University Basic Research

by Lee A. DuBridge

Granted that the fundamental arguments for pure research can be set forth in impressive array—how much monetary investment is justified each year, and how can it best be distributed?

The nation’s program of basic research in science is at a critical juncture. Its future progress is by no means assured, and much will depend on the outcome of the debates now in progress. These debates are going on not only in scientific circles but also in the public press, in the halls of Congress, and in the offices and conference rooms of many government agencies. Pressures for reducing or leveling off research budgets are evident.

In this debate the advice and the views of many scientists will no doubt be heard. But the critical decisions will not be made by scientists, for important matters of public policy are involved.

Yet the scientific community must be involved in this debate. Scientists must look again at the goals, the potentialities, and the values of science and set them forth clearly and persuasively. These views must, in fact, be formulated so convincingly that non-scientists in high places will be able and willing to speak out for scientific advance as a vital national effort. It is often asserted that scientists are so prejudiced by their personal interests that they are no longer always to be believed. Nevertheless, the case for basic research in modern society—if there is one—must emerge from careful considerations set forth by scientists themselves, for no one else is likely to undertake the task.

It has, indeed, been well begun. It was begun over 20 years ago when the case for the federal support of science was first cogently set forth in the famous Bush report, Science—the Endless Frontier. The discussion has continued across the country, in Congress, and in the White House ever since. The recent definitive reports from the Committee on Science and Public Policy of the National Academy of Sciences have added much to the public record.

But obviously the task is not completed. Possibly it is scarcely begun. Here it may be well to start by trying to clear up a few misunderstandings.

First we must ask whether the case for or against basic research has changed in recent years or whether it merely needs to be stated in different terms. In fact, the basic case is unchanged. The arguments can be grouped under four headings.

1) Research—that is, inquiry into the nature of the physical and biological world—is a prime human urge. The advance of knowledge has in itself been an elevating, inspiring aspect of human history.

2) Basic research has uncovered knowledge which has made possible practical applications which have enormously affected human civilization.

3) This planet, on which 3 billion (soon to be 6 billion) human beings live, cannot become more habitable and a better place to be unless new knowledge is found to make possible new technologies and new ways of living. (The words food and population control illustrate what I mean.)

4) Scholarly inquiry is an indispensable role of institutions of higher education and has a unique function in educating the minds of the future.

Basic scientific research thus has cultural or human values which result from enlightenment of the mind, and it also makes possible the advance of
technology. It has become a necessity for the future.

The case for these values of science can be, and
has been, documented time and time again. If people
are tired of hearing of the great results of the
researches of Galileo, Newton, Faraday, Maxwell,
Einstein, and the rest, there are many other exam-
pies that can be set forth. I suggest that we set them
forth, repeatedly and convincing. This is the case
that must be documented. Man is better off today
than he was 300 years ago, and science has done
much to this end by combating superstition and
prejudice, by allaying hunger and disease, by lay-
ing the base for technological advance. If the
world’s troubles still seem tragic and complex, this
is so not because we have too much knowledge but
because we have not learned how to use all our
knowledge effectively.

And here the scientist must face and answer a
new set of questions. If our great investment in pure
and applied science has failed to cure all the world’s
ills—if, indeed, they are getting worse—should we
not, in investing our money, focus more precisely
on the problems of war, of overpopulation, of ur-
ban living, or of achieving a stable economy and a
better way of life for all people?

The answer of course is yes, by all means! Science
never pretended to be a solution for all human prob-
lems. Science is a search for truth about the physical
world. The truth so far attained has led to solutions
of some problems. These solutions have come as
welcome by-products of scientific knowledge—so
welcome that we now spend eight times as much
money on exploiting the applications of scientific
knowledge as on seeking new knowledge.

This is fine. Applied science is important too. It
is also inherently more expensive than pure science
and more profitable in terms of immediate results.

But the world’s problems go far beyond the prob-
lems of science and technology. They include prob-
lems of human understanding; of fulfilling human
hopes and human desires; of understanding the so-
cial, economic, and political institutions which men
have created: of using the knowledge we have more
intelligently.

Every sensible scientist will see the need for ur-
grily seeking to understand and solve these prob-
lems, too. The university is the seat of the scholarly
inquiry and the source of the trained minds needed
for understanding and solving them. The universi-
ties need more resources for developing these hu-
manistic and social studies.

We as scientists may not have very effective ideas
on ways to proceed to solve these social problems,
yet we cannot withdraw from the field. We are hu-
man beings. We will suffer or prosper as other hu-
man beings do. Furthermore, many and possibly
most of these problems have scientific and techno-
logical aspects. We can associate with our friends
in the social and behavioral sciences and seek to
help in areas where our help can be useful.

But society will not be well served if pure science
is abandoned in this process or even substantially
impeded in its growth. The values of science remain.
All efforts and investments which the nation makes
in tackling these other problems will pay off in their
own right—just as our past efforts in science have
paid off handsomely, even in purely economic terms.

Granted that the fundamental arguments for pure
research can be set forth in impressive array, the
question remains: How does one set forth to govern-
ment representatives and the public just how much
monetary investment is justified each year, and how
it can best be distributed among subject matter
fields, among projects, or among the 50 states.

Here the complexities of the problem begin to
appear. And herein lie the challenges for initiating
a fruitful discourse between the worlds of science
and education and their various subworlds, the
world of government officials and the world of in-
fluential taxpayers. No one of these worlds, of
course, is a unified one; each contains individuals
and groups with widely differing attitudes, beliefs,
experiences, responsibilities, and concerns. We can-
not expect to find unanimity within any of these
worlds, much less full agreement between them.
Yet, by some form of consensus and compromise, an
agreement—or a decision—on national policy must
be consummated.

A few points should be stressed.
1) The present annual investment in basic scien-
tific research in universities (about $1 billion) is
sometimes said to be “extravagant.” But if we ob-
serve the results and observe the nation’s scientific
potential, we must conclude that this sum is a sound
investment in the future. It is indeed an inadequate
investment in terms of the opportunities which lie
ahead and of the needs of the government agencies
which support it. Every field of science sees oppor-
tunities unrealized.

2) We have purposely, during the past 20 years,
expanded the scientific community by training
many young scientists at great expense. Do we not
intend to put their talents to good use? Clearly,
support of science must not stay at current levels;
it must increase in order that we may capitalize on
the trained talents of these young investigators,
meet rapidly rising research costs, and exploit cur-
rently neglected fields.

3) We must clarify the role of basic science as
compared to applied science, to engineering, and

Engineering and Science
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to putting to beneficial use our new scientific knowledge. These are overlapping areas of endeavor with fuzzy boundaries. Yet each has its special and distinct place in our national effort; each depends upon the others. It is folly to neglect any one.

4) Most of the current federal expenditures for university-based research and education in science do not come from a direct effort to support such enterprises but accrue indirectly from government expenditures aimed at other national goals.

On this last point, for example, it is a matter of national policy—and of national necessity—that we improve our military technology. The Department of Defense spends large sums for this purpose. In the process it has found it necessary and desirable to encourage a comparatively modest amount of basic research in areas of science which seem to have immediate or long-range relevance to defense technology. When the Department of Defense finds, in a university, competent scientists who wish to undertake such research, is it not prudent to use their talents? Is it proper to regard such contracts as “handouts” or “benefactions” to the universities? Are the universities not simply performing a necessary public service?

The nation also has an established policy of advancing the technology of atomic energy for both military and peaceful purposes, of conducting a large program of space exploration, of seeking to improve the public health and to advance the conquest of disease. These and other missions in the national interest are assigned to appropriate government agencies for implementation. Each such agency turns, to a greater or lesser degree, to universities for relevant basic investigations. The scientists and the universities concerned welcome these research tasks whenever they fall within their realms of interest, enthusiasms, or competence. A scientist and his institution are fortunate when it is found that the kind of research they wish to do also serves a national purpose, in that some mission-oriented government agency deems it relevant to its mission. These agencies are not authorized to give handouts to universities; they are not philanthropic institutions. They are properly charged with investing taxpayers’ money in those research activities which promise to yield the greatest return. They have set up mechanisms for selecting with great care and great expertise just which of the many proposed projects they will finance. These tasks of selection have been performed with conspicuous success and integrity. It is not the fault of the agencies concerned if scientific competence has been found to be more plentiful in some parts of the country than in others.

Some 85 percent of the basic research funds allocated to universities has been placed by mission-oriented agencies in support of their own missions. In a sense it is only accidental if university science has been thereby strengthened.

Only 15 percent of the dollars for university research comes from the one agency which is authorized to support general basic research not visibly relevant to specific government requirements or goals. The National Science Foundation grants for research total only about $175 million a year. These grants go to hundreds of colleges and universities, large and small, throughout the nation, supporting important fields of science. The NSF has the most extensive array of expert committees and consultants of any agency, plus a large professional staff, to insure fruitful expenditure of funds. It seeks to be the balance wheel for the national science program. It has had enough funds for this.

Now what is wrong with this whole picture? Basically, nothing! Yes, there have been administrative headaches on all sides. No system operates perfectly. Some abuses have crept in here and there. Not all experts agree on the areas of importance or on the relative merit and promise of various project proposals. It is not easy for a mission-oriented agency to judge which research areas are really “relevant” to its mission. Every scientific discipline contains many members (often a large majority) who feel that their subject is inadequately supported. And they can usually prove it by pointing to opportunities unrealized, to promising young scientists inadequately supported.

But is a major overhaul of the system either necessary or desirable? I know of no widely accepted proposals for such an overhaul. Most of the arguments and misunderstandings about the total effectiveness of the system are based on conflicting opinions as to the relative importance of the various objectives of the mission-oriented agencies. It is said by some that we are spending too much on space and not enough on cancer—or vice versa; too much on military development and not enough on weather modification or oceanography or atomic energy.

Now these national policy objectives are deter...
mined by the legislative and executive branches of
the government on the basis of considerations hav-
ing little to do with the progress of basic science. 
Military strength, the practical exploitation of
atomic energy, the conquest of disease, the proper
use of national resources are all judged by the
government to have inherent value or to be neces-
sary in their own right, and it is only proper that
all relevant resources for implementing these ob-
jectives, including the resources of university sci-
ence, be employed. That many university science
and engineering activities in teaching and research
have benefited from the services they have rendered
to the mission-oriented agencies is undeniable—and
very fortunate! It is also fortunate that a fairly
broad-based program of research support has
emerged, thanks to extensive cooperation among
the agencies involved. Understandably, however,
there are serious gaps.

The confusion about the relation of basic science
to national-policy objectives is probably most evi-
dent in the space program. Is the purpose of that
program to extend scientific knowledge or to en-
hance national prestige or to achieve other objec-
tives? Obviously the space program has many aims
and objectives, and there is wide disagreement as
to which ones take priority. Those who feel (wrong-
ly) that the principal aim of Congress in supporting
NASA is the advance of basic science contend
(rightly) that $5 billion a year could be more fruit-
fully expended in other ways. Those who believe
that the principal objectives of the space program
are to enhance national prestige or to satisfy a hu-
mankind urge for exploration, or to assure future mili-
tary or economic dividends, argue that some or all
of these objectives are being achieved and that the
total result is worth $5 billion a year. Clearly the
question is not a scientific one; it is one of public
policy. And those in the Congress and the executive
branch responsible for establishing public policy
have decided that the expenditure is justified. Those
who disagree are entitled to say so—and they do.

Scientists who insist that this $5 billion could be
more profitably expended for other scientific enter-
prises may be right, but they miss the point. The
$5 billion is not being spent primarily to advance
science any more than the $50 billion expended by
the Defense Department is. Yet in both cases a
moderate fraction of the budget is necessarily used
to advance science. In the space program the result-
ing technologies are providing a valuable tool for
carrying on scientific investigations which would
otherwise be impossible. Many scientists are wel-
coming the opportunity to ride piggyback on this
great venture and thereby to greatly advance ter-
restrial, space, and planetary science.

However, it must again be stressed that neither
NASA nor any other agency charged with imple-
menting national policy is intended to be a philan-
thropic agency authorized to provide benefactions
to university science departments. They are agen-
cies seeking to get a job done, and they turn to uni-
versities only when the universities can render a
service—a service usually rendered at less than cost.
If the government wishes, as I believe it should,
to develop a more adequate and more balanced
program for strengthening American science per se,
than it should charge suitable agencies, principally
the National Science Foundation, with this par-
ticular task and provide funds for carrying it out.

As I have said, there is nothing basically wrong
with the system. But there are serious dangers
ahead in its current operations. The degree to which
mission-oriented agencies of government will invest
their precious funds in the rather long-range bene-
fits to be expected from basic science will vary. Al-
ready there are pressures for concentrating on more
immediate results. Project Hindsight will be used
by some as an argument to this end, showing, as it
does, that the results of undirected research appear
in the form of new weapons only many years later.
Mission-oriented agencies are, understandably, in
a hurry. Can we afford to let the basic knowledge
so necessary for future progress depend on the
winds of political and economic pressures which
blow hot or cold today?

A ready solution is at hand. The National Science
Foundation can be depended on to look to the long-
range future. It can be depended upon to recognize
the cultural as well as the practical values of basic
science. It can serve as the balance wheel to pro-
mote the broad advance of science—if its research
budget is substantially increased.

The budget levels for NSF are determined by the
Bureau of the Budget and by the House and Senate
appropriation committees, agencies to which scien-
tists at large and the general public have almost no
access. The burden of presenting the needs of sci-
ence thus falls almost solely on the members of the
Board and the staff of NSF, aided only by the be-
 hind-the-scenes work of the President's Advisory
Committee.

Here is a serious flaw in an otherwise viable sys-
tem. Herein lies the need for a widespread public
discussion of the issues—so that all congressmen and
senators become aware of the real values and needs
of basic science and of the critical role which can
and should be played by NSF. Presumably, only
wide public support will have the required influence
on the appropriate committees and offices.