(Biographical material attached)

Introduction

It is healthy and appropriate that the basic philosophy of U.S. space efforts and the investment in the Apollo program should be critically discussed at the present time. It would have been even more appropriate for this debate to have been held two years ago, when the country firmly embarked on this path -- nothing could be more ruinous and demoralizing than indecision and re-reversals of our basic policies.

Negative Criticisms of Apollo Non-Efforts Elsewhere

Most criticisms of the space program are negative ones. They decry what we are not doing in other fields. I support the space efforts, but I agree even more deeply with the criticisms of our non-efforts and will say more about them later. I do not believe our non-accomplishments along other lines should be an excuse to tear down a positive effort. The choices must be made between two or more actual constructive programs; let us work towards a confrontation of them. We may find some way of meeting all these needs; very often we will find that a technical effort in one sphere has a very substantial application to another one if we organize it properly. This is undoubtedly true of the space effort.

The sums involved in Apollo are large ones, but we should not exaggerate what could be saved by moderating this effort. In fact, we face the very serious danger that through misunderstanding, seeming luxurius might be trimmed from the NASA program. The basic booster program could not be safely impaired without a basic reversal in our whole space- and defense-related technological posture. No convincing

picture of direct military needs for the lunar and planetary explorations have been exhibited. But it is impossible to believe that we could neglect the continued development of boosters,which are the central effort of the Apollo program, of the deep space explorations of the next decade, and which give us assurance that we will not find ourselves at the wrong end of a sudden technological discrepancy in national security. What will then be cut? Laboratories and research facilities and the long-range development programs will give way to the priorities of current commitments. The net effect of "scientific criticism" of the NASA program would then be to erode its actual scientific vitality and to choke off its invaluable development of basic research resources.

It is often a matter of political or economic exigency to pare budgets to the bone. I hope the Congress will follow through on its scrutiny of levels of expenditure to exercise its responsibilities with full information and understanding of the consequences.

Man in Space

In joining a number of colleagues in a public statement supporting the space program, I was prepared to respond to the surprise of many of my friends who know that I have been vocally critical of over-emphasis on Man in Space. On strictly scientific grounds I would give higher priority to other parts of the space program. However, contrary to my first expectations, NASA is developing a balanced program in which Man in Space plays a central, but not preclusive role. The scientists and top leadership of NASA have understood the vital necessity of a broad advance in space science and technology as fundamental knowledge, as a source of many socially constructive applications, and as the essential basis of safe human exploration of space. If they have put less absolute stress on pure science, than might

be demanded — e.g., in the relative role of planetary exploration as compared to the Apollo program — one knows that they must synthesize a wide range of competing interests and respond to the popular temper too, which does not always give as much attention to scientific achievements as to the contributions of athletes and entertainers. And in the long run the same apparatus that generates a broad base of popular enthusiasm for space exploration would also accomplish our scientific work on a scale the latter along might never have the appeal to get done.

Finally, it would be foolhardy to be too dogmatic about the dispensability of human operators. It has been speculated that a comparable effort in instrumentation could match human judgment, taking into account the heavy burdens of cost that carrying man into space entails (the life support system, the need for extreme liability, the need to bring the mission back to earth). This is almost certainly true of short missions in which the astronaut plays an almost passive role, mainly to demonstrate the possibility of shielding him from the hazards of a space with which he cannot come to too close grips. When it comes to lunar exploration I would not lightly disregard the power of aheavily instrumented manned experimental station. Once the high "overhead costs" of man's flight are absorbed, man can certainly add special ingredients of versatility and inventiveness. One of the responsibilities of a balanced program must be to develop computer instrumentation that will magnify the power of human control and take his place for investigation and measurement where it can do the job more effectively or more cheaply. It would be as rash to exclude the development of the capability of man's participation in space flight as to rely entirely on primitive cunning and adventure to the exclusion of instruments in planning the exploration.

One criticism must be voiced about the representation of man in space. The scientist realizes that man knows his environment through his senses -- his eyes and ears are instruments of perception, his hands of manipulation. Man cannot survive in free space; he must shield himself from the most hostile forces of the cosmos. Beyond such a barrier any contact he can have must be indirect. Artificial instruments are another link between the real world and his perception; under certain circumstances they can afford a more realistic picture than his unaided delusion-liable senses. Knowing all this, the scientist realizes that he is man in space when he flys Tiros to image the earth's cloud cover, and when he can give remote commands to repair Telstar, even though he sits at an electronic console on earth. Correctively, we can have a more realistic image of the earth from space than even the astronaut looking out his porthole, whatever the subjective intensity of his private perceptions. It has never been an issue whether man should be in space; the issue is to what lengths to use his intelligence to study and to assimilate the environment he senses. A balanced program will give appropriate weight to all these modes of the projection of the human endeavor.

Scientific Values and Space Flight

This should be the core of my remarks, but they have been studiously and critically reviewed by the National Academy of Sciences Summer Study on Space Science. This has perhaps not been disseminated widely enough, and I would urge that it be incorporated into the record as a supplement to these hearings. To be able to dig into just one of myriad questions, whether life in the universe is unique to the earth, would by itself justify the cost of the space program. This is a large gamble, but it is also counterbalanced by the certainty of many unforeseeable sciences that will stem from the exploration.

Technological Spillover

There are of course many technologies we could invest in whose by-product benefits would amply repay the investment, some perhaps by even larger factors than space work. These suppositions should be bolstered by concrete alternative plans. Meanwhile, the breadth of challenges that space exploration must surmount is provoking the realization of many new technologies. The fruits of these may take a few years to ripen, and this will take positive encouragement from Congress and the Administration that this is among NASA's important missions.

In fields like medical instrumentation, which is notoriously backward in the practical use of present day technology by comparison to, say, communications, NASA is coming to play a special role. Our national resources in basic science are nurtured mainly in close harmony with the universities through grant administering agencies like NSF and NIH. The confusion of grants with contracts can have disastrous consequences. These agencies have not been attuned to deal with free enterprise industrial technology, which does and should require a different approach through the contract relationship. The defense agencies are fully preoccupied with hardware production and weapons developments. Being in touch with the same industrial resources, NASA can function as a catalyst for the most rapid reduction to peaceful use of the entire federal investment in technological advance far beyond that agency's expenditures. Its needs for successful space flight already cover the whole gamut of technological applications. NASA's mandate in this area should be reinforced as a potent amplifier of the public interest.

Perhaps the main shortcoming of NASA's program is already reflected in the critical voices of some scientists: inadequate communication between the scientific community and the top level of NASA administration. The

President has recognized the need to tap the intellectual resources of the academic community through his Scientific Advisory Committee. AEC and the services have their civilian advisory boards, as does NSF and NIH through the National Science Board and the Health Councils. These committees sometimes make unwelcome noises, but they have helped to maintain some level of contact with science and technology in the universities and industry at important policy levels. Especially if NASA is to fulfill its function of civilizing our military technology, this window is needed right in the Administrator's office.

Our Non-Efforts

The costs of the space program have focused attention on our non-efforts in other areas of intellectual life. The most significant non-effort is our failure to study them on a long range basis: the institutions should be doing this, such as Congress, the Executive, the universities, are so harrassed by day to day problems that what they do generate in long range thinking exceeds any reasonable expectations.

The state of our universities should be of special concern. They should be the seat of independent long range thinking where our youth can learn to face the subtle challenges of tomorrow. They have had a revival of sources of scientific expertise, largely through generous support from state and federal government. But the mechanismsthrough which this support has been administered have sapped their independence. There is no major university in the United States whose policies and resources are under the actual control of its own faculty. The impoverishment of the universities has stifled their growth, even worse their independence and leadership. What university president has time for intellectual leadership when he is absolutely preoccupied with seeking "charitable" contributions to maintain

the physical plant and maintain academic salaries at some fractional par of industry? In practice the wisdom, foresight, even forbearance, of many boards of trustees and of governing administrators has concealed and mitigated this dependence. Quite recently, however, government agencies have been impelled to exact standards of compliance in government-university relationships which the universities are hopeless to resist, and which plainly subordinate the university's responsibilities to those of Washington offices. Plainly, we have not evolved a satisfactory mechanism whereby the constitutional responsibility of the legislature and executive for public resources can support without stereotyping learning and research.

Many aspects of scientific development are frightening in their malevolent power. If we had the choice we might well ponder whether man is well served by the rapid growth of this power. We do not have the choice in the real world. America's failure to maintain technological leadership would not only deny our people the benefits of medical and industrial advance, but would subject us to the decay of economic failure. Perhaps most immoral of all, it might tempt aggressive competitors to take foolhardy gambles that would imperil the world. We have no choice but to take the responsibilities of technological maturity.

These responsibilities are still not sufficiently appreciated. The growth of biology and medicine is bringing us moral dilemmas no less cogent than those of atomic energy. Are we capable of understanding the intensity of the scientific revolution? The same society is going through the throes of automation and of racial integration. Life has never been more complex, and the revolution has barely started. If we do not repair the damage we will pay dearly for our non-efforts in understanding and bolstering the

role of the universities as the centers of intellectual responsibility in our society, or else for nurturing whatever other institutions can play this role.

None of the world's problems and pains has escaped notice of the space-critics as suitable substitutes for our technical effort. Considering the billions of dollars we have spent in foreign aid and the hundreds of billions in our national defense, it seems unlikely that the abolition of hunger in India or mortality in the United States will follow automatically from a Congressional appropriation. (It would be well within the pattern of history if astronautic nutrition and medical instrumentation, even by their very indirection, made a larger contribution to the same problems!) Our present state of wisdom to cope with these problems, even more how to cope with the world in which they have been solved, is indeed the most shameful admonition to our non-efforts. Tearing down a good effort does not necessarily bring about a better one.