than $p = .005$, as determined by the Wilcoxon matched-pairs signed-ranks test. In addition, a Friedman two-way analysis of variance showed the conditions to be the significant variable ($p = .005$).

24. S. J. Freedman and S. Secunda, paper presented at Eastern Psychological Association meeting, Atlantic City, 1962; *U.S. Air Force Office of Scientific Research Tech. Rept. AFOSR-2078* (1962).
25. J. Zacks and S. Freedman, paper presented at Eastern Psychological Association meeting, New York, 1963.

26. The program of research in visual-motor coordination on which this article is based was supported by the National Institute of Mental Health (grant M-3657) and the National Science Foundation. The work owes much to the assistance of Harry Cohen, Malcolm Cohen, Jack Glick, and especially Aglaia Efstathiou. The research in audition has been supported by grants from the U.S. Air Force Office of Scientific Research to Dr. Freedman (currently, by grant AF-AFOSR 53-63). The research in visual-motor coordination is being continued at Massachusetts Institute of Technology under the support of the National Institute of Mental Health (grant M-7642), the U.S. Air Force Office of Scientific Research (grant AF-AFOSR 354-63), the National Aeronautics and Space Administration (grant NSG-496), and the Rockefeller Foundation.

National Goals and the University

We face a dilemma that calls for a careful rethinking of national policy and university functions.

J. C. Warner

I want to take this opportunity to express some concerns about colleges and universities, about the people who administer them, and about the people who teach and do scholarly work in them.

These concerns have their origin in the fact that our universities and the people in them are being used, in this period since World War II, as instruments of national policy at home and abroad. National policy requires that we solve the necessary problems to attain two major goals: (i) to maintain or improve our position in the scientific, technological, economic, ideological race with the Soviet Union; (ii) to maintain our democratic institutions and a sound economy at home.

The first of these goals appears to mean a number of things: (i) providing and maintaining a military capability which is adequate to insure our defense and security and is never permitted to become obsolete; (ii) providing financial and technical aid for improving agriculture, industry, and education in uncommitted but underdeveloped countries; and (iii) maintaining a position of national prestige in such things as space exploration, space travel, high-energy physics, and the peaceful uses of fission and thermonuclear energy.

The second goal means a number of things: (i) preventing a rapid rate of inflation; (ii) maintaining such a rate of economic growth as will further improve our standard of living and will provide full employment; and (iii) providing the educational opportunities desired by our expanding population and necessary to the attainment of our other national goals.

I presume Americans are almost unanimous in support of the national goals I have mentioned. They are less than unanimous about the things which are essential to attain these goals, and they are far from unanimous, oftentimes acrimonious, when it comes to setting priorities or making choices among activities and enterprises which compete for dollars and for our most competent manpower.

In all of this the universities have found themselves "in the middle" because the various urgent demands made upon them and their people are often mutually inconsistent and often are of such nature that they force the university community to depart from its proper role in society, the role in which it is best qualified to serve society.

At the same time that the colleges and universities are being required to provide higher education for twice as many young men and women, to produce twice as many scholars and professional people educated to high levels of competence in their graduate and professional schools, and to undertake very substantial research programs for government departments and agencies, the government is calling upon the universities to give full-time leave to a very large number of their best people so that they may serve in government posts at home or in the multitude of foreign-aid projects which we support in the underdeveloped countries. And the government is calling upon the universities to give a host of others part-time leave to serve on advisory committees and panels too numerous to mention. This has thrown the colleges and universities into such strenuous competition for talent that any university determined to maintain the quality of its programs finds its educational costs rising a good bit faster than the price level, even when size is maintained constant. That the colleges and universities are faced with a financial problem of great magnitude is obvious. Higher education now costs us about $4.5 billion annually. By 1972 we are supposed to double our enrollments. Thus, costs may be expected to rise to about $9 billion because of size alone. If one includes even a conservative factor for inflation and the highly competitive market for faculty, the bill most certainly will be $11 or $12 billion by the 1970's.

The more fundamental problem (and I worry about it more than the money problem), both for the universities and the nation, is the competition that has been engendered for the very highly trained and creative individuals who comprise the faculties of our universities. How this precious talent is used will probably be the most important single determinant of whether or not we shall achieve our national objectives in the long run. It is a question too important to be decided on the basis of short-term propaganda victories; it is a question to which the

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universities, the government, and the general public must give careful and sober thought, lest in our haste to win a skirmish we lose the battle.

Historically, the principal functions of the university have been, first, to educate able young people to high levels of competence so that they may be better able to fill the economic, social, and cultural needs of our society and so that the most talented of them will become the next generation's scholars and professional men and women, and second, to serve as centers of learning where new knowledge and new ideas result from research and other scholarly-creative activities. The universities have been centers of basic research, or what some might call pure research, primarily because they can be concerned with knowledge and ideas without considering the uses to which these might be put. Although much good basic scientific research comes out of both industrial and government laboratories, the former are properly concerned primarily with research aimed at the development of new products and processes, and the latter, with research on problems of immediate national interest. Yet, developmental research that results in economic growth and in the advancement of national security must be rooted in the fundamental discoveries of basic research.

On the other hand, the universities cannot be unconcerned about the national interests. Freedom of thought, of inquiry, and of expression is at the very center of what the scholar and teacher does, and the preservation of freedom cannot be more important to anyone than to him. This brings us, I think, to the dilemma that must be solved if we are both to achieve our national objectives and to maintain the integrity and central purposes of our universities.

If, on the one hand, we divert large segments of the creative talents of our universities to a multitude of huge projects designed to create and maintain a national image of our ability to best the Soviet Union in every scientific endeavor we may wish to undertake, then we must certainly steal from our future to pay for the present. Those who are engaged in these enterprises must be taken from an already short supply of talent available to develop our next generation of scientists, engineers, and scholars in all essential fields, and from the kinds of research which will produce the basic principles and ideas on which the products and processes essential to our future economic growth are dependent. We almost certainly face a future that will demand fewer unskilled people and ever greater numbers of more highly trained people.

There are some who maintain that the scientific knowledge gleaned from our massive efforts in space will yield products and processes that will foster our future economic growth. The evidence to support this theory, however, is extremely meager, and when one measures the economic value derived from such efforts against the expenditures they entail, the results are pitifully small.

The choice we face is not whether we shall explore space or not, but how we shall do it and how rapidly we shall do it. Space is clearly a legitimate arena for scientific inquiry, and every effort should be made to support those who are deeply interested in unlocking its secrets. The difficulty is that we are now involved in space exploration not for the scientific or military values to be derived but for an aggrandizement of national prestige that is somewhat naive and that requires such a concentration of our resources, in both men and money, that it could seriously jeopardize the nation's future. We should not seriously expect that every important scientific discovery should be made by an American, or that every complicated feat of engineering should be achieved first by the United States. We cannot rationally believe that every creative accomplishment by an Englishman, a Frenchman, or a Russian is a vital blow to our national prestige. Americans have never insisted that all great paintings, all great music, all great literature be the creations of their countrymen. We have always taken pleasure in Italian opera, in French painting, and in German symphonies, without castigating our government, our schools, and our universities for having let others share in acts of creative genius. The United States does not have a monopoly on creativity in science and engineering any more than it does in art, music, and literature. To pursue a national policy that attempts to create the impression that it does, and to pour our national wealth and national talent recklessly into the preservation of such a myth, is both silly and dangerous.

There is, however, another side to the question. There are fundamental national interests to be served that are quite apart from the peculiar notion of national prestige that I have discussed. The nation's security, as well as that of the free world, is based in large part on a very sophisticated arsenal of weapons and defensive devices. The continuous effort to maintain a military capability that will deter any aggressor demands a formidable array of scientists and engineers. Others are needed to assist underdeveloped nations reach a standard of living and a self-sufficiency that assure their freedom and their self-respect. Universities cannot turn their backs on these problems, even though participation in them may be a new and strange experience for them. The problem is a real one. It must be faced and solved; it must not be ignored.

The dilemma, then, is clear. If we accept the premise that our national interests demand that we maintain a military capability which reasonably insures our security, that we preserve our democratic institutions, and that we enhance our economic development, and if we accept the further premise that our universities must maintain the capability and integrity that provide us with the trained talent to meet our needs and the fundamental research upon which future economic growth can be built, it is obvious that we do not have the amount of creative talent for the simultaneous, unrestricted pursuit of all possible objectives. I have tried to show that to recklessly hurl money and manpower into projects which, although they require a tremendous amount of scientific talent, are pursued primarily to support an untenable concept of national prestige will seriously endanger our future. I have also tried to point out that to insist that the nation's creative talent can be used only in the traditional activities of the universities may well jeopardize our national security and the attainment of legitimate national goals. A rational solution to this difficulty requires a careful rethinking of both national policy and university functions. As a start in this direction I suggest:

1) That the national government re-evaluate its present policies in terms of their future consequences;

2) That we as a nation discard the concept of national prestige which insists that we best the Soviets in everything they undertake;

3) That each of those massive undertakings, such as space exploration, the control of thermonuclear energy, and high-energy physics, that requires heavy concentrations of scientific and technical manpower and huge expenditures of the nation's wealth be considered by the government within the total context of possible scientific inquiry and possible economic growth;

4) That the government establish priorities and schedules for those undertakings which require highly trained and creative people who are also needed by the universities and by industry, and that it implement those priorities in a manner that does not drain off an excessive portion of the nation's creative talent and highly trained manpower; and

5) That the total national subsidy for research be broadened to create a more reasonable balance among all areas of inquiry, to foster greater economic growth.

At the same time, the universities have some hard thinking to do. While preserving the integrity of their scholars,

1) They must seriously experiment on methods of training more students to high levels of competence, with fewer teachers. That is, they must find ways to increase the productivity of their teachers without debasing the quality of their product.

2) They must make a greater effort to match up the research interests of their scholars with the research needs of the nation, so that more of our scholars, while pursuing their legitimate research interests, can make a greater contribution to the achievement of national objectives.

3) Finally, they must invent new administrative arrangements which will bring all projects involving both basic and developmental research within the framework of the university or a group of universities. In this way national research efforts can benefit from university experience in research management, and from the consultative services of highly competent research people. At the same time, the universities can benefit from those basic research problems that are consistent with the research interests of their faculties and from the part-time services of those involved in the developmental aspects of the project.

What I have described is not an abstract problem. It is a real and serious one that grows more serious every day and could have extremely grave consequences for our country. Yet it is not insoluble. What is required most of all is a maturity in the American people themselves which permits them to take a calm, long-range view of isolated events rather than to react violently and angrily every time the Communists perform a feat before we do. I am not suggesting complacency, but rather a willingness to understand and accept long-range national goals and to realize that, if we possess a strong military deterrent to aggression, ultimate victory will come to the nations with the institutions and economic strength that provide their people with personal freedom and a good and full life. Within such a climate it would be much easier for the government to assess its activities in terms of legitimate national aspirations than of national hysteria. We must grow up quickly, however, for I sincerely fear that if we continue to pursue our present policy for long we shall reap the whirlwind. I believe that we can grow up, and I know that we must do the hard thinking necessary to serve best the goals of our universities and the goals of our nation.

The Coming Changes in American Science

Science today is experiencing strains which are altering its basic character.

Norman W. Storer

Prediction does not necessarily provide for control, but it can be of vital importance in enabling us to compensate for unavoidable events. The forces now impinging upon American science are producing fundamental changes in the scientific community which, whether we approve of them or not, must be known before we can act intelligently in achieving the best possible adjustment to them.

Alvin M. Weinberg's well-known article "Impact of large-scale science on the United States" (*1*) is a perceptive discussion of some of these changes. It appears to stop short, however, of facing the full consequences of science's new position in society. In discussing the possibility that Big Science will "ruin" science, for instance, Weinberg suggests that by "nurturing small-scale excellence as carefully as we lavish gifts on large-scale spectaculars," we may "prevent the contagion from spreading." Needed now is a better picture of what is happening to all of science and how it is happening. To do something about such symptoms as "journalitis, moneyitis, and administratitis," we must understand the deeper changes that are resulting from science's enhanced ability to command support from society and to exert appreciable influence upon policy decisions at the highest levels.

I would like to argue that Weinberg has examined the top of the iceberg very well but has not seen clearly the greater part which is submerged. This greater part is hidden both in the slowness of time, which disguises important trends, and in the implicit assumption that quantitative change is unrelated to qualitative change. His discussion centers upon the consequences of the in-

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