they approach even the now-wavering level of scientific activity in the United States (see box). Furthermore, the institutional rigidity that is so commonplace in Europe frequently compels the need for great efforts to accomplish things that are relatively easy in the United States. As a White House science adviser remarked several years ago following visits to a number of his European counterparts, "We have our own particular problems, but

at least we can get something done."

West Germany, with its overflowing treasury and well-rooted scientific tradition, is coming along fast in its scientific renaissance. The annual growth rate in expenditures for research and development is in excess of 10 percent, and the German government is committed to achieving scientific quality across the board. But it is also worth noting that the sum of *all* German scientific and technical activity is somewhere in the neighborhood of what the United States—from all sources—spends on basic research alone, about \$3 billion annually. Lower wages make it cheaper to perform research in Europe; however, it is not unlikely that some of this advantage is lost in the archaic administration that often prevails in European research institutions. Selective vision causes Americans to focus on Germany's admirable growth rate for research and development, but many German scientists despair over the authoritarianism that still exists in many of their research centers, the out-of-date curricula that govern much scientific training, and the Kafka-esque complications that often develop in relations between government agencies and research institutions. In addition, the supposedly afflu-

ent Germans deplore what they consider to be inadequate financial recognition for their work. Salaries have been improving, but, even when allowance is made for a somewhat lower cost of living, they are surprisingly low by American standards. Thus, the widely applied civil service scale prescribes a salary and allowances totaling about \$600 a month for a scientist or engineer with a Ph.D., 10 years' experience, and two children. From a distance, the German scientific scene may look rich to Americans who are disturbed by the drop-off in U.S. support for research, but German scientists do not consider themselves to be wallowing in affluence.

The situation in France can be briefly summarized by observing that scientists there today look with envy on the steady and fairly rapid growth of German scientific activity. In recent years, French government support of research has gone through a series of disruptive fluctuations, as expenditures and commitments have been cut in response to economic crises. And, with the government now calling for still further reductions in spending, research has been singled out as an area for serious pruning. On top of this are two other factors that should deter anyone from conjuring up visions of France as a scientists' mecca. First, the government is showing a good deal of skepticism toward the value of basic science, and is putting emphasis on research that is thought likely to produce a rapid industrial payoff. Second, peace and quiet are yet to be restored to many of the research institutions that were swept up in the Events of May.

A useful introduction to the relative scale of American and European research efforts is to be found in the accompanying table, taken from *Reviews of National Science Policy: The United States*, published last year by the Organisation for Economic Co-operation and Development (*Science*, 12 January 1968). Although the statistics are 4 to 6 years out of date, the proportions have not changed significantly.

Comparison of the R & D effort of the United States with that of other Western great powers. [Source, OECD]

Country	GNP 1964 (billions of dollars)	GNP per capita (dollars)	Population 1964 (millions)	R & D expenditure			Qualified R & D personnel		
				In millions of dollars	Percent of GNP	Year	Total	Number per 10,000 population	Year
Germany	103.98	1,774	58.2	1,436	1.4	1964	33,382	6	1964
France	88.12	1,674	48.4	1,299	1.6	1963	32,382	7	1963
Italy	49.58	897	51.1	290	0.6	1963	19,415	4	1963
Belgium	15.44	1,502	9.3	123	0.9	1963	5,536	6	1963
Netherlands	16.86	1,385	12.1	314	1.9	1964	9,227	8	1964
EEC excluding Luxembourg	273.98		179.6	3,462	1.4	63-64	99,942		63-64
United Kingdom	91.90	1,700	54.2	2,159	2.3	64-65	59,415	11	1965
Sweden	17.47	2,281	7.6	253	1.5	1964	16,425	22	1964
Japan	69.08	622	96.9	892	1.5	1963	114,839	12	1964
Canada	43.54	2,109	19.2	425	1	1963	13,525	7	1963
United States	638.82	3,243	192.1	21,323	3.4	63-64	474,900	25	1965

British science is far from affluent, and it, too, is confronted by a government that is increasingly unhappy with the seeming paradox of considerable scientific skill and poor industrial productivity. As Anthony Wedgwood Benn, Britain's Minister of Technology and Power, recently remarked in an interview, "We're a country full of Nobel prize winners, but we constantly have to borrow money to pay our bills." But, though operated on what many British scientists consider to be short rations, research in Britain is blessed by one feature that is painfully absent in the United States—namely, financial predictability. The University Grants Committee, the government's principal agency for channeling general funds to the universities, lays out its spending plans 5 years in advance. And the various research councils plan their spending at least 3 years in advance. Thus, the director of one of Britain's major biomedical research centers, commenting on the budgetary cliff-hangers that the U.S. National Institutes of Health goes through annually, observed that he could well do with more money but at least had the certainty of knowing what government funds would be available to him in 1971. Nevertheless, there is probably more research and development currently going on in California and Massachusetts than in all of the United Kingdom. And, as is the case with most Europeans who are familiar with the conduct of research in the United States, British scientists express puzzlement and amusement at the cries of anguish now coming from their American colleagues. In their view, most European scientists would be quite pleased to ascend to what Americans consider to be a level of austerity, both in salary and in working conditions. As for the complaint that jobs are lacking for a substantial number of newly graduated American scientists, many Europeans, coming as they do through an educational system that takes in a relatively small proportion of the university-age population, tend to feel that U.S. enrollments exceed the supply of potential scientific talent.

It can be properly argued that, though Germany, France, and Britain are the most populous and powerful countries in Europe, none comes near the United States in population or productivity per capita, and that therefore individual national comparisons are not relevant. But what of the much-talked-of multinational efforts that are boosted as a means for Europe to combine

resources and compete in scale with the United States? With high-energy physics the principal exception, the situation in this regard could easily produce weeping among proponents of "big science," for the fact is that the forces working together have yet to achieve a decisive margin over those that cause each nation to take a narrow view of its own interests. Thus, the European Launcher Development Organization, the cooperative agency for building large rockets, started out with high hopes but has since come to near extinction on the probably quite sensible grounds that even a vast investment will leave Europe far behind the United States. Its sister agency, the European Space Research Organization (ESRO), is considered competent and productive for the development and operation of space research satellites, but France recently announced that, for economy reasons, it plans a substantial reduction in its support of ESRO. Even in high-energy physics, the story is one of the cooperative spirit just surviving, rather than vigorously triumphing. Europe's model for big scientific cooperation is the European Organization for Nuclear Research (CERN), whose 28-GeV laboratory near Geneva is universally admired as an outstanding example of international harmony in a costly and complex field. For several years, CERN has been planning the construction of a 300-GeV accelerator, arguing that without the proposed machine, high-energy physics will decline and eventually disappear in Europe. In turn, the argument goes, this would have a variety of stultifying effects that would touch off a new brain drain, with detrimental consequences for European science, education, and industry. (In view of the situation in the United States, it would be interesting to know the drainees' destination.) Eighteen months ago, the prospects for the new accelerator were seriously shaken when Britain announced that, for financial reasons, it would not take part in the project. The plans were redrawn to compensate for the absence of Britain's support, and CERN officials then cheerfully predicted that the project would soon proceed. For a year nothing happened. Then gloom descended upon CERN following reports that France might follow Britain's example and pull out of the project as part of its effort to cut down spending and put greater emphasis on applied research. Such a move would have laid the 300-GeV to

## NEWS IN BRIEF

● **BAN ON GERM WARFARE:** As *Science* went to press, President Nixon renounced any resort to chemical or germ warfare and promised to destroy U.S. stockpiles of such weapons. Tear gas and riot control agents are apparently not included. Nixon asked the Senate to ratify the 1925 Geneva protocol prohibiting the first use in war of "asphyxiating, poisonous or other gases and of bacteriological methods of warfare." He said future government research in this area will be limited to defensive measures.

● **DDT RESTRICTION:** A government announcement of impending pesticide restrictions (*Science*, 21 Nov.) has been followed up by a partial ban on DDT. Secretary of Agriculture Clifford Hardin has ordered cancellation within 30 days of all DDT uses for shade tree pests, pests in water areas, house and garden pests, and tobacco pests. About 14 million pounds, or 35 percent of the total DDT used in this country, is manufactured for these purposes. Hardin also announced his intent to cancel all other uses of DDT by 31 December 1970, and requested industry to comment within 90 days. Exceptions would be made where DDT is needed for prevention or control of human disease and essential uses for which no alternative is available. Beginning March 1970, Hardin said, action on other persistent pesticides will be taken. The Interior Department will review water quality criteria and hazards to wildlife relative to pesticides; and Health, Education, and Welfare will review established tolerance levels of specific pesticides in food and drinking water.

● **CYCLAMATE BAN EASED:** The ban on cyclamates has been eased with the announced intention of helping diabetics and weight-watchers. Secretary Robert H. Finch of Health, Education, and Welfare approved the use of the sugar substitute for foods, but foods must be labeled to show the cyclamate content in an average serving. The new order also allows the use of cyclamates as concentrates in tablet or liquid form. All beverages containing cyclamates will still be banned after 1 January, however. Finch modified his 18 October order after hearing recommendations of a medical advisory group, who told him that the product was needed by diabetics and weight-watchers.

rest, since France was to provide about 30 percent of the cost. On 10 November, however, the story was provided with a happy ending, when the French government announced that it would take part in the project. Clearly, the decision to proceed is a landmark event for European scientific cooperation, but high-energy physics benefits from peculiarities that are not present in other fields. First of all, it is too expensive for any one European nation to pursue alone. In addition, it is untouched by the tendency for individual nations

to go their own way when they sense the possibility of a commercial payoff. Finally, it is so incomprehensible to laymen that—with Britain the notable exception—governments cannot easily ignore their scientists' warnings of miserable consequences for nations dropping out of the field. How the British budgeteers summoned the nerve to do so is probably a fascinating, but so far unrevealed, story.

On that other frontier of basic research, molecular biology, Europe has long resonated with calls for coopera-

tive efforts. But attempts in this direction, going back to 1964, have produced fairly limited results. It was in that year, with molecular biology booming in the United States and flourishing at only a very few centers in Europe, that a group of biologists established the European Molecular Biology Organization (EMBO). Formed as a private organization, somewhat along the lines of an honorary academy, EMBO set out to encourage increased government support for molecular biology, one major goal being the establishment of

## New SIPRI Yearbook of Armaments, Disarmament

*London.* Items from a unique and newly published reference work:

*Because of an expansion of underground weapons testing, the annual average of nuclear explosions has actually increased since the atmospheric test ban went into effect in 1963.*

*Accidents involving nuclear weapons are far more frequent than is generally realized by the public.*

*Worldwide military expenditures rose nearly 30 percent between 1965 and 1968, with the result that they today exceed spending on education by more than 40 percent, and are more than three times worldwide expenditures for health purposes.*

*American industry spends \$7.50 on research and development for every \$100 of civilian manufacturing output; the Defense Department spends \$54 for every \$100 of military procurement.*

These and innumerable other illuminations of the military state of the world are contained in the *SIPRI Yearbook of Armaments and Disarmaments 1968/69*,\* published this month by the Stockholm International Peace Research Institute, an independent, internationally staffed research organization that was established with Swedish government funds in 1966 (*Science*, 27 Dec. 1968). The work is a bit lopsided, relying heavily as it does on the scattered but abundant public information about Western armaments and strategic policy, and handicapped by a relative dearth of similar information concerning the Soviet Union and its affiliates. But, as the first in what is intended to be an annual series, it represents an impressive effort at packing into one volume a huge collection of statistics, facts, documents, and analyses on contemporary war and peacemaking, and is likely to become a standard reference throughout the "peace research" industry and beyond.

Thus, from a variety of sources, and with careful attention to the problem of shifts in purchasing power, the Yearbook presents a nation-by-nation compilation of military expenditures from 1948 to 1968. An accompanying commentary notes that the United States and the Warsaw Pact countries account for most of the recent

surge in worldwide military spending. On the other hand, Western Europe, with the exception of France and its nuclear aspirations, has refrained from joining in. "The United Kingdom's military expenditure has been virtually flat since 1965, in real terms," the Yearbook concludes. "West German military expenditure has been falling; the big increase in its spending came between the years 1958 and 1963." Of the smaller European nations, Greece and Portugal have sharply stepped up military spending; the sums are small in big power terms, but large relative to the economies of these two nations.

The Yearbook also includes a "register" of several hundred international arms transactions, specifying supplier, recipient, type of equipment, and dates. In reference to such deals, it notes, "Since 1960, the emphasis of U.S. military assistance policy has shifted from the defense of states from possible external attack to the defense of governments from possible internal insurrection; developing countries have been encouraged to acquire counter-insurgency equipment rather than sophisticated conventional equipment."

Listed in another section are all publicly announced or suspected nuclear test explosions between 1945 and 1968. An analysis of these shows that between 1950 and 1963, when the partial test ban went into effect, such tests averaged out to 40 a year; since then, the annual average has been 46. The U.S. average increased from 24 to 32 a year; the Soviet average declined from 13 to 9. Since the Soviets do not announce their tests, and the AEC withholds information on some of its own, SIPRI concludes that, if anything, the figures for pre- and post-ban are probably low, though the proportions are very likely correct. The Yearbook points out that despite assertions that an aboveground test ban would impede research necessary for the development of more powerful or sophisticated warheads, "yields and magnitude of underground tests have continued to rise," and marked success has been achieved in the improvement of warheads.

Accidents involving nuclear weapons or vehicles carrying them rarely come to light in any detail. In general, the U.S. government merely acknowledges that they happened, but almost invariably, such acknowledgments are made when there is prior public awareness of a mishap, such as the crash of an aircraft. Thus, it is

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a big international laboratory. While working toward this goal, it operated on funds provided by the Volkswagen Foundation, and developed a program of fellowships, workshops, and summer studies, all of which have proved useful, but none of which really required the presence of still another struggling organization on Europe's crowded landscape of science-related agencies. The proposed laboratory is yet to be built, or even agreed upon, and prospects for it actually appear to be diminishing. Meanwhile, EMBO has metamorphosed

into the European Molecular Biology Conference, which will become a full-fledged international, governmentally supported organization when a majority of its 12 member nations get through the process of ratification. (Belgium, normally a strong supporter of European cooperative ventures, declined to join the conference, on the grounds that there is no need for still another treaty organization in the scientific field.) What the conference will do is not yet clear, but even getting agreement to establish it was a somewhat laborious

process, not on substantive grounds, but simply on the question of the official languages. West Germany, which, on a national wealth formula, would be the single largest contributor (22.3 percent), insisted that German be accorded official status along with English and French. This is a line that the Germans have lately been pursuing in various other international scientific bodies. To those who regard such insistence as mere chauvinism, the Germans reasonably respond that, though many Germans are multilingual, many

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## Documents the Direction, Pace of the Arms Race

quite likely that accidents have occurred out of public view without the Defense Department or the Atomic Energy Commission volunteering any information. The Soviet Union and the other nuclear powers are yet to report any accidents, outside of a recent case involving a minor collision of a British Polaris submarine and a merchant ship. But there is no reason to assume that other countries have been any more accident-free than the United States. Even in this situation of a paucity of information, SIPRI researchers have collected references—though most of them quite skimpy—to 33 American nuclear weapons accidents between 1950 and 1968. Some are simply listed as involving an “unspecified” weapons system in “unspecified circumstances,” but others are more detailed, such as the “accidental jettisoning” of an atomic bomb off the Georgia coast following a midair collision in 1958, or the well-publicized loss of four hydrogen bombs following a B-52 crash in Spain in 1966.

In terms of analysis, perhaps the most illuminating section is that concerned with “The Technological Arms Race,” for here the point is made that military research has become so well-supported and productive that the growth of killing power far outstrips the growth of expenditure, though the latter is far from lagging. Thus, drawing upon statistics prepared by the Organisation for Economic Co-operation and Development, the Yearbook shows that research and development expenditures per unit of military hardware are vastly greater than those for civilian products. The figure for the United States has already been cited. For France, it is \$51 of research and development for each \$100 of military procurement, as compared with \$1.90 for \$100 of civilian products. For Canada, the figures are \$20.40 and \$1.30; for Sweden it is \$10.80 and \$3.30. Britain, with its current emphasis on a small but technologically elite military force, presents the interesting case of \$62.20 for R & D per \$100 of military procurement, as compared with \$4.90 on the civilian side. As great as these disparities are between civilian and military research spending, the Yearbook concludes that “the military research figures are understated. They exclude space research and atomic energy research, both of which have extensive military applications. Making some allowance for this, there is little doubt that the research input per unit of

output is at least 12 times greater in the military field, taking the United States, Britain, and France together.”

These funds, the report goes on, tend to give military technology a powerful life of its own in strategic planning. “Once massive funds are voted for weapons research, and once there are large permanent establishments doing nothing but weapons research, it is inevitable that further improvements will be made and inevitable that new fields of warfare will be explored. Once some weapon improvement has been discovered it is often inferred, without direct evidence, that a potential enemy will have made the same discovery, and that therefore it is dangerous not to take the next step—the actual development of the weapon. Weapons research proliferates in another way as well: each new weapon spurs the development of counter-weapons. The development of the ballistic missile submarine sets off an immense research program into techniques of anti-submarine warfare. Here again, there does not have to be evidence that the enemy already possesses the weapon for which counter-measures are being devised; it is sufficient to assume that sooner or later he will do so.”

This thesis is expanded upon in four case studies, concerning submarine-launched missiles, chemical and biological warfare, helicopters, and image intensifiers for nighttime military operations. These studies are too detailed and carefully composed to allow summarizing, but they all contain an important message for observers of the arms race, namely, that military research has led to such a high level of “product improvement” that numbers and expenditures are no longer a sure measure of military might. Thus, image intensifiers, though relatively low in cost, make it possible for military operations to proceed through the night. And increases in accuracy and payload have the effect of sharply multiplying the destructive power of the Polaris submarine force, despite the fact that the number of submarines has remained constant for several years and no change has been made in the number of missiles they carry.

Also of value in the Yearbook is a chronology of major disarmament efforts from 1945 to mid-1969; the text of the nonproliferation treaty; maps and commentary on border disputes around the world, and a compilation of military conflicts that have occurred since World War II.—D. S. GREENBERG

are not, and, unless highly proficient in English or French, are seriously handicapped in taking part in meetings. At present, the Volkswagen grant has been either expended or committed, and since the conference does not yet legally exist, it is operating on funds voluntarily offered by the member nations. The amount for this year is set at \$478,000, and about 80 percent of this has been delivered or promised. Those who back the conference point to this voluntary support as solid evidence of government interest. But there is also evidence pointing in the other direction. Britain, which is slated for 20.8 percent of the costs, is doing quite nicely on its own in molecular biology, and many

of its workers in this field doubt the wisdom of sending abroad scarce resources that could be used profitably at home. (The 1 November issue of *Nature* contains a detailed account of a meeting at the Royal Society in which this matter was thrashed out.) In any case, a framework exists for European cooperation in molecular biology, but, beyond a lot of hope, talk, and a bit of money, there is not much inside that framework.

The once-bright hope, but long-standing despair, of European scientific and technological cooperation is, of course, Euratom, which may well be moving now into the terminal stage. For nearly 2 years it has been operating on sharply

reduced, provisional budgets. Even such financing now seems to be beyond the interest of its Common Market sponsors. Last month, following the latest in a long series of failures to agree on a budget, Euratom workers took to public demonstrations. And Euratom ran a large advertisement in the international *Herald Tribune*, announcing the probable availability for new employment of substantial numbers from its scientific and technical staffs.

It is no consolation for the American scientific community, but the fact is that, on the whole, Europe does not offer a healthy contrast to the situation that prevails in the United States.

—D. S. GREENBERG

## Medical Care: As Costs Soar, Support Grows for Major Reform

Less than 5 years after the United States government entered the health care business on a large scale, Medicaid is widely acknowledged as a disaster, Medicare is costing more than had been anticipated, and the average citizen's medical bills are rising three times faster than the cost of living. As a result, support is spreading for radical reform in both the financing and delivery of medical care.

In money terms, the federal government has certainly stepped up its effort to improve medical care: ten years ago it spent \$1.1 billion on personal health care; in 1969 it spent \$11 billion, a ten-fold increase. But, some experts say, this increased federal involvement has exacerbated the crisis in health care by investing more money and involving more patients in an inefficient system without reforming that system.

### Fee-for-Service Care

At the core of the present system of medical care delivery is the fee-for-service principle. Among people who can afford it, the prevailing pattern is based on payment to the doctor for services rendered; for certain higher medical expenses such as hospitalization, the patient is reimbursed by a private insurance carrier with which he has a policy. When Medicare and Medicaid were being debated, their supporters argued that the people who

most need medical care, the elderly and the poor, cannot afford fee-for-service care and, to get any care at all, they must settle for the inferior care of the overcrowded, understaffed outpatient clinic of the municipal hospital. Medicare and Medicaid, although structurally quite different, both attempt to correct this inequity by providing the means for the elderly and the indigent to take advantage of fee-for-service medicine.

Because they deal with different groups and have different structures, Medicare and Medicaid—which together cost the federal government over \$6 billion in 1968—have had dissimilar records, with Medicare considered something of a success and Medicaid a total failure (see box). In spite of their different structures and histories, Medicare and Medicaid have a common weakness, shared also with private insurance carriers, which critics consider the primary reason for the inefficiency of health care delivery and for the inflationary cost spiral. They all dole out money to providers without giving any incentives to the providers to lower their rates. Just as Blue Cross reimburses hospitals on the basis of "reasonable costs" but offers no bonus to the hospital that tries to keep costs in line, so Medicare and Medicaid fail to reward economies. Medicare, for example, reimburses patients on the basis

of "reasonable charges" by their physicians, which essentially means whatever the doctor can square with prevailing community rates, nature of the service, and self-assigned value of his own time.

Medicaid permits the state to choose its own financing mechanism but recommends Medicare-style financing. Thus, the doctors set the fees and the government pays them. With this de facto encouragement from government, doctors' fees have been increasing more than twice as fast as they were before Medicare and Medicaid were enacted. Because Blue Cross, Medicare, and Medicaid have a built-in tendency to cause fee increases and because the government programs have placed an increased patient load on an already overburdened fee-for-service medical care apparatus, costs to the health care consumer are skyrocketing. In 1960, a father of two children paid an average of \$408 in medical bills, including insurance premiums and out-of-pocket payments. In 1969, it was \$676—a 67 percent increase. Since the cost of living rose roughly 20 percent during the decade, medical costs have been increasing more than three times as fast as total costs.

These rapidly rising costs, plus increasing opposition to Medicaid from the states, the doctors, and the recipients, are the major elements of what President Nixon called in July a "massive crisis" in health care. There are other dimensions to the crisis, such as manpower shortages. But it is the financial squeeze that is bringing the crisis to the middle class and that has triggered a burst of discussion this year about the entire medical delivery system and ways to reform it. Already