PHYSICS IN EUROPE

Trends in research funding

Pierre Aigrain

First we must remind ourselves that there is no such thing as "European physics." The various countries of Europe are of course not politically united, and they have different science policies. But the pattern of funding in the various countries has gone through cycles that have been quite similar although not simultaneous.

One important point physicists of all countries would agree on is that their feeling about the state of physics is probably much more dependent upon the rate of growth of the means put at their disposal than the absolute value of these means. Actually the absolute value, the value *per capita* of science spending (and within that, physics spending), has during the last few years tended toward a relatively uniform level all over Europe. Those countries that were spending more money than average are slowing down; those that were spending less than average are now spending more. Thus there has been a significant narrowing of the range of spending on a *per capita* basis. Germany, for example, after starting from a level of expenditure much smaller than that of the UK or France, had a fast rate of growth over the last six or seven years. In the meantime the UK and France have been reducing their level so that right now, the countries are rather close together in their *per capita* expenditures and certainly closer than they have ever been in the past.

It is important to keep in mind that this situation of uniformity is the result of very different evolutions in the countries involved. In the UK the rate of spending increased tremendously between the 1950's and 60's. In France it increased tremendously between 1960 and 1968. In Germany it started increasing around 1965 and kept on increasing until 1973. So that all of these countries have gone through a period of extremely fast increase. but not at the same time. And after the extremely fast increase, funding in nearly all of the countries has tended to go down or level off.

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Effects of pinch

This changeover from a fast growth to a stabilization has everywhere created tensions and real, not only psychological, problems for physicists. The nature of the problems and the feelings that physicists have about the problems—for instance how seriously they react to the financial pinch—are different in each of the countries. We usually find physicists reacting most strongly in those countries where the pinch has been on for a few years. If it is just starting as in Germany, physicists do not feel too bad about it yet. On the other hand, the British have had time to adjust themselves to the no-growth situation, so that it is probably in a country such as France that one finds the most tension. There a no-growth situation has existed for about five years, allowing time for the problems to accumulate but not enough time for the necessary adaptation process to have taken place.

Although the absolute level of funding is becoming uniform, the budget procedures are still quite different in the different countries simply because the structure of the different countries, of course, is quite different. Thus in countries that have a centralized government—such as France and Belgium—an extremely centralized science budgeting system has developed. In these countries nonmilitary R&D expenditures are planned and budgeted on a year-to-year basis essentially by a central agency (in France the DGRST and in Belgium the Science Policy Committee), which actually negotiates with the government for the global science budget and proposes to the government how to allocate this money to the various agencies. This is a much more elaborate system than what PSAC used to be in the US. It combines the power of the science advisor and a good deal of the power of the Office of Management and Budget. This kind of structure cannot exist, of course, in a decentralized government. In Germany, for example, the Ministry for Research and Education controls only part of the global science budget; a sizeable part comes from the various German states. In the UK the situation is more similar to what it used to be in the US. There is a science advisor at the government level, but he is purely an advisor. (See box on page 35.)

At the extreme of decentralization are two countries that in practice have no government—Italy and the Netherlands. Of course there are always at least caretaker governments, but about 50% of the time these countries are without governments that can formulate and carry out policies. However, at least for the Dutch things go smoothly because much of their economy depends on the activities of a few large multinational corporations, which are Dutch owned. So in spite of the fact that there are twelve different political parties in the Netherlands, each with about 8% of the vote, the Dutch economy runs rather efficiently . In Italy the situation can only be described as a gigantic mess. And science is affected like everything else. We mentioned above that the various countries have

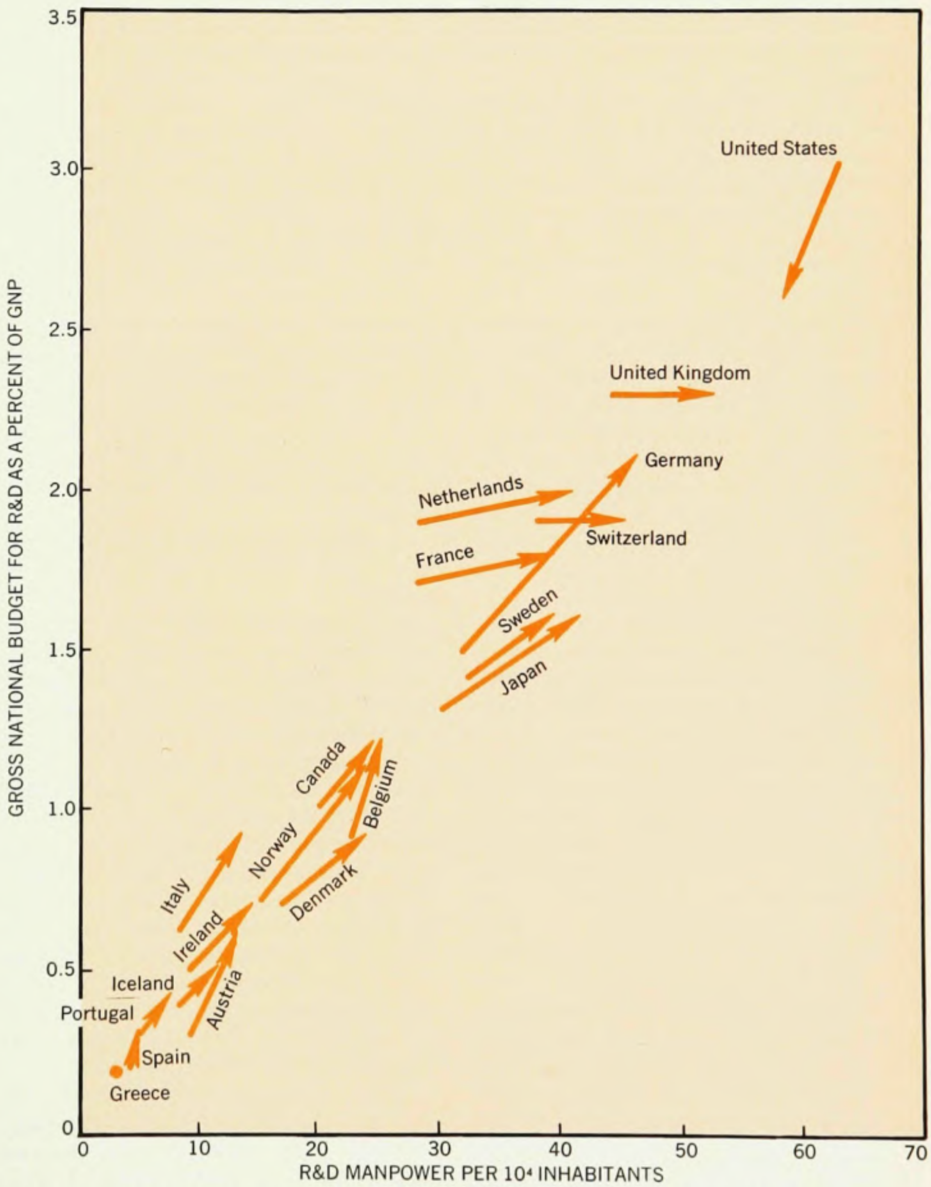
Annual funding for physics is leveling off at about the same fraction of GNP in each country, with the outlook bleak for future increases; however, job security for individuals is good compared with the US.

each gone though a cycle of fast increase and then slowing down or leveling off. Italy just a few years ago started a period of fast increase from an extremely low level of science spending. But at this time the political situation is such that we have no idea of what will happen to this plan.

The particular budget procedures used in a country can lead to some interesting problems. For instance in France it is relatively easier to get money for equipment and physical plant than money for salary and especially operating expenses. For reasons having to do more with the traditional procedures of the financial people, the pinch has been quite unequal in these various areas. It just has not been possible to adjust the relative spending in these three areas to produce an optimum. Although this imbalance makes things harder for French scientists, it does not mean people have been laid off at research centers. There have been no cuts in the total number of people employed in physics in French government labs. The financial system is such that the money necessary to pay salaries is automatically provided, even without parliamentary approval. In fact it would take a parliamentary decision to cut down on the number of people. But if there is not enough money for operating expenses, it is obviously impossible to increase the number of people. There is, in fact, a formal limitation on new hirings, but even if this limitation was not written in the budget, it would be imposed in practice by the insufficiency of the operating expenses.

Limitations on hiring

Even though countries like France have not suffered the severe cutbacks experienced in the US, this limitation



Changes in the relative amount of resources devoted to R&D since 1963–64. Ordinate scale shows gross national expenditure on R&D as a percentage of the Gross National Product; abscissa shows the manpower in R&D per 10 000 inhabitants. R&D activities grew more rapidly than total national resources in all countries except the United States and the United Kingdom.

on hiring new people has been very strict. The problem of very tight operating expenditures lagging behind may be worse in France than in some of the other countries but it is generally true throughout Europe that there is very little job mobility—people leaving one position for another. The one exception is the Netherlands. For example, the total number of new people hired each year in French government science for all disciplines has been about 1 percent of the total science work force. Now the total active population of the country is increasing at a rate of 1 ½ percent a year, so that the number of physicists in the active population has been going down at the rate of ½ percent a year, in proportion to the active population.

The main effect of the limitations on hiring in most European countries (here again there are differences, important differences, between France for example and the Netherlands, where there has always been a tradition of relatively high mobility of scientific personnel, from government laboratories to industry) is that the number of jobs that are open each year is very small, and in physics is essentially nil. You find you can't hire people at all. You can't even replace departures, because nobody departs.

The very fast increases in physics budgets started only around 1960. There were signs of increases starting around 1954, but these were beginning from such low levels that the number of people hired between 1954 and 1960 were very few. Most people were hired after 1960, and most of them were very young at the time—less than 25. If you were younger than 25 in 1960, you are still below 40 in 1974, and far from retirement.

Older physicists

So the rule in Europe is that nobody departs. Physicists do not go to industry or elsewhere. And the laboratories find themselves in the situation where the average age of the scientists is increasing at nearly one year per year. In fact in some laboratories, such as the French Atomic Energy Commission, the rate of increase in average age has been some years faster than one year per year because the few departures that have occurred have been among the young, not the old people. For the older staff in the Commission the salaries are good and they have a very good retirement plan, so that a staff member aged 45 is much more difficult to tempt with another job than a younger man would be.

The aging problem has two consequences: one is the problem that we know physics is a young man's game, in general, and we would have to admit that the efficiency of the various labs has not been going up. But there is also a psychological problem. As the staff members get older, they are not finding higher openings in the hierarchy. Although the salary scales are reasonable, the chances for promotion are very small.

Salaries are not everything. People want chances for promotion, even if the promotion is not accompanied by salary increase, and they are finding their chances for promotion are very poor. So that they have the feeling that there is no future left in physics. Strangely, this is not accompanied by moving out of physics or even out of government labs.

Young physicists

The problem of physicists just getting out of school is different and depends on their level of training. Physicists leaving colleges in Europe with an MS degree have a hard time finding a job in physics. There are no openings. But it is not true that such people cannot find a job. The reason is that all over Europe, except possibly in the UK, there is a full-employment situation. You can find people who complain that this is not so. But if you look at numbers, for the number of unemployed in a country like France, you find that unemployment is of the order of one percent of the labor force. Now, this would certainly be felt as a full-employment situation in a country like the US. Europeans are more sensitive to the specter of unemployment, and so governments all over Europe have avoided it at all costs. The unemployment rate in France peaked at nearly two percent in May 1968, and this is felt to be one of the main causes for the May 1968 outbreaks.

So people at the MS level do find jobs, but they are not jobs in physics research.

If you go to the PhD level, you will find that again there is no unemployment. I know of extremely few unemployed physics PhD's and even these few cases are really marginal problems that involve serious mental or health problems, for example. PhD's do find jobs—but the jobs they find are nothing like those found by physicists ten years ago. At that time physicists could hope to become associate professors within three years of their PhD. And even those who were not that good did get associate professorships fairly quickly. Not everyone got his first choice, such as Paris, but if you were willing to go to Montpellier there was no problem.

This is not true anymore; today the jobs available are just not in the same category. Very often you find the new PhD's today are better than their PhD advisors. (Frankly, if the PhD advisor is any good, his students *should* be better than he is. After all, the job of the advisor is to turn out people who are

Approaches to a national science policy

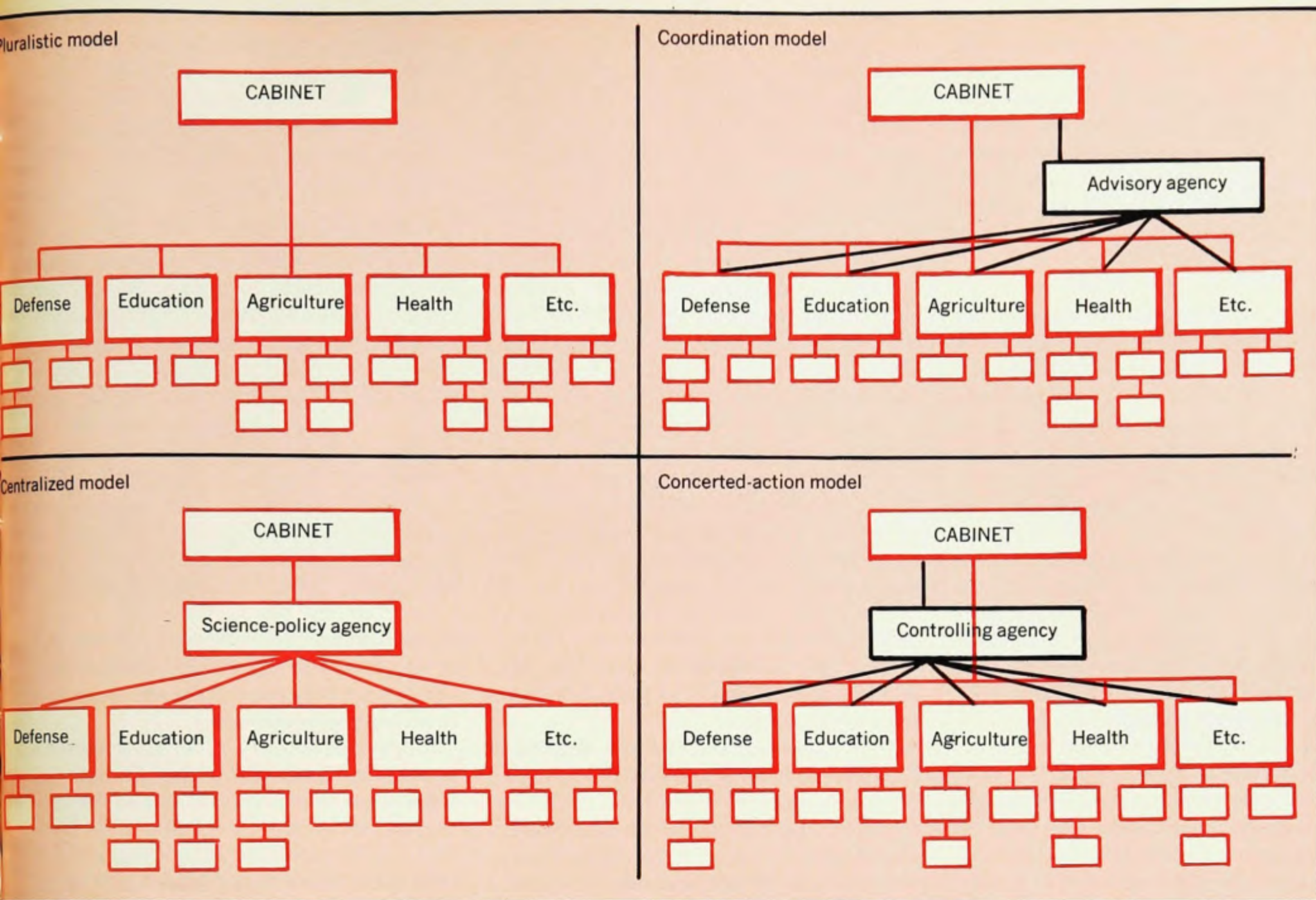
In the "pluralistic" system, common in many countries until the 1950's, financial resources are assigned to each autonomous government research and development sector—for example, defense, transportation, agriculture, health—which then makes independent decisions on how to proceed. Now universally rejected, such a plan produces a disjointed system with much wasteful competition among the sectors. The alternatives include the "coordination model," in which an advisory agency links the individual science policies together somewhat weakly, and the "centralized model," in which a strong central agency is supposed to exert complete control over all government scientific activities. A so-called "concerted-action model" would combine the best features of these two extremes, with individual agencies developing specific science policies, complemented by some kind of strong and effective central organization.

The US adopted a coordination model with the establishment of the President's Science Advisory Committee in 1957, strengthened by the formation of the Office of Science and Technology in 1962. Both OST and PSAC were abolished in 1973, with their duties reverting to the NSF, in an apparent return to pluralism.

The UK's experience with a centralized model dates from the formation in 1916 of the Department of Scientific and Industrial Research. The DSIR had wide powers to control academic research and the government's own research laboratories. But with the postwar growth in science and technology this machinery began to fail and Britain began to decentralize its government-run scientific activities during the 1960's. The current system is based on Lord Rothschild's 1971 report calling for decentralized agencies and a relatively weak "central policy review" board; in addition the Chief Scientific Advisor attempts a coordination role.

France is developing a "concerted-action" model in which the different ministerial departments with scientific programs have their research budgets scrutinized each year by the DGRST (General Delegation on Scientific and Technical Research). Further examination by the Scientific Advisory Committee and the Interministerial Committee follows. The design and performance of the R&D programs remain the business of the departments and agencies in which they are conducted, but the central machinery has the strength and authority to exert significant control. An important feature is that the central review boards are able to attract and hire sufficient highly trained specialists in science and technology to perform a useful function.

[The information in this box is derived in part from "A Science Policy for Canada," the report of the (Canadian) Senate Special Committee on Science Policy, volume 3: "A Government Organization for the Seventies.]


Pluralistic model
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Coordination model
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Advisory agency
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Centralized model
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Science-policy agency
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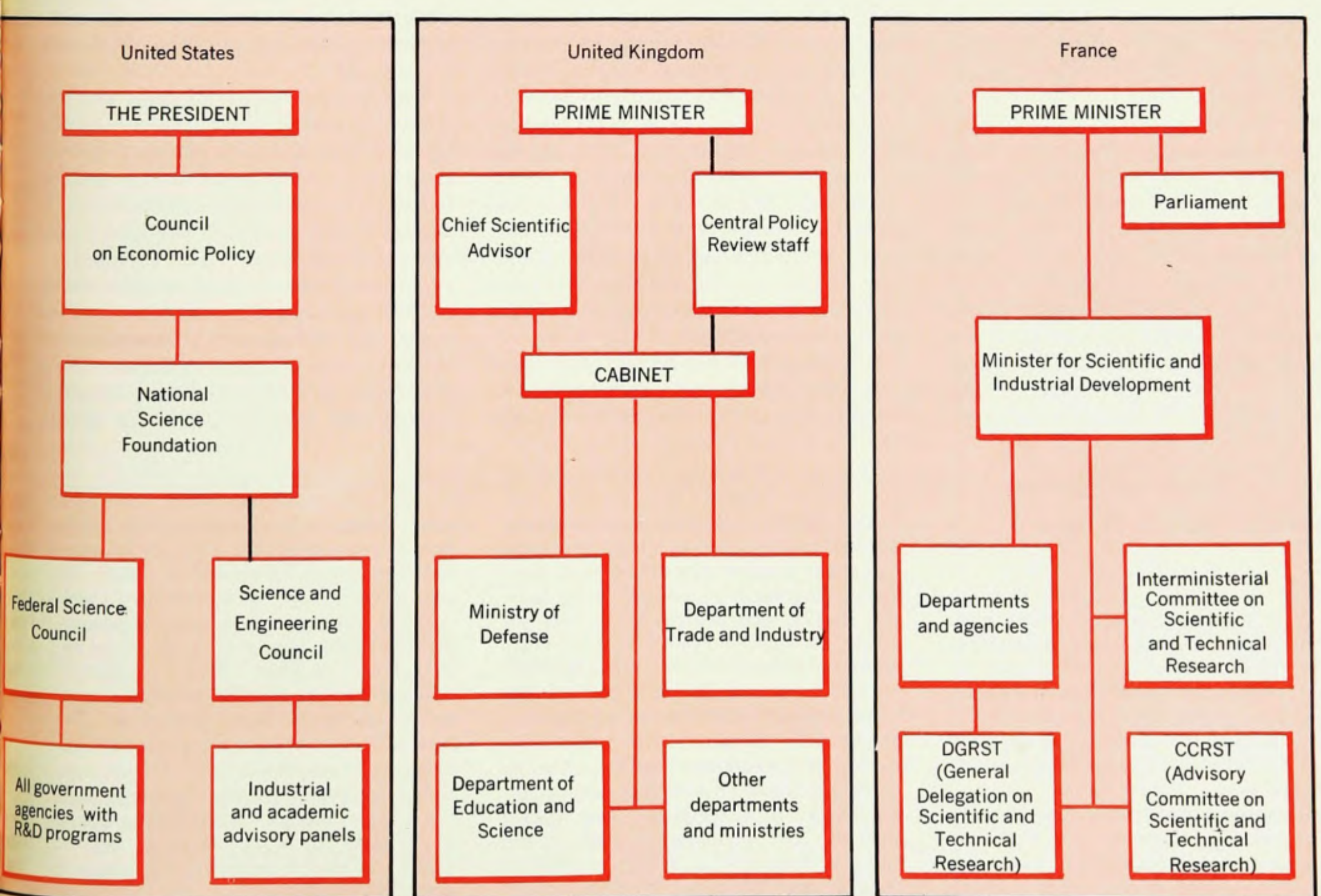

United States
THE PRESIDENT
Council on Economic Policy
National Science Foundation
Federal Science Council
Science and Engineering Council
All government agencies with R&D programs
Industrial and academic advisory panels
United Kingdom
PRIME MINISTER
Chief Scientific Advisor
Central Policy Review staff
CABINET
Ministry of Defense
Department of Trade and Industry
Department of Education and Science
Other departments and ministries
France
PRIME MINISTER
Parliament
Minister for Scientific and Industrial Development
Departments and agencies
Interministerial Committee on Scientific and Technical Research
DGRST (General Delegation on Scientific and Technical Research)
CCRST (Advisory Committee on Scientific and Technical Research)

better at the work than he is himself.)

But where the advisor may have become a full professor in something like ten years, the chances of the new PhD of ever becoming a full professor are very small. And this creates a problem. In the best of cases the new graduates feel this is an injustice. In the worst of cases, they revolt more or less openly against the situation.

Physics versus other sciences

Hence in Europe the problem is not unemployment, but these two more subtle types of dissatisfaction experienced by the older and younger staff members. These problems are more acute in physics for two reasons: In the first place, physics was the first discipline to expand after World War II. The reasons for this were obvious. Physics was more mature and ready for expansions compared with say, biology, and for many years it enjoyed a more rapid growth. But now not only have government budgets for science as a whole leveled off but within these budgets we find that biology and the social sciences are being emphasized at the expense of physics.

If you argue that in Germany the absolute money for physics may still be going up, it is still true that the proportion of the total German science budget devoted to physics is going down. The switch of funding from physical sciences to biology is universal, although the pinch is really felt in those countries where the total science budget has already leveled off.

Physicists cannot really complain. Although I am a physicist, in my position as General Delegate for Research and Technology in France I myself recommended such a shift in allocation. Just as happened in physics 30 years ago, the intellectual evolution of these disciplines has reached the point where they require a boost. I grant that this is hard on physics and has led to further *de facto* or planned cutbacks within physics itself. In France, for instance, one of the choices has been that particle physics has experienced an even sharper cutback than the average.

In recent years particle physics has absorbed a very large part of the total science/physics budget in France, much more than it does, for example, in the US. In fact, more than half of the total French Budget for fundamental science has been spent on particle physics (including basic nuclear physics). So in France this discipline has been subjected to an even greater pinch. The budget for particle physics is now limited to a very slow rate of increase (or slow rate of decrease, if you take inflation into account). But this pinch has been eased by two further decisions: The first one was to put more and more money into the international operations of CERN. The share of CERN in the French particle-physics budget has doubled only in the last nine years in that nearly half of the particle-physics money now goes to CERN.

The second thing is that we have tried hard to protect the field from fluctuations in budget.

It is not unusual to see European budgets go down 1 percent one year and go up 5 percent the next year. Of course, you get much better results with a uniform increase in research budget than you do by ups and downs. There are many reasons, mostly political, for these fluctuations. For example, we had a bad 1973 budget for science in France because 1973 was an election year and the Government did not want either to increase taxes or cut down on some projects that have voter appeal. Since science has limited voter appeal, science was one of the victims.

The 1969 budget was very bad because it was just after the 1968 outbreak, with some economic consequences that led the government to cut down the total budget, and of course again science suffered.

Then in 1972 we had a very good year. In 1974 we had a so-so year. So French science has even in the last few years suffered non-uniform rates of increase. During this time, we have tried to keep the rate of evolution of the particle-physics budget as uniform as possible. This is an example of how we have tried to make the best of a bad situation for a discipline whose growth had to be leveled off.

US versus European funding

There is a major difference between funding procedures in the US and Europe that makes things much easier, in general, for the Euopean scientists. In the US nearly all the research money is obtained for specific projects. In Europe it is the opposite—most of the money comes through automatic or base money funding. Very little is tied to specific projects. For example, at my old laboratory at the University of Paris, the salaries of the research personnel are, first of all, paid by the University or by the CNRS (the French equivalent of the NSF) and not charged to any research effort. (As discussed in the box on this page these are essentially all tenured positions.)

For research the University receives a grant each year from the Minister of Education, based on the size of the university, and it does not have to be justified. (The university itself has a scientific committee that decides how to divide up the total grant among the different efforts its people are involved in.) This grant may account for 40% of the operating expense and 20% of the capital expense.

The third source of money for both operating and capital funds comes from the CRNS in the form of long-term contracts (four years or so) on a nonproject basis, which provide another 60% of the capital funds and another 40% of the operating expenses. The remainder—expenses for secretarial salaries, another 20% for capital investment and not quite half the operating expenses—are obtained from outside agencies such as the BSS and the Defense Research Agency and also the CRNS for specific

Research jobs in Europe

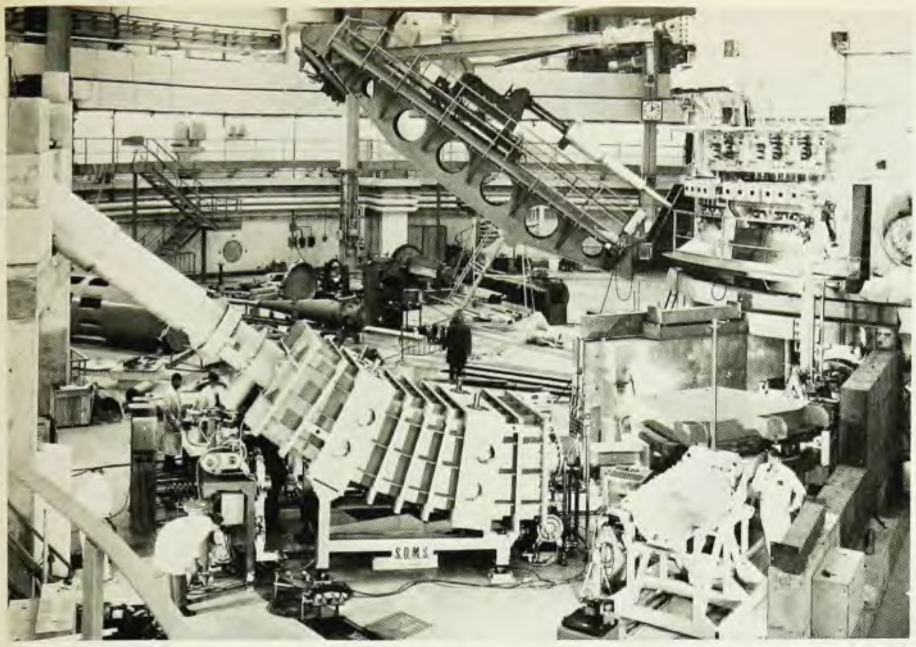
In spite of severe inflation made even worse by the energy crisis, salaries in research positions have kept up all over Europe. This is true even though inflation rates vary widely over Europe—for instance a 7% rate in Germany (lower even than the US's 10% rate) compared to 15% in France.

The reason is that for the most part scientists working at universities or in laboratories supported by government grants are in effect government employees and receive automatic cost-of-living increases.

Now that the dollar has been devalued, salaries for scientists in Europe are comparable to salaries of US scientists, even though differences in salaries for the average working man are still large. For example, the salary in France for a university professor in the top 10% is about $25 000 a year. If you take into account the much lower income tax in France, this figure is not far from the $32 000 a professor in the top 10% receives in the US. For the overall labor market American salaries are still about 1.6 times higher than French salaries. But for university positions the factor is close to 1.0. Additional financial benefits are socialized medicine—fairly uniform all over Europe—and free education. Education at a university is tuition-free in France (except for a $20 annual registration fee), compared to $3500 per year tuition at, say, MIT in the US.

Since positions are essentially government positions, tenure, or *de facto* tenure, is almost universal. Thus, in France, teaching assistants at the universities have tenure as government employees and cannot be fired or even transferred except by a judicial process.

The "publish-or-perish" syndrome does not exist in Europe. Promotions depend on reviews by a committee of elected peers. In judging an individual's scientific merit, the committee takes into account all aspects of his contributions to the field.



The fission-product spectrometer "Lohengrin" of the high-flux reactor at the Institut Max von Laue–Paul Langevin, in Grenoble, France. (Photo courtesy B. Maier, Laue–Langevin Institute.)

projects. Hence the fraction of funding for a lab tied to specific projects is usually no more than 20% and less than this on the average. On a global basis in France, specific projects actually make up only 10% of the total funds available for science budgets.

Of course the procedure for getting the money for the specific projects is the same as in the US and involves proposals and reviews by committees and so on. But since it is only 20% of the total, people don't have to spend as much time and effort getting money on a project basis.

One result is that European scientists feel less pressure than in the US to go to the public and try to enhance public understanding. Scientists in the US are mostly trying hard to develop public understanding, but in Europe they are unconcerned. Actually, the astrophysicists and biologists are not doing a bad job in this area in Europe. But in solid-state physics very little is being done and worst of all are the particle physicists, who don't seem to realize the need for public understanding even though they are the biggest spenders.

Future trends

As for the future trends in science funding in Europe I prefer to be a realistic optimist. As an optimist I hope that the level part of the curve will not be level but will show a sufficiently large positive slope. As a realist, it will take time to achieve that positive slope.

You might think that the energy crisis would help increase science budgets in Europe, but the effect has been smaller than in the US because the amount of money (fraction of the GNP) already being spent by governments on energy-related problems was much larger in Europe than in the US. When the energy crisis came along it gave only a slight boost to these budgets because they were already high, while the US—which was spending ridiculously small amounts on this type of R&D—is now suddenly planning to spend ridiculously large amounts in this area. I doubt if good use can be made of the funds that are abruptly poured into an area in this way. First of all it detracts from the funding for other areas. And five or six years from now, when people conclude that none of this research has helped the least bit in solving the energy crisis, the budgets will be cut off and you will have repeated what happened with the space program.

The European governments have had a much better policy on energy R&D with high levels of funding over the last ten years which are steadily increasing. Most of this kind of research is done by an agency equivalent to the US AEC in each country. In France, for instance, the French AEC budget will probably get an increase of about 10% this year, which is a sensible increase.

Although I don't see very fast increases in European funding on the horizon, especially for physics, on the other hand I don't see the risk of a collapse of support for science such as the US nearly had a few years ago. I do not think this will occur in Europe. For one thing, the Europeans generally have a large inertia. It takes really catastrophic events to change the course of things. The most likely thing is a continued leveling off, which we can hope will turn into a modest positive slope provided we can develop enough public understanding. □