One possible explanation for the small amount of learning done in small companies in some industries is that these companies buy their learning from outside agencies instead of doing it themselves. The National Science Foundation study casts considerable doubt upon the validity of this explanation, however.

Whatever the reason for the small learning effort in small electrical manufacturing companies, it is an economic fact. There appears to be a critical company size, for research effort, of very roughly 20,000 employees; companies with more than 20,000 employees sometimes do learning work at the same rate as large companies, but smaller companies almost never do. Of the 170 companies in the 1000-to-20,000-employee class, only two (Hughes Tool and Sprague Electric) come up to the average of the largest companies in intensity of effort. For petroleum companies the critical size is very roughly 5000 employees; only 4 of 83 companies in the 1000 to 5000 employee come up to the level of the top two groups in intensity of effort. For chemical companies there is no true critical size, but it is roughly at the 4000-employee level that the intensity of effort drops to half that in the top two groups.

Factors Favoring Research Support

So much for the factual presentation of data. What is revealed about the conditions under which industry finds it profitable (or thinks it profitable) to do basic research? It appears that two important requirements must be met. (i) The industry must be one in which innovation and associated obsolescence proceed rapidly. (The pace of innovation and obsolescence is very rapid in the pharmaceutical industry and moderately rapid in the chemical, petroleum, electrical manufacturing, and aircraft industries. These are the industries in which basic research flourishes. The pace in other industries is slow by comparison.) (ii) The company must be sufficiently large and diversified. (For pharmaceutical companies, almost any size seems to be large enough, but for electrical manufacturers, anything less than about 20,000 employees is definitely too small. It seems probable that small electrical manufacturing firms are poorly diversified in their activities and cannot make efficient use of the relatively unpredictable results of basic research.)

These two requirements seem reasonable. A company in a slowly developing industry need do no basic research. Innovations are few and far between, and it is more profitable to copy those adopted in other plants than to try to be first. Even in a fairly rapidly developing industry, it may be wise for small companies to wait until innovations appear, and then to copy them. Only the large competitors of such companies have both the resources for supporting an integrated research program and the wide diversification that enables them to take advantage of the products and by-products of basic research.

Size does not seem to be a factor in the pharmaceutical business. Perhaps this is because the pace in this field is so rapid that there is no time to copy one's competitors; by the time a competitor has been copied the product is obsolete. If a company does no basic research, it falls by the wayside.

Basic research in industry is a relatively new activity, which was almost unknown in 1900. It has grown to the point where in 1953 somewhere near $150 million a year was invested in it, in spite of the fact that a decade or so must elapse between the beginning of a research program and the point at which the possibility of practical results, if any, can first be glimpsed. The work is done by scientists whose motivation lies in science, not in economics. Yet such work is generally believed to be a sound investment for diversified companies in rapidly expanding industries, and it may even be necessary for survival in the pharmaceutical business.

Time alone will show how rapidly industry's rate of investment in basic research will grow, and by how much it will exceed industry's present value of 4 percent of its total expenditures for research and development.

References and Notes

1. "Science and Engineering in American Industry, Final Report on a 1953–1954 Survey," *Natl. Sci. Foundation Rept. No. NSF 56-16.*
2. I am indebted to Mrs. Ann S. Cooper and to B. W. Roberts for their assistance in collecting and correlating the data upon which this study is based.
3. *Poor's Register of Directors and Executives* (Standard and Poor's Corporation, New York, 1956).
4. *Fortune* 54, Suppl. (July 1956).

News of Science

Five Euratom Nations Consider Reactor Construction

Euratom, a six-nation cooperative organization set up to bring atomic power to Europe, has received letters of intention indicating that five of the member nations have "enterprises" within their borders that plan to submit proposals for reactors to be built under the Euratom–U.S. Joint Nuclear Power Program. The five nations are Belgium, France, Germany, Italy, and the Netherlands. Luxembourg did not submit a letter of intention. The term *enterprise,* which was used in an official announcement of the receipt of the letters, was not further defined.

Letters of intention for the proposals were submitted 28 May to Euratom headquarters in Brussels. These letters, however, as AEC authorities here stress, do not constitute commitments to build. They are submitted only to give Euratom officials some indication of response to the program. This was less enthusiastic than U.S. officials had hoped, according to observers. Members of the Atomic Energy Commission had hoped for six to eight proposals, to ensure an active role for the European power agency. The U.S., through an Export-Import loan, is providing $135 million in financial aid for the program.

The question that hung on the letters of intention was this: did European utilities find the offered United States financial assistance a sufficient inducement to proceed with expensive reactor development on a sizable scale? The answer seems to be a qualified "yes."

Obsolescence Feared

Reports from Europe have indicated that many producers of electric power were reluctant to invest large sums in types of reactors that might be surpassed in efficiency in a short time. This reluctance, along with other factors—for example, the changes in the European power-supply situation since Euratom was conceived, during the oil shortage coincident with the Suez crisis—has threatened to upset the schedule originally devised for European nuclear development. The Euratom pact, an "agreement for cooperation," provides that the proposed reactors should be in operation by 31 December 1963. Under provisions of an exemption, completion of two reactors may be deferred until 1965.

According to this time schedule, if there is follow-through on all five letters of intention, there should be at least three power reactors in operation in Europe by the beginning of 1964. It remains to be seen whether this amount of activity will be sufficient to convince American legislators that financial aid for the Euratom program should be continued and expanded. Recently, the Joint Congressional Committee on Atomic Energy proposed that there be a substantial slowing down of U.S. aid to the research and development aspect of the program, on the grounds that Euratom has fallen behind schedule. How the committee will view the receipt of the five letters of intention, as an index of European interest in the total program, is yet to be seen. A critical test will come in September when definite, obligated projects, rather than letters of intention, will be called for by the Euratom administrators.

National Science Foundation's Budget Cut by House

The House of Representatives cut $17 million from the National Science Foundation's requested budget of $160 million for fiscal year 1960. The cut, which may be partially restored by the Senate, leaves the foundation with $143 million—an insufficient amount, according to the director, Alan T. Waterman, to ensure adequate government support for basic scientific research. The foundation had originally requested $206 million, but the Bureau of the Budget lopped off $46 million in line with the Administration's balanced-budget policy.

On the House floor almost no debate followed the introduction of the Appropriations Committee recommendations, and no member of the House urged that the sizable cut be restored. The members simply approved the committee's action. Apparently, there was general agreement with Representative Joe L. Evins (D-Tenn.) of the Appropriations Committee when he said, "The committee is impressed by the importance of science in the modern world, but it does not believe we should issue a blank check to the Foundation. An increase of $9 million over the funds provided last year should provide a substantial increase in NSF activities."

The House cut left some programs of the foundation intact, with appropriations at the level deemed necessary by NSF officials. Among the programs that might have to be curtailed if the cuts remain, according to Waterman, are research studies on weather modification, plans to continue and enlarge programs for translating Russian scientific works, and proposals to support a larger percentage of the research projects that are submitted to the foundation each year. The effect of the cut will be particularly serious in this last area, foundation officials say. The $60.5 million approved by the House for these basic research grants is, according to the director, "inadequate to meet the Foundation's objective."

Other House Action

In other budgetary developments, the same House Appropriations Committee approved $17.25 million for research and technical services at the National Bureau of Standards. This is an increase of about $5 million over last year's authorization. These funds will allow the bureau to buy six new field stations that are now operated under lease and to build another wing at its Boulder, Colo., station.

Another division of the Commerce Department, the Weather Bureau, received $49.85 million from the House committee to support its activities in fiscal 1960. Last year's figure was $45.24 million. These funds were authorized with the stipulation that 24-hour weather station operations at major airports be restored. During the past two years the bureau has had to cut down on weather services at 51 airports around the country. With the funds authorized by the committee, around-the-clock service will be resumed at 13 of these stations.

The House's action on these budgetary matters is only the first round for the various federal agencies involved. The cuts and the increases must be passed on by the Senate, and the actions of House and Senate, if different, must be reconciled before the final money authorizations are made. In its appropriations for science and technology the Senate tends to be a little more generous than the House. Because there has been no particular criticism of the House action by members of the Senate, there is reason to believe that there will be no drastic revisions of the various appropriations when the Senate acts.

Australian Academy of Science

Scientists in various fields of international scientific endeavor will have observed that Australia has been represented by the Australian Academy of Science in arrangements for participation in the International Geophysical Year, for the Symposium on the Chemistry of Natural Products in Australia in 1960, for the specialist Conference on Haematin Enzymes in September 1959, and for activities of the Pacific Science Association and Pan Indian Ocean Science Association.

The Australian Academy of Science is a relatively recent establishment. Prior to 1954 Australian science had been represented in international activities by the Australian National Research Council. This council, which was formed in 1919, particularly to provide for Australia's participation in the International Research Council, acted for many years as the top representative body of science in Australia. Many Americans will recall the activities of the council, perhaps chiefly in connection with its participation in Pacific Science Association affairs and for its long and successful program of anthropological research.

Over the years the National Research Council had widened its membership to include leaders in the social sciences as well as in the natural sciences. By 1951 there was a strong feeling that the natural sciences needed a body of men, distinguished in their respective fields, to foster the pursuit of the natural sciences in Australia and to represent Australia in the increasing international activities. The social scientists were also ready to form a separate organization, now known as the Social Science Research Council.

The Australian National Research Council agreed to the suggestion that two entirely new bodies should be formed and that the old Research Council should be disbanded. The initiative in the natural sciences was taken by a group of 12 fellows of the Royal Society of London, resident in Australia, who invited 11 other scientists of high standing to join them. These scientists became the Foundation Fellows of the Australian Academy of Science and received a sympathetic hearing from the Prime Minister, the Right Honorable R. G. Menzies, who promised financial support