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The Process Values of University Research

A new research funding system is needed for federal support of the process values of university research.

James D. Carroll

In the 1960's tension has developed between support of university research by federal agencies for its "product values" and support for its "process values." Properly directed, this tension can be a creative one. Improperly directed, it can harm the university research enterprise in the United States.

The distinction between the process and the product values of university research should be recognized for purposes of analyzing federal university-research programs and formulating federal policies for the support of university research. In this article I analyze the differences between these values and suggest policy lines for the creative direction of the tension between them.

The Product Values

The product values are the values to federal agencies, to scientists, and to the public of the information produced. University research has four primary product values: the value of the information produced to agencies in the performance of their missions in defense, space, health, agriculture, and so on; the value of the information produced for the advancement of science as a worthwhile end in itself, and as a desirable cultural process; the value of the information produced to members of the public, particularly in civilian collective consumption sectors such as air supply, water supply, public health, public transportation, and public safety; and the value of the information produced as an element in economic growth.

Since publication of *Science—The Endless Frontier* in 1945 (*1*), the basic justification given for federal support of university research has been the potential or immediate value of the information produced. Year after year agency representatives have appeared before appropriations subcommittees and authorization and oversight committees expressing variations of the theme composed in its modern form by Vannevar Bush (*1*, p. 19):

> Basic research leads to new knowledge. It provides scientific capital. It creates the fund from which the practical applications of knowledge must be drawn. New prod-

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ucts and new processes do not appear full-grown. They are founded on new principles and new conceptions which in turn are painstakingly developed by research in the purest realms of science. . . . Publicly and privately supported colleges and universities and the endowed research institutes . . . are uniquely qualified by tradition and by their special characteristics to carry on basic research. . . . It is chiefly in these institutions that scientists may work in an atmosphere which is relatively free from the adverse pressure of convention, prejudice, or commercial necessity.

The project system, in which the emphasis is upon evaluation of the potential value of the information to be developed to science or to an agency mission, and upon the ability of the investigator, has been the basic administrative procedure for realization of the product values of university research.

The product values traditionally have been the incentives to, and the justifications for, federal support of such research. However, in the 1960's a new set of incentives and justifications has been recognized as a basis for the design and administration of federal university-research programs: the process values of research.

The Process Values

The process values of university research are the values of the activity of research itself, as distinguished from the products, to the people performing the research and to the university and the locality in which it is performed. Recognition of these values of university research is not new. During the New Deal, research was recognized as a potential way of reducing unemployment of scientific and technical personnel (*2*). The idea of supporting university research for its process values also was advanced in the debates over the creation of the National Science Foundation (NSF) (*3*). What is new in the 1960's is formal recognition of the process values of research as a basis for the design and implementation of federal university-research programs.

University research has four primary process values. The first is the value of research as a way of teaching and training students. This value was stressed in *Science—The Endless Frontier* and in many ways is similar to the product values of research, although the primary "product" is a person rather than specific information. Although, since the late 1940's, various agencies, in administering research and science education programs, have taken into account the educational value of the activity of research, the Seaborg Report (*4*, p. 11) in 1960 criticized the "artificial and fundamentally wrong division between research and teaching that bedevils the government's relations with universities" and asserted that "*basic research and scientific education* go together." (The italics are in the original.)

In universities and colleges in which organized research is a well-established activity the educational values of research can be, and often are, realized in the research process itself, through the use of graduate students to perform research and through the teaching activities of researchers. However, in universities and colleges in which organized research is not a major activity, realization of these values requires programs specifically designed to allocate funds on the basis of educational need. It may be that the educational value of the activity of research depends upon the quality of the research performed (*5*). Whatever the merits of this point, liberal arts colleges and low-ranking universities that cannot rival major institutions on a quality basis usually take the position that even routine research for educational purposes is better than no research at all (*6*).

The second process value is the value of the activity of research as a way of strengthening universities and colleges, or particular units within universities and colleges. The idea of using specialized research programs in conjunction with the acquisition of equipment and the conduct of science-education programs as a way of stimulating the development of "centers of excellence" derives, at least in its current form, from the assertion in the Seaborg Report (*4*, p. 14), "We must hope that where there were only a handful of generally first-rate academic centers of excellence a generation ago and maybe as many as fifteen or twenty today, there will be thirty or forty in another fifteen years." President Johnson's Memoranda of 13 and 14 September 1965 express presidential approval of the use of research funds to support programs designed to strengthen the scientific capabilities of particular universities and colleges (*7*).

The third process value is the real or presumed economic value of university research to the locality in which the research is carried on. First there is the direct economic benefit to a locality from expenditure of research funds on salaries, equipment, and supplies. Second, and more heavily stressed, there is the potential long-range economic benefit to the locality in which research is performed, a benefit that derives in some cases from the creation of spin-off research enterprises and the attraction of research-oriented industry to the locality. The available studies of the question (*8*, pp. 133–35) indicate that in specific situations university research can generate spin-off enterprises and attract research-oriented industry, but that it does not invariably have this effect. The National Science Foundation has taken the position (*8*, p. 135) that the role of university research in regional economic development is somewhat unclear:

> Although Federal funds for R and D can have a marked influence upon a local community, the extent and character of this influence depends upon both the nature of the R and D activity and of the community. The state of knowledge does not permit an unequivocal prediction that a particular activity will have multiplying and/or clearly beneficial effects upon a given community.

Other analysts of the effects of research expenditures have argued that university research activities are clearly an important element in regional economic growth (*9*).

The fourth process value of research is the cultural and community-development value of research as an activity. The presence of many researchers in an academic community may contribute to the cultural tone of the community and set an example for young people to follow. Researchers also may participate in a quasi-professional capacity in local affairs and apply their specialized skills to the development of the community.

Recognition of the Process Values

The process values have been given recognition in federal academic-research policies through the creation of new programs explicitly designed to provide opportunities for realizing one or more of these potential values and through the incremental adjustment of some existing programs.

The following programs are directed, in varying degrees, toward realization of the process values.

1) The University Development Program of NSF, created in 1967 through

the division of the Science Development Program into two programs. The object of this program is the broad and rapid development of a limited number of universities with a demonstrated potential for the achievement of excellence.

2) The College Science Improvement Program, created in 1967 through the division of the Science Development Program into two programs. The object of this program is to improve the total scientific enterprise of selected undergraduate institutions with demonstrated potential for improvement.

3) The Departmental Development Program of NSF, created in 1967 to support a single science department or interdisciplinary area in institutions which are not ready to achieve overall excellence but which may be able to attain excellence in one or more departments.

4) The Institutional Grants for Science Program of NSF, created in 1961 to provide flexible funds—a given percentage of the project funds received by an institution—for use for any science-development purpose.

5) The Undergraduate Research Participation Program of NSF, created in 1966 to provide increased opportunities for scholarly development of outstanding undergraduates who may pursue careers in science.

6) The General Research Support Program of NIH, created in 1962 to provide general, flexible support of the health-related research and educational programs of health-oriented professional schools heavily engaged in health research.

7) The Biomedical Science Support Program of NIH, created in 1965 to extend flexible support to non-health-oriented professional colleges and universities for developing a health-research program.

8) The Health Sciences Advancement Awards of NIH, initiated in 1966 to provide support to institutions with demonstrated potential for improving their health-research and health-education capabilities.

9) The Sustaining University Program of NASA, initiated in 1962 to support institutions in the conduct of research and the education of students in fields relevant to NASA's missions.

10) The Defense Department's Project Themis, initiated in 1967 to support the development of defense research capability in developing institutions.

11) Several Office of Education research and science education programs, set up under the Higher Education Act of 1965, designed to encourage the use of research as an educational device.

In addition, the Technology Transfer Programs of NASA and of the Atomic Energy Commission and the State Technical Service Program of the Commerce Department include research components that, in part, are directed toward realization of the economic process values of academic research.

To what extent should these programs be classified as research programs? The National Science Foundation, in its budgetary analyses, classifies several of its process-oriented programs as partly for research and partly for education (*10*). While all process-oriented programs involve a substantial research component, for purposes of clarity they should be classified as educational or as science and economic development programs, rather than as research programs per se.

There is some evidence that, in addition to being taken as a basis for specific new programs, the process values of academic research are being taken into account in the administration of traditional projects. For example, in 1965 NSF submitted the following statement (*11*) to the Reuss Subcommittee, concerning the administration of traditional research projects:

> The quality of the institution as a whole does not enter into consideration unless the merit of the proposal is of less than highest quality. Proposals of less than highest quality are rarely supported at institutions having highly developed research activity. However, not infrequently middle range proposals are supported at lesser institutions in order to encourage development and improvement of their research and instructural programs. Similarly, in cases of proposals of substantially equal merit, priority is given to those from the less well-developed institutions.

Underlying Trends

The recognition now given process values in some university research programs has resulted from the convergence in the 1960's of several social and economic trends at the federal policy level. These trends have generated political demands that have been translated into policy and refined in specific programs and procedures. Here I first identify the major trends and then assess the implications of the recognition of these trends in federal research policies.

The most important trend is the continuing nationalization of the American economy and the public commitment to the ideology of economic growth. The nationalization of the economy has generated demands for federal support of university research on a regional basis, arising from the belief that university research can contribute to regional economic growth.

The nationalization of the economy has taken two forms: domination of the income tax by the federal government, and commitment of the federal government to the objectives of the Employment Act of 1946—rapid growth, full employment, price stability, and balance-of-payments equilibrium (*12*). Domination of the income tax has placed the federal government in a commanding position over state and local governments, which traditionally have borne a major responsibility for the welfare of higher education in the United States. The federal government today collects about 93 percent of all revenue derived from income taxes in the United States. Revenue from income taxes constitutes about 55 percent of all governmental revenue—local, state, and federal (*13*). A progressive income tax is the most effective form of taxation because it is more responsive to increases in gross national product than property, sales, excise, and other forms of taxation. For every 1-percent increase in gross national product, income tax revenue increases by about 1.7 percent, whereas property, sales, and other tax revenues increase by only about 1 percent (*13, 14*).

Federal domination of the income tax has resulted from the magnitude of the military and international commitments of the federal government, and from fear on the part of individual states of driving individuals and industries from the state by levying taxes higher than those levied by other states. Because of this domination the federal government today is in sound financial condition, whereas state and local governments are not. As a result, in the absence of wartime pressures, federal politics tend to be innovative, policy politics—politics directed toward the resolution of emergent social issues. In contrast, state and local politics tend to be traditional, fiscal politics—politics directed toward the allocation of scarce resources to the traditional functions of state and local governments, such as public welfare, public safety, and primary and second-

ary education (*15*). For this reason, the federal government is in a far better long-term position to support university research than state governments are.

Commitment of the federal government to the objectives of the Employment Act of 1946, particularly to rapid economic growth, also underlies the new stress on the economic process values of university research. Walter Heller has observed (*16*) that "emphasis on high levels of investment—not only in plant and equipment, but in brainpower and research—is here to stay. It is essential to the economic growth and well-being of the nation." On going commitment to the ideology of economic growth entails a set of federal fiscal and budgetary policies designed to stimulate technological development, and the support of university research as one element in that development (*17*).

A second trend, closely related to the first, is the continuing shift in the American economy from a production orientation to an idea-and-service orientation. This trend, which is most evident in such industries as education, health, electronics, publishing and printing, and communications (*18*), is evident in the renewed emphasis upon manpower and upon the educational process values of university research in the 1960's (*19*). This trend is closely related to the systematic application of science to technology, because most service-knowledge-growth industries are scientifically and technologically oriented (*20*). The federal government has strongly influenced the shift in the economy toward a knowledge-and-service orientation, not only through direct allocations to research and development but also through tax and regulatory legislation and policies.

It is increasingly apparent that the nationalization of the economy and the systematic application of science to technology are generating a new complex of values, activities, and organizations that are scientific-economic, or "scienomic," in nature. In the federal government a new complex of values and a new bureaucracy are emerging as a counterpart to the merger of scientific and economic interests in the private and quasi-public sectors (*21*). The primary function of this new bureaucracy is to collect, to organize, and to analyze scientific-economic, or "scienomic," information, and to formulate recommendations for action for the realization of national objectives through scientific, technological, and economic policies and programs. While commitment to the objectives of the welfare state is still important in the United States, it is increasingly apparent that the welfare state is being superceded by a scientific-economic, or "scienomic," state. By this I mean a form of the state in which the organization and the regulation of the fusion of scientific, technological, and economic values and activities is the critical factor in the achievement of public objectives in employment and welfare, economic growth, urban development, environmental control, public health, and other sectors of national life.

A third major trend is the extension of the arena of competition for higher-education funds, from private and state sources to federal agencies and Congress. This trend is in large measure a result of the concentration of economic power in the federal government and the emphasis on advanced education and training as conditions of individual economic survival—an emphasis engendered by the shift in the economy to a knowledge-and-service orientation. This trend also reflects the new affluence of the middle class, expressed in demands for more and better education, and the American reaction to Sputnik.

The extension of the arena of competition for funds is reflected in the shifts in the state and federal contributions to that part of the current income of universities and colleges which is composed of government funds. In the last two decades the federal percentage has increased while the state percentage has remained almost constant. In 1939–40 the federal government contributed 5.5 percent, while state governments contributed 21.3 percent. In 1959–60 the federal contribution was 17.9 percent, while the state contribution was 23.9 percent. By 1963–64, the federal contribution, 22.4 percent, slightly exceeded the state contribution, 22.3 percent (*22*).

Of a total $2.3 billion obligated to universities and colleges by federal agencies in 1965, the year for which the best data are available, R & D funds constituted $1076 million or 47 percent; R & D plant and facilities, $126 million or 6 percent; other academic-science activities related to R & D, $528 million or 23 percent; and other educational activities, $543 million or 24 percent (*23*). These funds were heavily concentrated both geographically and institutionally. This situation has generated the familiar demands of "have-not" institutions and regions for a "fair share" of funds. However unsound and undesirable it may be to use programs labeled "research" for the purpose of building universities and colleges, the past pattern of federal expenditures has generated intensive demands that this be done on a wholesale basis.

A final trend relevant to the recognition of the process values of research in federal programs is the continuing urbanization and metropolitanization of the United States, and the extension of the involvement of the federal government in urban development (*24*). In the period 1940 to 1965, a general deconcentration of population occurred in urban areas, a deconcentration reflected in the relative decline of the populations of central cities in relation to suburban areas. This deconcentration entailed a migration of population across governmental boundaries and a general, although not uniform, magnification of social and economic disparities between the populations of central cities and of the surrounding areas (*25*). This deconcentration coincided with other changes in American life, including an increased migration of minority groups into central cities; the shift in the economy mentioned above; the new affluence of the middle class, as expressed in suburban life and demands for better governmental service; and the continuing despoliation of the environment through the indiscriminate use of technological processes (*26*).

The rise of gross disparities between the public-service needs and the fiscal and human resources of central cities has created massive problems for all governments. The tax resources of central cities in relation to the resources of surrounding areas have steadily diminished as a result of the concentration in central cities of those elements of the population that need governmental services the most but are least able to pay for them: low-income families, minority groups, the elderly, and the unemployed. The problem of diminishing tax bases is seriously compounded by the general obsolescence of central-city capital plants.

In addition, the deconcentration of urban population has created severe problems of communication and coordination among multiplicities of limited governmental jurisdictions in the provision of area-wide services, particularly services with technological

components, such as air-pollution control and transportation.

The basic strategy for circumventing the fiscal and coordination problems of urban areas has been reliance on federal aid in many forms. While no one knows how relevant the product and process values of research may be to the "crisis of the cities," this crisis will have a significant influence on the social and political environment in which university research programs are designed and administered (*27*).

Implications

These general trends have been converted into political demands and into public policies which recognize the process values in two ways. The first is through the interrelationships of science advisory groups, agencies, and congressional appropriations subcommittees (*21*, pp. 227-241). For example, the idea underlying NSF's original Science Development Program was advanced by PSAC in the Seaborg Report, refined by NSF and the Bureau of the Budget in NSF's 1962 budgetary request, and, after some delay, approved by the appropriations subcommittees. In this pattern, which is not unique to research policy, decision-making power resides in interest groups of scientists and the agencies they advise and influence. As often as not, the interest groups of scientists are as influential in the administration of a specific policy as they are in the design of the policy.

Second, the process values are recognized through the relationships between interest groups and authorization and investigation committees. In the 1960's, individuals and interest groups who want a change in the status quo have attempted to change the locus of the power to decide who gets what, from advisory groups and agencies to authorization committees. The general strategy has been to redefine the objectives of federal support of university research, replacing narrow terms used by scientific specialists by general terms, such as *regional development*, which have encouraged formation of coalitions of universities, state and local public officials, and economic interests to whom the advancement of science is only one of several objectives to be realized through university research programs. In the 1960's a loose coalition of "have-not" universities, regions, and associations such as the Association of State Universities and Land-Grant Colleges has taken its case for the support of the process values of research to the Elliott (*28*), Daddario (*29*), Reuss (*30*), Harris (*31*), Nelson (*32*), and Clark (*33*) committees, which have served as public forums for the review of decisions of the agencies, the Bureau of the Budget, and the appropriations subcommittees (*34*).

These two patterns have significant administrative as well as policy implications. The advisory-group, agency, appropriations-subcommittee pattern is particularly appropriate for the design and administration of project grants in which the judgment of advisors and administrators is crucial in determining who gets what on a merit basis. In this pattern the political process shifts from Congress to the agencies, and competition for influence and money occurs in an administrative context. In contrast, the interest-group, investigation-and-authorization-committee pattern is more appropriate for the design and administration of institutional programs and grants based in part on formulas and other legislatively determined apportionment criteria. In this pattern, political conflict is centered primarily in Congress, and tends to be more visible than in the advisory-group, agency, appropriations-subcommittee pattern.

In what I have termed the "scienomic state," individuals and groups of scientists, economists, and others skilled in the manipulation of information have a natural access to the centers of policy-making and administrative power of the federal government. The tension between the product and the process values is in part a tension between different patterns of formulating and administering policy. The access that information specialists have to the centers of power raises the question of how the analyses and recommendations of these specialists can best be subjected to public review and debate to determine where "the public interest" lies, and how other interest groups, also, can obtain access to the centers of power. The problem is an old one in American democracy, but in the context of the fusion of scientific and economic interests in the past two decades it has acquired a new setting. As significant as these questions are, their further analysis is beyond the scope of this article.

Can the interests of those who support the product values and of those who support the process values of university research be reconciled in one comprehensive policy for federal support of university research? The budgetary pressures of Vietnam make an immediate reconciliation unlikely. However, a long-term reconciliation is possible. In his testimony before the Harris subcommittee on 25 July 1966, Leland J. Haworth, director of the National Science Foundation, argued that there is a clear need for development of the research capabilities of universities and colleges on a state and regional basis—for scientific, economic, cultural, and educational reasons. However, he continued as follows (*35*):

> To be most effective, development on a state and regional basis must, in my opinion, involve local planning on a scale broader than that of individual institutions. . . . Planning of this sort should be on a multi-state or regional basis with careful attention to the specific needs of the region in terms of its geography, its resources, its present and potential industries, and so forth. . . . By so doing, it should be possible to minimize the effect of too wide dispersion of talents and resources and to concentrate effort in such a way that the "critical size" essential to high quality and effective results can be achieved.

Haworth in effect proposed the development of a funding system to take into account the process values of research, a system that would supplement the present product-oriented system. In this new system colleges and universities in geographic regions would, through cooperative associations, evaluate their own capabilities and recommend ways in which federal agencies, state and local governments, and the private sector could contribute to the development of institutions on a regional basis. The system would be based on the realization that limitations on manpower, money, and other resources make it impossible for every institution in a specific region to emulate the balanced strength of major institutions. The basic premise of the proposed system is that all institutions, including liberal arts colleges, have the potential to develop strength of a kind, and in subject areas, appropriate to their purposes. A division of labor in regional research and education is necessary. The proposed regional development system would recognize this fact. At the same time, agencies would continue to fund product-oriented research on the basis of merit through the existing system.

The idea of a regional development

system is contrary to past policies, practices, and politics of both (i) universities and colleges and (ii) federal agencies. There has been little coordination of agency funding activities, although the Committee on Academic Science and Engineering is now at work on this problem, and even less cooperative effort by universities and colleges to help themselves through cooperative action. Both the agencies and the institutions need some incentives for cooperating in the development of a regional funding system. As an initial step, Congress should enact legislation authorizing and directing the Office of Science and Technology and the Office of Education jointly to undertake feasibility studies to determine whether a system of planning for regional development through research and related programs is possible.

Summary

The process values of university research are important in the context of several significant social and economic trends in American life. These values are being taken into account in the design and administration of federal programs. Federal programs to support these values should be distinguished from programs to support the product values of research. Failure to distinguish between these two types of programs will lead to a further dilution of quality in programs designed to advance science as a legitimate end in itself. The scientific community can best protect its own interests by helping federal agencies and universities and colleges develop a funding system to support the process values of university research on a cooperative, regional basis.

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