# Institutional Grants of the National Science Foundation

The value of flexibility and autonomy in the use of these funds is appraised in a four-year review.

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Federal support of basic research in American universities has mainly taken the form of financing research projects of individual scientists. Recent studies of the relations of government and higher education have drawn attention to some upsetting effects of federal research grants upon the total programs of colleges and universities, especially upon undergraduate instruction, and have suggested that the undesirable effects could be offset if research support for individuals were supplemented by grants that could be used for broader institutional purposes. Testimony before congressional committees often echoes the suggestion of "institutional grants." Because of the growing interest in the institutional-grants idea, a brief account of the experience a government agency has had with grants of this type may be useful.

The National Science Foundation began its program of Institutional Grants for Science in the summer of 1960 and made the first grants in June 1961. The purpose of the grants, as stated in the first announcement, was

> to strengthen the general research functions and programs of the institutions [of higher education] in the mathematical, physical, biological, social, and engineering sciences, by supporting the development and maintenance of a sound, well-balanced program of basic research, research training, and related scientific activities, without specifying the precise research and related scientific activities to be undertaken with the grant funds.

Thus, NSF intended to strengthen scientific research in universities and colleges; but the announcement also emphasized "balance" of research and education, and academic institutions could decide for themselves the best means of strengthening and balancing their scientific programs. Although the strains resulting from federally sponsored research were apparently greatest within the universities receiving the largest amounts of federal grants, NSF opened the program to any American college or university receiving research grant payments from NSF, of whatever amount.

The size of an institutional grant is computed by applying a formula to the amount of research money (the "base") a college or university has received from the foundation. The first formula was a simple one: 5 percent of the total research-grant payments during the period 1 July 1960 to 31 March 1961. The intention was to fix the maximum institutional grant in 1961 at $50,000, but since the first grant period covered only nine months, the maximum for the first grants was set at $37,500. Ten universities received maximum grants, but more than half of the 248 recipient institutions received less than $2000 each.

The formula and the maximum have been changed each year. A 100-percent matching feature was added for the first few thousand dollars of the base in order to insure that each participating institution would get a grant large enough to do something worth while with it, and the maximum grants were increased so that institutions having the largest base amounts would not suffer unduly from a tapered formula. Another important change in 1963 was the extension of the base to include the amount of grants made under two research-training programs—Undergraduate Science Education, and Research Participation for College Teachers.

Tables 1 and 2 show the distribution of institutional grants and recipients, by amount of grant, during the first four years of the program. The number of colleges and universities receiving grants rose from 248 in 1961 to a high of 397 in 1963. A change in the formula to allow 100 percent of the first $5000 of the base in 1962 and of the first $10,000 in 1963 and 1964 significantly increased the amounts of the grants in the lower ranges. The average grant in 1961 was $6035; in 1964 it was $30,690. The median rose from $1220 in 1961 to $13,239 in 1964.

## Administration

NSF has kept the administration of the institutional-grants program simple, both for itself and for colleges and universities. Only a short letter from the chief administrative officer of an institution is required in order to apply for a grant. He pledges that the funds will be used only for direct costs of scientific activities. Once a year the institution submits a report, telling the purposes for which grant funds have been spent; appraising the results of their use; and accounting for the grant funds on hand at the beginning of the year, the amounts received and expended during the year, and the amount carried forward.

In the first year, NSF asked applying institutions to indicate the expected uses of the grants. This request has since been dropped. An indication of intended use is apt to be looked upon as a binding commitment, and the foundation chose to permit college and university officials to change their minds and to use the money to meet unanticipated needs or take advantage of unexpected opportunities.

Only one institutional grant a year is made to an institution. Because of differences in organization of universities, the question is sometimes raised, What is a separate institution of higher education? When the 100-percent matching feature was added to the formula, some universities and university systems asked to be considered as being made up of several separate institutions. In dealing with these requests, NSF has sought to determine whether or not the "separate" institutions are autonomous. In 1964 medical and other health-professional schools and

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Table 1. Distribution of recipients of institutional grants, 1961–1964, by size of grant. Percentages may not add up to totals because of rounding off.

| Size of grant (thousands of dollars)* | 1961 | | 1962 | | 1963 | | 1964 | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| Under 2.5 | 146 | 59 | 10 | 3 | 21 | 5 | 6 | 2 |
| 2.5– 4.9 | 27 | 11 | 28 | 9 | 39 | 10 | 25 | 7 |
| 5.0– 9.9 | 29 | 12 | 170 | 56 | 53 | 13 | 49 | 13 |
| 10.0– 19.9 | 22 | 9 | 44 | 15 | 174 | 44 | 165 | 45 |
| 20.0– 29.9 | 10 | 4 | 15 | 5 | 39 | 10 | 26 | 7 |
| 30.0– 37.4 | 4 | 2 | 10 | 3 | 20 | 5 | 12 | 3 |
| 37.5– 49.9 | 10 | 4 | 8 | 3 | 12 | 3 | 20 | 5 |
| 50.0– 74.9 | | | 17 | 6 | 17 | 4 | 17 | 5 |
| 75.0– 99.9 | | | | | 22 | 6 | 17 | 5 |
| 100.0–149.9 | | | | | | | 29 | 8 |
| 150.0 | | | | | | | 4 | 1 |
| Total | 248 | 100 | 302 | 100 | 397 | 100 | 370 | 100 |

* Determined by formula, as follows: In 1961, 5 percent of total research payments received 1 July 1960 to 31 March 1961, to a maximum institutional grant of $37,500. In 1962, 100 percent of the first $5000 of total research payments received 1 April 1961 to 31 March 1962, plus 5 percent of the remainder, to a maximum institutional grant of $50,000. In 1963, 100 percent of the first $10,000 of total grants for research, Undergraduate Science Education, and Research Participation for College Teachers received 1 April 1962 to 31 March 1963, plus 10 percent from $10,001 through $100,000, plus 5 percent thereafter, to a maximum institutional grant of $75,000. In 1964, 100 percent of the first $10,000 of total grants for research, Undergraduate Science Education, and Research Participation for College Teachers received 1 April 1963 to 31 March 1964, plus 10 percent from $10,001 through $1,200,000, plus 1 percent from $1,200,001 through $3,000,000, plus 0.5 percent thereafter, to a maximum institutional grant of $150,000.

two-year extension centers and divisions of universities or university systems were excluded from eligibility for separate institutional grants. Other degree-granting institutions, whether under a common central administration or subordinate to a main university campus, were considered separate if the chief administrative officer of the "system" of which they were members so requested and furnished satisfactory evidence of their educational and administrative autonomy.

NSF's confidence that colleges and universities will use institutional-grant funds responsibly for direct costs of science has been justified. The bounds of "science" are hard to draw, however, and arbitrary judgments based upon the titles of academic departments are improper. Colleges and universities usually include within their social science divisions branches of knowledge of which some parts are ineligible for research support from NSF; but new ideas and new methods of research are erasing or expanding traditional distinctions among the disciplines. When an institution reports a use of the funds for an activity that seems doubtfully "scientific," the foundation asks the reporting official for more information. Sometimes the institution justifies the use; sometimes, after reconsideration, it decides to support the activity with unrestricted funds and replaces those from the institutional grant.

Table 2. Distribution of institutional grants, 1961–1964, by size of grant. Percentages may not add up to totals because of rounding off.

| Size of grant (thousands of dollars)* | 1961 | | 1962 | | 1963 | | 1964 | |
|---|---|---|---|---|---|---|---|---|
| | $ | % | $ | % | $ | % | $ | % |
| Under 2.5 | 91.3 | 6 | 15.4 | † | 34.0 | † | 10.9 | † |
| 2.5– 4.9 | 105.6 | 7 | 106.9 | 3 | 146.6 | 2 | 95.7 | 1 |
| 5.0– 9.9 | 227.2 | 15 | 1057.7 | 28 | 377.1 | 5 | 348.9 | 3 |
| 10.0– 19.9 | 316.4 | 21 | 647.7 | 17 | 2239.5 | 29 | 2132.3 | 19 |
| 20.0– 29.9 | 246.0 | 16 | 370.6 | 10 | 953.8 | 13 | 631.0 | 6 |
| 30.0– 37.4 | 135.1 | 9 | 328.2 | 9 | 676.7 | 9 | 397.4 | 3 |
| 37.5– 49.9 | 375.0 | 25 | 354.2 | 9 | 523.6 | 7 | 854.1 | 8 |
| 50.0– 74.9 | | | 850.0 | 23 | 1012.0 | 13 | 992.9 | 9 |
| 75.0– 99.9 | | | | | 1650.0 | 22 | 1501.8 | 13 |
| 100.0–149.9 | | | | | | | 3790.4 | 33 |
| 150.0 | | | | | | | 600.0 | 5 |
| Total | 1496.6 | 100 | 3730.6 | 100 | 7613.3 | 100 | 11,355.4 | 100 |

* See footnote to Table 1. † Less than 0.5 percent.

In discussing their administration of the grants, institutional officials emphasize the contribution the funds make to institutional flexibility. Planning is facilitated when the institution has funds at hand that it can commit without a long wait while a proposal is prepared and submitted and assurance is obtained that money will be available for the project. As institutional-grant funds are not tied to a specific use, the institution is able to employ them in a variety of ways, according to its own particular conditions. One vice president for research reported:

> We believe that the flexibility and rapidity with which such funds can be employed internally contribute tremendously to their value and effectiveness. These funds . . . have not required another layer of administrative superstructure to be added to an already growing administrative chore. We simply are permitted to utilize these funds for science in just the same manner we would if they came from an endowment fund restricted to science.

Moreover, the institution may accumulate the funds for a year or two, thereby increasing their effectiveness at a later time. (In each of the first two years of the program the uncommitted funds amounted to about 14 percent of the total amount of the grants.)

The grants are made to the presidents of colleges and universities. Responsibility for deciding the uses of the grants has in most cases been delegated by presidents to academic committees charged with administering research funds or to special faculty committees appointed to deal solely with institutional grants. These special committees are usually composed of members of the science faculty and the administration. In some cases, a single official, such as a dean of science or a coordinator of research, has been made responsible for recommending uses of the grant funds; final decisions may rest with a designated committee or a top administrative officer.

At some institutions the grant funds have been awarded on the basis of competition open to all science departments. Some institutions have circulated statements of policies governing the use of institutional grants and invited the submission of appropriate requests for support. Other institutions have made administrative decisions on the use of the funds, allocating them to selected departments or to a particular purpose in all science departments, such as purchase of equipment, library expansion, student support, or

Table 3. Distribution of institutional-grant expenditures, 1 July 1962 to 30 June 1963, by use and by class of institution. Percentages may not add up to 100 because of rounding off.

| Use | Class of institution* | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | II | | III | | IV | | | |
| | $ | % | $ | % | $ | % | $ | % |
| Equipment | 118,144 | 62.5 | 191,229 | 55.4 | 955,357 | 36.0 | 1,264,730 | 40.0 |
| Facilities | 16,121 | 8.5 | 23,834 | 6.9 | 298,618 | 11.3 | 338,573 | 10.6 |
| Library resources | 4,540 | 2.4 | 27,169 | 7.9 | 262,574 | 9.9 | 294,283 | 9.2 |
| Research projects | 31,815 | 16.8 | 60,212 | 17.4 | 576,996 | 21.8 | 669,023 | 21.0 |
| Salaries and stipends | 15,760 | 8.3 | 24,994 | 7.1 | 305,599 | 11.6 | 346,353 | 10.8 |
| Travel | 1,220 | 0.6 | 5,892 | 1.7 | 87,839 | 3.3 | 94,951 | 3.0 |
| Printing and publications | | | 3,927 | 1.1 | 21,975 | 0.8 | 25,902 | 0.8 |
| Special projects | 1,500 | 0.8 | 6,190 | 1.8 | 46,878 | 1.8 | 54,568 | 1.7 |
| Reserve funds | | | 1,641 | 0.5 | 96,020 | 3.6 | 97,661 | 3.1 |
| Total | 189,100 | 100.0 | 345,088 | 100.0 | 2,651,856 | 100.0 | 3,186,044 | 100.0 |

* Class-II institutions grant only the bachelor's and/or first professional degree; class III, the master's and/or second professional degree; class IV, the doctorate of philosophy and equivalent degrees. Tabulated here are 46 class-II institutions (and one junior college in addition), 78 class-III institutions, and 171 class-IV institutions. These represent 98 percent of the institutional-grant recipients in 1962.

special projects. Only rarely has a grant been turned over to a department whose direct research grants from the foundation were the basis for the institution's receiving it.

## Uses of the Grants

Annual reports show the variety of uses colleges and universities have made of institutional-grant funds. Table 3 gives reported expenditures by type of use and by class of institution during the year 1 July 1962 to 30 June 1963. Although the titles of type of use are generally self-explanatory, a few comments should be made.

Of the expenditures for facilities, about two-fifths was for renovation (mainly of laboratories). The remaining expenditures were for new construction and computer facilities. Nearly all of the expenditures for library resources were for books and periodicals, but some money was spent for improving science-library services and for the employment of additional staff in science libraries. Institutions developing new graduate programs often used large parts of their grants for library expansion. Funds for research projects most often helped young faculty members to begin to develop their research ideas and were frequently used in areas of science which campus scientists and administrators considered important but which had not attracted much support from outside sources. The greater part of the expenditures for salaries and stipends was for research by faculty members and graduate research assistants; in many cases these funds enabled faculty and graduate students to carry on full-time research in the summer and freed the students from the necessity of taking summer jobs unrelated to their academic programs.

Undergraduate colleges spent a much larger share (62 percent) of their funds for equipment than did Ph.D.-granting universities (36 percent); institutions giving the master's degree—most of them essentially undergraduate colleges—allocated 55 percent of their funds for equipment. Ph.D.-granting universities allocated 10 percent and M.A. institutions 8 percent to library resources, whereas undergraduate colleges spent only 2 percent for this purpose. Ph.D. universities also spent a noticeably higher percentage for salaries. In all three types of institutions, the allocations for research projects clustered around 20 percent.

As shown in Table 4, 44 percent of the expenditures went for physical and engineering sciences, about 29 percent for biological and medical, about 10 percent for social sciences (including psychology), and the remainder for interdisciplinary activities which could not be allocated to specific fields. The biological sciences of physiology, zoology, and biochemistry accounted for 20 percent, chemistry for 14 percent, engineering for 10 percent, and physics for 9 percent. The B.A.-only and B.A.-M.A. institutions spent a higher proportion of their grant funds for chemistry and biology than did Ph.D. universities. On the other hand, Ph.D. institutions accorded a higher percentage of their funds to the social sciences than did either of the other types.

## Conclusions

The simplicity of the institutional grants program, the government's recognition of institutional autonomy, and the flexibility with which the funds may be used have naturally gratified administrators of colleges and universities. Presidents and deans have had an opportunity to use the grants to foster

Table 4. Distribution of institutional-grant expenditures, in dollars, 1 July 1962 to 30 June 1963, by class of institution and by field of science.

| Field of science | Class of institution* | | | Total | |
|---|---|---|---|---|---|
| | II | III | IV | Amount | % |
| Biological and medical sciences | | | | | |
| Agriculture | 11,500 | 23,839 | 126,299 | 161,638 | 5.1 |
| Biology | 69,950 | 107,552 | 457,117 | 634,619 | 20.0 |
| Medicine | | 3,200 | 136,805 | 140,005 | 4.4 |
| Physical sciences and engineering | | | | | |
| Chemistry | 37,745 | 64,586 | 350,612 | 452,943 | 14.2 |
| Physics | 16,102 | 36,130 | 249,144 | 301,376 | 9.5 |
| Mathematics | 9,901 | 24,059 | 74,462 | 108,422 | 3.4 |
| Engineering | 4,738 | 4,398 | 309,940 | 319,076 | 10.0 |
| Other | 4,969 | 20,628 | 204,817 | 230,414 | 7.2 |
| Social sciences and psychology | | | | | |
| Social sciences | 2,008 | 14,599 | 202,369 | 218,976 | 6.8 |
| Psychology | 6,104 | 14,262 | 95,005 | 115,371 | 3.6 |
| Interdepartmental | 26,083 | 31,835 | 445,286 | 503,204 | 15.8 |
| Total | 189,100 | 345,088 | 2,651,856 | 3,186,044 | 100.0 |

* See footnote, Table 3.

programs they think deserve more financial support. They have been able to ease some of the strain caused by tight travel and library budgets, furnish equipment that would persuade a promising Ph.D. to accept an appointment or keep a valued professor from accepting a position elsewhere, or speed the establishment of a computing center to serve the entire institution.

It is often assumed that *the* purpose of NSF institutional grants is to offset imbalances caused by grants for research projects. Many times they do perform this function. The addition of a recent doctoral graduate to a small physics department may mean that a college can give a physics major as well as majors in chemistry and biology, and this results in better institutional "balance." Also, the grants often serve as catalysts for the procurement of other funds to support research outside the sciences. Yet, the annual reports show that "balance" and "imbalance" are not easily definable when applied to the total educational and research activities of a university. Concentration of spending upon one activity may mean the deliberate creation of an imbalance in the interest of furthering a special mission which the institution thinks it has. In general, colleges and universities think of the grants as a means of strengthening their science programs—perhaps through trying to achieve a roughly even level of competence, perhaps through concentration of effort in a particular area, perhaps by trying to revive a weak department. Despite the similarity of problems in science confronting higher educational institutions across the country, the problems are always unique on each campus. The very nature of local direction and control of institutional grants means that colleges and universities decide the purposes of the program so far as they are concerned.

The fact that the grants have grown in amount has led to greater attention to their potential value as a means of continuous rebuilding and regeneration of institutional science programs to meet changing social demands. When compared with the first year's annual reports, those on the second year of the program show greater awareness of the possible importance of the grants, more imaginative and less routine administration of them, and more signs of institutional planning for the best use of the funds.

The relations of the federal government and higher education constantly shift and change, and the institutional-grants program shows one of the ways in which they are changing. It is a means of fostering greater national strength in science. At the same time it is an expression of confidence in the initiative of institutions and in their ability to use the resources responsibly for the building of excellence in science.

# Massive Extinctions in Biota at the End of Mesozoic Time

## Any proposed explanation should account for the profound effect on marine planktonic life of that time.

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The profound and geologically abrupt changes in the earth's biota, particularly those marking the end of Paleozoic and of Mesozoic time, have been the subject of much speculative discussion. A review by Newell (*1*) is one of the more recent and comprehensive on this subject, but does not include the possible explanation suggested here. These great changes primarily reflect a geologically sudden extinction of many important elements of the earth's population—the extinction of some large populations thriving toward the end of Mesozoic time being more demonstrably abrupt than that at the end of the Paleozoic. However, the causes of these major events were not necessarily similar, since the physical condition of the earth and the populations of organisms most affected were not closely similar at these two times. The extinction at the end of the Mesozoic seems, in the fossil record, to be most obviously and strikingly reflected by the planktonic life (plant and animal) of the oceans and by the larger forms dependent on plankton, such as ammonites and belemnites, whose extinction at that time has long been recognized. That so much marine life became extinct solely from a lack of adequate nutrition seems an oversimplification, but evidence that such a lack may have been the critical factor under the probable environmental conditions of that time deserves some consideration.

Among previous explanations, the one suggestion that the extinction occurred as a result of excessive radiation from an exceptional cosmic event might seem intriguing because such radiation could have had widespread and nearly instantaneous effects on life. Loeblich and Tappan (*2*) suggest that such radiation might have induced mutations and more extinctions in the planktonic than in the more protected benthonic foraminifera at the end of the Mesozoic. However, even a thin layer of surface water would serve as an effective blanket, according to Urey (*3*), and, as mentioned by Newell (*1*), the radiation would have affected land plants much more than the record indicates. The suggestion of a climatic change with a reduction in temperature seems to have little support, and the effects of such a change should likewise be most apparent in the fossil land plants rather than in the marine life. Changes in sea level may have adversely affected nearshore marine life, as Newell and others have advocated, but such changes should not have affected the plankton populations to the unusual degree that is evident.

Life in the oceans may include an

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