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Summary Of

Proposed Studies On The Implications Of Peaceful Space Activities For Human Affairs

by
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A Report Prepared for the COMMITTEE ON LONG-RANGE STUDIES OF THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

by
THE BROOKINGS INSTITUTION

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LETTER OF TRANSMITTAL

The Brookings Institution
Washington, D. C.
November 30, 1960

HON. JOHN A. JOHNSON
Chairman, Committee an Long-Range Studies
National Aeronautics and Space Administration
Washington, D. C.

DEAR MR. JOHNSON: I am pleased to transmit herewith a report on "Proposed Studies on the Implications of Peaceful Space Activities for Human Affairs," which has been prepared for your Committee on Long-Range Studies of the National Aeronautics and Space Administration, pursuant to Section 102(c) of the National Aeronautics and Space Act of 1958. This section specifies that the "aeronautical and space activities of the United States shall be so conducted as to contribute materially", to several objectives, among which is "(4) establishment of long-range studies of the potential benefits to be gained from the opportunities for, and the problems involved in the utilization of aeronautical and space activities for peaceful and scientific purposes."

In seeking assistance in carrying out the objectives of this section, NASA, through your Committee, and the Brookings Institution agreed that there was a wide range of studies in the social sciences that could be made of the potential benefits and problems arising from the peaceful use of space. In fact, the full range of possible studies was so great that some guidelines had to be established to aid in the orderly selection and pro per support of those studies that would contribute most effectively to the policies and purposes of the Congress as stated in the National Aeronautics and Space Act. It was believed, therefore, that if a program of such studies were to be developed, NASA would be in a better position to discharge its statutory responsibilities. The attached report is designed to assist in the development of that kind of comprehensive and long-term program of research and study. The report recommends for the consideration of NASA a wide range of studies regarding the social, economic, political, legal, and international implications of the use of space for peaceful and scientific purposes.

The agreed upon multiple objectives of the report would be well served if it generates research activities within as well as outside of NASA in

accordance with the interests of those in the academic community, private research organizations, industry, and other government agencies. Therefore, some material is included which, while familiar to NASA, is felt to be necessary background for those who have not been close to some of the problems discussed.

The Brookings staff members and the consultants responsible for the study collaborated through a series of monthly two-day conferences. In addition, over 200 people were interviewed throughout the course of the project. These persons by contributing their experience, imagination, and critical insight have been of great assistance in the preparation of this report. Throughout the preparation of the report the Institution has bad the wholehearted cooperation of your Committee on Long-Range Studies, whose assistance the Institution acknowledges with gratitude.

Midway in the project, the views of the staff were evaluated and enhanced by the participation at a two-day conference of: Lincoln P. Bloomfield, Director, United Nations Project, Center for International Studies, Massachusetts Institute of Technology; George Clement, Assistant to the President, the RAND Corporation; Deane Davis, Project Engineer, Centaur, Convair Astronautics; Alfred J. deGrazia, Director, Center for Applied Social Research, New York University; Joseph M. Goldsen, Senior Staff, the RAND Corporation; H. Field Haviland, Jr.., Director of Foreign Policy Studies, the Brookings Institution; Bert F. Hoselitz, Director, Research Center in Economic Development and Cultural Change, University of Chicago; Melvin Kranzberg, Editor, Technology and Culture, Case Institute of Technology; Daniel Lerner, Professor of International Communications, Center for International Studies, Massachusetts Institute of Technology; Jiri Nebnevajsa, Professor, Department of Sociology, Columbia University; Jack C. Oppenheimer, Executive Secretary, NASA Committee on Long-Range Studies; Harvey Perloff, Director, Program of Regional Studies, Resources for the Future; Henry W. Riecken, Head, Office of Social Science, National Science Foundation; and Oscar Schachter, Director, General Legal Division, United Nations.

The study was directed by Donald N. Michael, who is primarily responsible for the interpretations, conclusions, and recommendations in, and the final drafting of this report. Collaborating with him were Jack Baranson and Herbert E. Striner of the Brookings Institution; Raymond A. Bauer, Professor of Business Administration, Harvard Graduate Scbool of Business Administration; Richard L. Meier, Professor, School of Natural Resources, University of Michigan; Aaron B. Nadel, Technical Military Planning Operation, General Electric Company; Herbert A. Shepard, Professor

of Behavioral Science, Case Institute of Technology; and Christopher Wright, Executive Director, Council for Atomic Age Studies, Columbia University. Substantial contributions in the form of work papers on specific topics were made by Jack Baranson and Mary E. Robinson o the Brookings Institution; Curtis H. Barker, Center for International Studies, Massachusetts Institute of Technology; Earl W. Lindveit, Washington, D. C.; and Messrs. Nadel, Wright, and Bauer (with Edward E. Furash, Assistant Editor, Harvard Business Review) . Research assistance was provided by Ruth Darmstadter, Leonard Schwartz, and Jane Webbink. Charles Clapp, Robert W. Hartley, H. Field Haviland, Jr., Bert G. Hickman, Mark Massel, and Ralph W. Watkins, all of the Brookings staff, reviewed sections of the report; appreciation is expressed to them as well as to Kathleen Sproul, who edited the transcript. The study was made under the general supervision of James M. Mitchell, Director of the Conference Program on Public Affairs.

The Brookings Institution is particularly indebted to the following people who took time out of their busy schedules to review specific sections of the draft report: Lloyd V. Berkner, President, Associated Universities, Inc. ; Scott Buchanan, Consultant, Center for the Study of Democratic Institutions; John J. Corson, Director, McKinsey and Company; Cora Du Bois, Professor, Department of Anthropology, Harvard University,, Morton M. Grodzing, Professor, Department of Political Science, University of Chicago; Caryl P. Haskins, President, Carnegie Institution of Washington; James R. Killian, Chairman of the Corporation, Massachusetts Institute of Technology; Herbert E. Krugman, Director of Research, Raymond Loewy Associates; Natban Maccoby, Professor, Mass Communications, Stanford University; Margaret Mead, Associate Curator of Ethnology, American Museum of Natural History; Rhoda Metraux, Associate Directori Project on the Factor of Allopsychic Orientation in Mental Health, American Museum of Natural History; Charles Morris, Professor, Department of Philosophy, University of Florida; Oscar Schachter, Director, General Legal Division, United Nations; Gerald W. Siegel, Lecturer on Business Administration, Harvard Graduate School of Business Administration; and Stephen B. Witbey, Director, Public Affairs Studies, Survey Research Center, University of Michigan.

Finally, it should be noted that the time available for the completion of this report has been short in view of the broad range of subjects and the new areas of research to be considered. The authors have made a pioneering exploration into new fields of investigation in the attempt to foresee types of research which space activities make desirable. The treatment, findings, and recommendations are those of the authors and, in accordance with usual procedures, do not necessarily reflect the views of other members of the Brookings staff, its administrative officers, or members of its Board of Trustees.

Robert D. Calkins
President

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I. INTRODUCTION: GOALS AND METHODS

1. In November 1959 the National Aeronautics and Space Administration contracted with the Brookings Institution to "undertake ... the design of a comprehensive and long-term program of research and study regarding the social, economic, political, legal, and international implications of the use of space for peaceful and scientific purposes."

2. The long-term program of research set out in the report (and briefly outlined in this Summary) includes:

a. Sufficient description and evaluation of speculations on the implications of space activities to provide a basis for judging which implications may have sufficient impact on human affairs to merit research.
b. Specification of criteria for selection of high priority research.
c. Specification, when feasible, of high priority research areas for initiating a long-range research program; specification of other research areas which will extend the utility of the initial research; and specification of research which may become central under later circumstances.
d. Suggestions as to methods, persons, and organizations that might assist the conduct of research. (The suggestions are made chiefly through footnote citations of pertinent publications and projects and are therefore not included in this Summary, which carries no footnotes.)
e. Suggestions on the organization and function of a NASA research capability to implement the program (Chapter 2).

3. Space activities require great investments of money, men, material, and creative effort and thereby compete with the needs of other areas of human endeavor. They contribute to rapid rates of technological change and thereby give rise to social and personal readjustment problems. Thus it is most desirable that the problems and opportunities they may imply for society be understood. Since the potentialities of space activities are wide ranging, so, too, must be a research program on their implications: examined herein

are the problems and opportunities that may be introduced by hardware (such as a weather satellite forecasting system); events (such as the adventures of astronauts in space); and ideas (such as those embodied in discussions of the degree to which national prestige may be dependent on success in space accomplishments). Certain implications may be directly related to, aspects of a specific social environment; in such cases, these aspects will be examined.

4. Research on the implications of space activities requires a reasonably clear picture of the associated larger social context. Given the complex problems facing various components of world society and the technological developments that are believed possible in fields other than space, it appears impractical to speculate beyond the next twenty years, and perhaps even be beyond the next ten. Even within this time span, however, the consequences of space activities can be foreseen only in part, since the effect of any given development in space may be vitiated by unexpected but contingent scientific, technological, or social developments. This report, therefore, does not attempt to predict what will happen to society as a result of space activities. Rather, it poses questions about what might happen and specifies contingent factors which may affect the likelihood of one implication being realized rather than another.

5. Certain potential products or consequences of space activities imply such a high degree of change in world conditions that it would be unprofitable within the purview of this report to propose research on them. Examples include a controlled thermonuclear fusion rocket power source and face-to-face meetings with extraterrestrials.

6. The impact of innovation is no respecter of differences in academic disciplines. To stress the interdisciplinary nature of research on the implications of space activities and to permit a coherent exploration of specific products, events, and ideas the report is organized into chapters that (except for Chapter 2) each represent a major area of problems and opportunities. Within these major areas, all pertinent aspects of the problems are discussed, whether economic, political, or social, or combinations thereof. Certain chapters necessarily overlap, since some of them cover general aspects of problems which are specific to the subjects of other chapters.

7. Time, resources, and especially the lack of a single formulation of social science theory, broad-ranging enough to encompass the variety of problems involved, imposed arbitrary limitations on the amount of research undertaken to back the speculation underlying the report. Thus, the report is not exhaustive in its research recommendations, but the descriptions of the problem areas (developed through 'Interviews, conferences, and reading) are intended to provide the reader with a basis for proposing specific research projects in connection with the study areas recommended here. It is important to note that, as a consequence of this approach, the first specific research project to be undertaken with regard to many of the problems here discussed should be an assessment of the literature to determine what existing knowledge, if any, can be applied directly and what further study needs to be done.

8. Suggesting a comprehensive research program makes it necessary to examine the range of implications needing study, irrespective of who might conduct the research. Not all the research suggested should or could be sponsored directly by NASA; some proposals ' are more properly within the interests of other groups.

9. "Research" is broadly used herein to refer to a variety of approaches, including "think-pieces," sophisticated logical and / or mathematical evaluations and analyses, and empirical studies in the field. Studies would range from broad programmatic research to detailed inquiries. Most of the projects are phrased in terms of space activities, but many of the suggested investigation could as well be stimulated by or applied to a number of other major on-going or contemplated scientific developments. Examination of the implications of space activities also provides a new standpoint from which to observe human behavior before, during, and after social change resulting from innovation. Thus, the proposed research program offers extraordinary opportunities for fundamental social science research as well as applied.

10. The recommended high priority research areas (listed at the end of each Summary section) are intended to provide NASA with a "mix" of projects to be an initial basis for a long-range research program. The priority criteria emphasize:

a. That the results of the research would have important applications to the social consequences of specific space activities.

b. That the study is urgent in order to identify and resolve operating and policy problems associated with imminent or on-going developments.
c. That the study is non-deferrable in that if the data and methods are to be available when needed it is necessary to begin acquiring them now;
d. That the study would significantly forward the development of a program of peaceful and scientific uses of space.
e. That the study would, through the development of methodology, facts, or theory, contribute exceptionally to understanding or foreseeing the social implications of space activities.

Which projects NASA may choose to implement, even among those which might be thought of as urgent, will depend on factors not within the purview of this report, including budget, availability of research capabilities, important events which have transpired, and the extent to which previous research has paid off.

11. Research areas are included in the report which are not now considered of high priority, but which are likely to become so as social developments and space activities evolve and as high priority research is completed.

12. No assumption has been made as to whether or not specific studies are already underway. If an area recommended for study is presently being competently researched, the priorities here assigned to the area would alter.

13. The magnitude and direction of a long-range research program on the social effects of space activities will depend on the organization NASA establishes to select, monitor, and conduct the studies. One of the most pressing and continuing research challenges for this capability will be to:

- develop effective methods to detect incipient implications of space activities and to insure that their consequences are understood.

14. Each section of this Summary corresponds to a chapter of the full report and sets forth the main points of the chapter and the recommended high priority research for the problem area. In the body of the report, the presentation of potential implications involves discussion of and suggested research on all the issues that seem to be pertinent to a problem area including some that do not warrant research at the present stage of the

problem area development, and some that it would be inefficient to study until other recommended research is completed. This supportive discussion constitutes the bulk of the report and in a summary can only be suggested. Its intent, however, is to make clear (1) the significance of the research recommended, (2) the variety of the projects implicit in the research areas, (3) the order in which related projects could be carried out, and (4) the opportunities for approaching various problems in broad or narrow contexts of research and application. Therefore, although for some readers this Summary chapter may provide sufficient information -- since these four clarifications may not be of central interest to them -- it is assumed that the potential researcher will find it essential to read the body of the report.

II. COMMENTS ON THE ORGANIZATION AND FUNCTIONS OF A NASA SOCIAL SCIENCE RESEARCH CAPABILITY

1. An integral part of the research program as proposed herein is the development of a research facility capable of conducting and evolving a series of long-range research projects pertinent to NASA's directive to study the problems and opportunities implied in peaceful and scientific space activities.

2. To develop within NASA an understanding of the need for these studies and support for their conduct, to assure the maximum likelihood that the research findings will be applied, and to keep in close touch with the technical developments which presage social implications, it is recommended here that the research capability consist of a NASA in-house core of senior social scientists, which would have available to it over time the services of outside organizations. Which functions can best be conducted in-house and which might be handled through the services of outside organizations can only be determined as the scope and pace of the program evolves.

3. The functions that a social science research facility must be able to perform if it is to organize and implement a long-range research program include the following:

a. Identification of problems to be researched. (This report is intended to be a major aid in this area, but its suggestions will need frequent revision, redefinition, and supplementation.)

b. Selection of high priority research. (This report suggests criteria for selecting research, but these must be supplemented by criteria pertinent to NASA goals and circumstances.)
c. Determination of resource allocations, including funds, available research personnel, and field situations for specific studies.
d. Informing and stimulating potential researchers in other government organizations, universities, foundations, nonprofit organizations, and private research organizations.
e. Developing and stimulating potential supporting facilities to provide research tools and other services.
f. Selecting, developing, and implementing research proposals.
g. Liaison -- with divisional groups within NASA, with . potential research personnel, and with interested government agencies whose research or activities have significance for the social implications of space activities.
h. Assessing the progress and direction of research in progress, to insure that the studies continue to be pertinent to the evolving situation and that their quality merits continued support.
i. Distributing the research findings to those for whom they were specifically developed and to other pertinent professional people and organizations.
j. Assisting in the application of the findings. (Arrangements regarding applicability of findings should be initially planned, with the participation of the user, during the early definition and selection of the research to be undertaken.)
k. Keeping track of pertinent social science research that is applicable to space activities research, but not a part of NASA's program.

4. In establishing an organization to fulfill these functions, three general points are important:

a. The research which NASA will regard as appropriate to sponsor directly will vary with circumstances. Systematic means should be devised for (1) anticipating the important studies which other research organizations, foundations, and government agencies might be better adapted to carry out and (2) encouraging participation by other research facilities in the program.

b. Recommended research will vary in duration from a few months to several years. Operations procedures for supporting research will differ for longer and shorter time spans, and these procedures will need to be developed.
c. Research is also a device for training researchers. It will be beneficial to support a certain amount of research whose aim is in part to help train social scientists to deal with the implications for society of space activities.

5. To provide the necessary intellectual stimulus for the development of a vigorous program and to carry out the intricate and varied tasks that will be required, it is recommended that no fewer than three senior social scientists of high competence compose the professional staff of the in-house core. Their first tasks are seen as including:

a. Selecting first-order research.
b. Establishing in-house relationships.
c. Establishing outside connections with the research fraternity.
d. Laying the organizational groundwork for the conduct of the first-order research.
e. Establishing a library of selected social science materials especially useful for fulfilling the functions of the facility.

6. The research facility, as a staff function, should have access to those concerned with the over-all interests of NASA. Formal arrangements should also be made to insure the social science staff access to information on technical, political, and economic aspects of the space developments that derive from NASA's divisional activities. Such information will familiarize the social scientists with the space program's operating problems and with the possible research opportunities implicit in them.

7. A person familiar with both the social sciences and the technological activities of NASA and versed in interagency relationships should be responsible for arranging interagency liaison so that research on the social implications of space activities will be forwarded efficiently through the sharing of information on pertinent activities.

8. A committee is needed to assess and review research in progress.

9. A committee analogous to the Space Science Board of the National Academy of Sciences is needed to keep the in-house organization cognizant of

of on-going or anticipated social developments related to an evaluation of the implications of space activities.

10. Aside from the liaison function and the awarding of contracts and/or grants, other functions could, as time and circumstances dictate, gradually be transferred to outside organizations. However, the in-house core will need to keep in close touch with assisting services and with personnel carrying out research projects to insure participation at all stages of those who will most directly use the findings and to maintain its essential role as the spark and drive of the program.

III. IMPLICATIONS OF SATELLITE-BASED COMMUNICATIONS SYSTEMS

1. Involved scientists and engineers believe that in a relatively few years the world will be wrapped in a communications net based on the several advantages of communication satellites. The problems and opportunities associated with financing the development and application of communication satellites, with legal and political arrangements for their use, and with their specific applications are closely related to their technological characteristics. Research and development efforts have been concentrated on two operational types of systems: the passive reflector (e.g., "Echo"), which requires very large ground-based transmitting and receiving antennas and powerful transmitters, and the active repeater, which is itself a complex transmitting and receiving station, and thus requires much less large ground-based transmitters. Under many circumstances, signals from repeater satellites could be received directly on private receivers. Careful scheduling is required, however, if active satellites are not to be overloaded, whereas passive satellites can be used anytime they are in range of any facility with transmitting and receiving antennas. To varying degrees, technological problems remain to be solved for both systems -- problems having to do with system capacity, reliability, weight, and the use of higher frequencies for radio and television.

Organizational problems and implications

1. The economics, technology, organization, and utilization of satellite communications cannot be resolved wholly within the framework of the United States' interests and operating methods. Since such a system will be of major utility to international communications, planning must take into

account the potential users abroad and the problems that international use will imply. Research will be necessary to delineate and suggest resolutions for such organizational and operational problems as these:

a. Frequency allocation and/or sharing. Here and abroad, frequency control is already rife with economic, social, and legal problems which would be intensified by the broad coverage and relative non-directionality of satellite signals and the different frequency control requirements of active and passive systems.
b. International agreements on comparability of equipment components used by various nations and produced by various manufacturers.
c. Privileges and priorities of satellite use. Cost-sharing arrangements may be more difficult to enforce with passive systems, and the scheduling of messages requires special agreements when the active satellite system is used.
d. Receiver antenna control and sharing (and in some cases, transmitter antenna, too).
e. Access to audiences: privileges and priorities. Active satellites provide better opportunities for control over transmission. Passive satellites provide better opportunities for control over reception.
f. Program content control, including: amount and type of propaganda, advertising, entertainment, information, and education.

2. Central to the resolution of these organizational problems are the national philosophies which have defined the structure of local operational procedure and organization of present telecommunication facilities. The differences between one philosophy and another as to the purposes and proper use of telecommunications may have substantial implications for the way satellite systems might be used and for the negotiations and organizational inventions necessary to reconcile competing interests within each involved nation, competing national interests, and international interests. Systematic study of these problems is recommended.

3. The United States' role in developing and using a satellite communications system is completely bound up with questions covering the relationships of our national (government) interests and private profit motives. For example, under what circumstances should the United States government provide launching facilities and research and development in connection with satellite development? If taxpayers are to finance portions of

the technological development of communication satellites, what provisions are to be made about patent ownership and satellite utilization? If the government is the major developer of a satellite communications system, what should its policy be about present privately owned and operated systems which may be displaced or made obsolete?

4. The possibility that the USSR and/or other nations will develop competing communications satellites has implications that need study. Further, some informed observers argue that only by placing satellite system radio and television facilities under United Nations or other international agency auspices can frictions resulting from their use be minimized and the benefits maximized. Anticipation of either competition or internationalization would affect the evolving relationship between the United States government and private enterprise concerning development and use of a satellite system, since private incentive to invest in research and development depends on the profitability that could be expected from the system's operation.

Possible uses' and their implications

1. With the initiation of a satellite communications system, large amounts of the newly available channel capacity will most probably first occur for radio telephony rather than for television. High-speed, inexpensive voice communications should provide far-flung business and other organizations with a further capability for extending themselves through the increase in control and coordination thus made possible. Ever larger organizational entities might thus be encouraged, to the detriment of existing small organizations. Alternately, the increased communications capacity might increase the ability of small organizations to survive, through better control and coordination of their resources. The implications of these alternatives and their consequences for organizational growth and stability merit study.

2. The advantages of increased voice-to-voice communication for world diplomacy are not clear, since the present pace of diplomatic communications is sometimes deemed already too swift for careful analysis. However, the availability of sufficient telephone channels might encourage the evolution of an international "secretariat" at the working level, in the long run more identified with task goals than specific national interests. Research should help clarify the special problems and opportunities for diplomatic relations.

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3. World-wide data search, coding, retrieval, and processing and the integration of far-flung systems operating automatically via computers and feedback control would be made possible by large-capacity communication satellites (or by their freeing-up of conventional facilities for this use), to the great benefit of scholarship, science, business, and government. Handling of data for a world-wide weather forecasting facility (as discussed in Section IV) and coding the contents of the major libraries of the world for machine search are important examples of this utility. Substantial increases in computer production and data-coding personnel would be required, and computer, programming and system building and maintenance would involve extensive operations. international standards of component compatibility and reliability would be mandatory, thus further extending multinational interdependence. The social, economic, and political prerequisites and consequences of these potential developments need study, especially because such facilities may provide a tool and stimulus for a concerted attack on the problem of efficiently using the overwhelming amount of data presently threatening to swamp this civilization.

4. In view of the possibly radical increase in the pace of organizational activities resulting from high-speed interlocking of data, decisions, and actions, it is not clear whether more or less strain would be put on decision makers. Further, the opportunities for coping with increased organizational complexity could make society vulnerable to serious disruption should the communication system break down. The possibility of tying together data, men, and decisions in a world-wide interdependence has vast implications for attitudes about man and his meaning in the context of his society. Preliminary inquiry may help provide perspective and prepare the way for more systematic study as the situation evolves.

5. The use of satellite-based radio and TV for teaching in underdeveloped areas has been much discussed. However, unless the development of, satellite-based, multichannel TV is accelerated specifically for this purpose, other more conventional teaching means may develop to a degree that would challenge the advantages of education via telecommunications. In any case, behaving and believing according to the standards and information conveyed by telecommunications involves a number of complex cultural and psychological factors, especially in an area which may lack the literacy and at least some degree of urbanism normally associated with learning from TV and radio. Research is clearly necessary to specify and understand these

pertinent factors. Problems are also posed and study is needed in regard to the capacities in such localities for distribution, maintenance, and replacement of receivers.

6. In already advanced nations, the immediacy of exposure to world-wide events and ideas via radio and TV could affect general education levels. However, important changes in perspective that might lead to greater tolerance and understanding merely on the basis of this exposure are not guaranteed by the evidence so far available. Research will help clarify the factors involved here,

Using satellite communications for formal learning sessions may not be generally efficient in view of expected developments in film and video tape libraries, reaching machines, and air-borne TV. Nevertheless, special "live" events, which otherwise would have to be taped and distributed singly to local schools or local transmitters, could be presented by an active repeater system if such problems as scheduling and time zone differences can be solved. A satellite system could also transmit TV tapes from central libraries to local schools for retranscription. The costs of TV tapes might thus be lessened, and access would be provided o a much larger and up-dated library of materials than many schools otherwise could afford. The social and economic costs and benefits of these schemes will need careful examination.

7. A combination of powerful active satellites and simple receivers and antennas could be used to enhance or splinter political identification via propaganda, incitement, or information in areas lacking local ground-based transmitters. Research will be necessary to determine under what circumstances such communication methods would be sufficiently effective to merit their use -- and if effective, bow to control their use.

8. If large TV channel capacity becomes available -- via satellite or via conventional facilities freed-up by the satellite -- conferences via multiple closed circuit linkages are possible. This would save time, inconvenience, and physical risk and permit a greater marshaling of home-based resources for each participant. Technological capabilities and social, psychological, and economic considerations will decide whether such conferences would become routine. Should they become routine, the consequences might

be serious for the travel and hotel industries, for which conferences of all kinds have been of great importance.

* * * * * * * * * *

To provide social criteria for decisions regarding communication system design, research should determine:

- The specific sources of demand for increased communications capability, and the assumptions, made by those claiming that they would pay for the use of satellite services, about the capabilities of the communication system for meeting their needs. What are the implications for system design?

An important group of decisions related to government policy for communications system development support would benefit from study to discover:

- The advantages and disadvantages of various means whereby the government might fulfill its obligations to private enterprise, the nation as a whole, and special interest groups with regard to: supporting the development of a satellite system; ownership; frequency assignments; allocating profits and costs; and assuring the use of the product in the best interests of the nation. What are the most appropriate and effective roles for government, private enterprise, and other organizations in financing, developing, owning, controlling, using, and negotiating for the use of satellite communications domestically and internationally?

A good place to begin studies which will help in eventual negotiations on satellite use is to determine:

- What economic, cultural, and technological factors, in each nation or region involved, could complicate or facilitate the conciliation of interests in using and controlling satellite-based communications? What technological, economic, organizational, and legal arrangements could be developed to overcome specific major difficulties for conciliation as detected in the above? To take advantage of specific major opportunities?

Since the benefits for society could depend on the organizational approach

taken, and since these problems are better studied before imminent developments obscure issues, research should be begun now to determine:

• The cost and benefits of turning over to an international agency those communication functions which are inherently unprofitable for private interests and/or which have the potential for stimulating international unrest. Under what conditions would such a transfer of function be in the interests of the United States? In the event the facilities were internationalized, what activities might be prohibited or subjected to international control and what should be the functions and powers of such an international body?

Because the effective use of satellites for teaching purposes will require much more understanding of learning factors in relation to telecommunications than we now possess and because the application of such findings would be very important for world society, it is most desirable to begin now to:

Apply and further develop knowledge of and methods for understanding the factors -- such as culture habits, literacy, subject matter, auspices, format, and opportunities to use what is learned -- which affect the degree and type of learning from telecommunications. These studies must be aimed at meshing the content and purposes of telecommunications with other forms of communications from interested government groups, private organizations, and international agencies.

IV. IMPLICATIONS OF A SPACE-DERIVED WEATHER PREDICTING SYSTEM

1. Space activities are expected to contribute in two ways to the development and maintenance of a world-wide system for accurate long-range and short-range weather forecasting: (a) information for improvements in meteorological theory and the routine observations necessary for its application will be provided by space probes and satellites; (b) theory development and application will require a correlative and interacting world-wide net of ground-based, lower-atmosphere data collecting, processing, and distributing facilities, for which communication satellites appear to offer the most feasible system for handling the expected vast amount of data. Once the ground facilities are established, which may be in the relatively near future,

many nations may have access for the first time to systematic science-based forecasts similar to those presently available in regions using conventional forecast methods. Implications meriting research will presumably derive from the problems and opportunities inherent in the establishment and maintenance of the world-wide, integrated satellite and ground-based system, and in the uses made of the forecasts. The degree of utility will depend in part on what other technological, social, and political developments have occurred by the time the capability is available.

Establishing and maintaining a world-wide weather organization

1. A world-wide forecasting system will require the evolution of a globally standardized set of rules for the complex operations and negotiations involved. The increased emphasis thus placed on the interdependence of all components of world society might well help diminish international friction. Nevertheless, the system's development period will probably take place amid some degree of the mutual national suspicion and economic and political competition that now pertain. Further, since weather information will continue to be important for all types of warfare -- including economic the exchange of weather data may be inhibited under some circumstances. If potential inhibiting circumstances can be delineated through research, it may be possible to anticipate and thus avoid them.

2. The many decisions that must be made about the location of ground-based facilities for collecting, processing, and distributing weather data imply the need for studying the potential legal, economic, and political complications. For example, who will pay for and control the installation and maintenance of the facilities? It is very probable that some countries would not wish to contribute to the effort during its developmental stage, while others might from the beginning consider participation highly desirable, especially if facilities could be installed within their borders. There may be conflicts between technical and political criteria concerning the "best" placements for facilities. Study of potential conflict factors might resolve them before the fact. Who, for instance, will make such decisions and on what bases? Are these to be national or multinational decisions, or should they be made by an international organization? If decisions are not to be made by individual nations, what is the appropriate role for the United States in facilitating the development of theory and practice? Given the military

utility of weather data, what criteria should be used for evaluating the strategic cost and benefits of releasing specific weather information? How would various possible policies affect the various possible interests of specific nations?

3. Once the alternatives of ownership, funding, and control have been clarified, negotiations must be Undertaken to establish the operating organization, its standards of quality and equipment compatibility, and the procedures for handling sporadic, deliberate non participation or continued noncompliance of members of the network, The negotiations will be subject to complex pressures arising from the differing motives, legal procedures, and political arrangements of the various nations participating in them. Systematic inquiry might valuably elucidate these factors and their relationship to negotiation alternatives.

4. Highly trained meteorologists have been in short supply for some time, but many will be needed as well as many other personnel to operate equipment, develop theory, make local forecasts, and distribute them. People especially trained to translate weather forecasts into meaningful ideas for users unfamiliar with them will also be needed. Questions are thus implied that require research. Who, for example, will pay for the training of the needed personnel? Where will they be trained, and who will train them (teachers being in abort supply)? What major changes in and additions to curriculum content will the developing field require? Some nations may prefer to use their scarce, talented manpower in other technological endeavors that they consider of higher priority than weather forecasting. Others may welcome participation as a way to train personnel in the general idiom of technology so that they would thereby also be useful for other high priority purposes. How, then, should the training and use of personnel for a weather system be planned so that it will aid in expanding the world's general supply of scientists and technicians?

Implications for weather control

1. The possibility of a space-derived forecast system has aroused much discussion of relatively immediate advances in weather control. However, with the exception of possible occasional experiments or a certain amount of localized, legally acceptable, rain-making, developments in weather control will probably depend on meteorological knowledge made available only

through the gradual development of a weather theory adequate for world-wide, long-range forecasts. There may nevertheless be pressures for experimenting with such devices as nuclear explosions to disrupt typhoons and hurricanes. Conducting such experiments without jeopardizing human safety would involve international agreements. Preliminary research could help to prepare a basis for . solving the collaborative problems as their nature became clearer.

Implications for product raisers

1. Long-Range or seasonal forecasts will face the farmer and those who make farm policy with many decisions. Given a partially unfavorable forecast, for example, bow much land should be kept in use and what crops grown? What techniques might mitigate the weather effects? Associated decisions would have to do with the availability of easily obtained and adequate financial support when the direction of a prediction made it desirable or necessary to cover costs of seeds, fertilizer, equipment, stockpiling facilities, and the like. All these decisions imply an alteration in the behavior patterns of both farmers and government policy makers in tradition-oriented agricultural areas. Changes in traditional farming patterns would eventually produce profound changes in distribution and marketing methods and in consumption patterns and government policy. Much careful research and advanced planning will be necessary if full advantage is to be taken of the opportunities for raising standards of living, and if the disruption attendant on the transition is to be minimized.

2. Methods must be developed for handling such consequences of responses to forecasts as bumper crops of the same product being grown in several different parts of the world. International crop planning and allocation procedures may be necessary to balance out economic and substantive inequities and otherwise assure the distribution of supply in keeping with the immediate demand and with longer-range storage requirements. Such international arrangements, implying major changes in a nation's policies regarding its domestic farming, would require much anticipatory study.

Implications for tourism and related recreation industries

1. For recreation facilities, the main consequence of both short- and long-range weather forecasts may be a sharp increase in overloads and underloads.

The forecast of a bad season for regions having tourist-dependent economies the French Riviera, parts of Florida, Switzerland, etc., -- could have major national or regional economic repercussions, and could strain international relations. Economic reorganization of the tourist and recreation industries might become necessary, so that facilities unused because of expected bad weather could be balanced against facilities where there is expectation of good weather. other questions raised concern the role of the government in mitigating major national and regional imbalances, given its part in providing the forecasts. All of these problems will benefit from research.

Implications for water resources and fossil fuel utilization

1. Seasonal forecasts would permit optimum use of multiple-purpose dams that now retain part of their capacity to cope with unforeseen seasonal over-loads or underloads.

2. More efficient use and realistic stockpiling of fossil fuels would be permitted if seasonal demands are known in advance. With urban and population growth, the world demand for fuel is continually increasing; an advanced planning capability should encourage world-wide programming of fuel allocations, both to fill routine needs and to alleviate suffering in times of weather emergency. Important questions of pricing, production regulation, and national and private profit interests arising in this connection merit study.

Weather disaster mitigation

1. Many nations may relatively soon have the advantage of hurricane and typhoon forecasts, if Tiros-type satellite observations prove to be as useful as it is believed they can be. Such disasters as droughts and major floods may eventually be predicted also.

2. Providing forecasts of imminent disaster does not by any means assure that they will be acted on. Emergency action depends on the physical resources available, the motives of the leadership that must decide what information to make available to the public, the psychology of the public about action, and the time available. Quick and productive reactions to disaster forecasts require a certain amount of education of both leadership and the public. Much more research is needed on how to educate for disaster, especially in the many world cultures where a traditional fatalism has

prevailed. Decisions must also be made about what expenses any community or any nation wishes to sustain to be prepared for infrequent disasters such as tornadoes or hurricanes; these decisions would benefit from cost and benefits studies and operations research on preparation arrangements.

3. Long-Range forecasts of such lingering-effect disasters as drought and heavy flooding will confront involved nations with the need for preparations to cope with the people and institutions that would be displaced by or threatened during the disaster. In many nations this would require an organization of personnel and an allocation of resources -- both of which do not now exist or are needed for or absorbed by other activities. Governments warned publicly of disasters with which they have little competence for coping may be seriously embarrassed. This implies opportunities and problems for other nations in deciding how and to what extent they would provide personnel and resources to mitigate the consequences of a disaster in another nation. The resolution of the many facets of these problems deserves intensive pursuit through systematic inquiry.

Implications for transportation

1. More efficient use can be made of commercial transportation facilities if accurate forecasts make it possible to anticipate transportation needs as functions of the effects of weather patterns on clients' shipping plans.

2. In nations with somewhat primitive transportation systems, weather forecasts would provide the opportunity to use weather-dependent transportation methods and routes more efficiently. This may also help to raise living standards and further the development of rationalized decision making and of the requisite technical and human systems to implement it. Research would be desirable into methods for helping these areas take advantage of the opportunities provided by the forecasts.

As a prerequisite for planning further research activities on the implications of the uses of weather forecasts study is necessary to determine:

- The activities that will be most advantaged or disadvantaged by varying amounts of improved forecasts. Here it is necessary to consider the time at which improved forecasts are expected to be realized and the technological and social

contingencies which may affect the degree of weather-dependence. In particular, legal, political, economic, and cultural factors must be considered for their influence on the advantages and disadvantages of long- and short-range predictions.

In view of the likelihood that many nations will have access in the relatively near future to forecasts of hurricanes and typhoons, via satellite observations, research should begin at once to determine:

- What needs to be done and what can be done in other nations as well as the United States to prepare for various types of imminent disasters at various levels of destruction, in whatever time would be available. Here it is necessary to examine (a) the communication facilities and organization required to provide the requisite information soon enough, and (b) the organizational and personnel equipment and, possibly, the legal procedures required to cope with emergency action.

The ground-based facilities needed for developing better weather theory may of themselves provide reasonably good forecast in many areas. Since they may be installed relatively soon, and since such forecasts could have major effects on farming methods and product distribution and utilization, it is most desirable to begin now to plan activities to make the transition as comfortable and effective as possible. Basic to such plans will be research which will determine:

- The extent to which the requirements for using science-based forecasts are compatible with the perspectives and behavior of those who will directly use the ideas or methods and of those at higher levels who must approve the ideas or methods for use. Among factors of special interest with regard to product raising methods and ideas are: the degree of acceptability of scientific statements as a basis for action; existing methods for making long-range forecasts; reactions to shifting the customary rhythms of crop processing behavior, and to both growing and eating alternative crops; how directions or advice are taken from higher echelons; and what the definition of "qualified authorities" is.

The implications for national interests of supporting a national or international weather system are many. These will take much study and time to clarify. It is recommended that research be initiated to determine:

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. . .The relative advantages and disadvantages -- economic, political, cultural, and military -- of international, national, or non governmental control of all or parts of the theory development system and, eventually, the weather predicting system. What problems need to be resolved regarding ownership, funding, and staffing of facilities in each of these cases?

V. THE IMPLICATIONS OF TECHNOLOGICAL BY-PRODUCTS

1. The term "by-products" is used here to define those technological items or methods whose development probably would not have occurred or would not have been accelerated to the present extent bad space activities not existed, and only items meeting this definition are examined in this section. Many other products given glamour by being popularly called by-products of the space effort are more logically ascribed to the general trend of technological invention.

2. Even for the "legitimate" by-products, more importance seems in some cases to be claimed than is justified b# a review of their implications. Better understanding is needed of the economic relationships between the derived products and the original products, and methods also need to be developed for recognizing whether byproduct developments have or are likely to have really important social implications.

Derivation, uses, and implications

1. Putting man in space will systematically expose him to great physical and emotional stress. Special methods, drugs and medicines, and equipment are being developed for measuring stress and possibly for coping with it. Although it is known that human capabilities are sometimes extraordinary under stress conditions, systematic information on the matter is sparse. The studies being made in relation to the Mercury astronauts contain important space by-products, in their potential for contributing to knowledge on this subject. They may also, especially if the information and new medical techniques they produce are applicable to the general public, change attitudes about subjecting man to stress, thereby generating basic ethical and moral questions, the resolution of which may have profound implication for man, both in space and on earth.

2. Telemetry, the technique whereby the state of an object is sensed by electronic or mechanical devices, transformed into an electrical impulse, and transmitted to recording and analysis equipment, owes its recent rapid development almost entirely to the space effort. Given associated equipment, it could be used in any situation where information at a distance was required, thereby permitting new orders of human and physical control. Among the many potential uses of this space-stimulated by-product, its utility for the field of medicine is of special importance and interest. The possibility of conveying medical and emotional data to central computers via surgically imbedded microminiaturized telemetering equipment appears to be realizable. This could permit continuous two-way monitoring of a person's state of health whether he is in the hospital or ambulatory -- and release doctors to some extent for specialized work, thus helping to relieve the anticipated aggravation of the doctor shortage. Such an approach to routine medical surveillance presents legal, political, moral, and ethical problems, which doubtless would be vigorously argued and which would benefit front careful study. An extension of this application of telemetering devices involves monitoring emotional states by obtaining the physiological information that is associated with them. The process would be useful for psychiatric therapy. It could also be of use to institutions and governments in various ways, some of them perhaps not acceptable to the democratic ethic. There are profound moral implications inherent in the possible applications of this space technology which deserve study to clarify the problems and opportunities involved.

One likely consequence of making very broad use of telemetry (in association with computers and with other communications devices) will be an intensification of arguments on whether man can continue to be master of his machines. If preoccupation with the problem increases, attitudes may be affected to an extent that the possibilities of use would not be permitted full exploration.

3. Of the power sources being developed for space craft, at least three could be used on earth. (a) Plasmas and magneto-hydrodynamic power would seem to have no new implications for the using environment. (b) Solar power could operate small devices, such as data recorders, in isolated areas (which thus would be helped to accumulate new knowledge) and low power appliances, such as small radios; it is limited as a power source, however, and storage is needed for night operation and cloudy days. (c) Nuclear-powered

thermionic converters could provide isolated areas with more substantial amounts of power and do not need storage devices. Either of the latter two could be used in highly urbanized societies for operating equipment remotely and reliably, but they probably have no special implications for change except as the power sources for telemetry equipment. In underdeveloped areas their highly compact and reliable characteristics might provide power sources without requiring major ground transport into the region as is usually the case when conventional power sources are used; the implications for social change under these circumstances deserve study.

4. New plastics, alloys, and combinations of metals and plastics may compete strongly with conventional metals and other fabricating materials because of their extraordinary strength, lightness, and temperature resistance. But the demand for conventional ores may not be reduced, given the demands of increasing population and urbanization throughout the world. The social implications of the new materials include their potential for displacing extant technologies and manpower, disrupting supporting communities from the mine to the fabrication plant, and changing the patterns of the international metals trade. Study will be necessary to assess the possible extent of changes thus produced, and, if the changes appear large, to discover means of coping with them.

5. The need to develop highly reliable components for space activities is generating a variety of changes in manufacturing technology, quality control, equipment design, and utilization philosophies. Many of these changes are applicable to products for general use. Highly reliable consumer products would free repair and service personnel for other tasks. Moreover, materials now applied to the replacement of short-lived components would be available for other use. Such changes would provide many opportunities as well as problems for consumption-oriented economies, especially in the light of the developing nations' aspirations for higher standards of living and the international competition for resources. Research on the interrelationship of these matters is therefore recommended. Reliable components also have important implications for bringing telecommunications to underdeveloped areas (see Section III).

6. The closed cycle ecological systems being evolved for maintaining human life during space travel by reprocessing biological waste into

food, water, and air are applicable in principle to certain human situations on earth. However, within the twenty-year time span observed by this study, such systems would probably not outweigh the advantages of other sources of these necessary elements.

7. The social and economic costs of rocket propulsion for humans and for freight (the costs for the latter. including packaging, transport time to launching sites -- which must be distant from cities -- unpackaging, and transhipping) need careful study before the implications, if an I can be .Y evaluated. Research is also needed to ascertain whether there is significant utility in ever faster human transport if the world has easy telecommunications via satellite and reliable, comfortable jets. Aircraft braking and lifting rocket boosters would provide access to areas not now directly reachable by jets, but the implications, if any, for society will not be clear until the plans for and need of such projects are further clarified.

8. Given the anticipated development of precision guidance systems within the next twenty years, it is very possible that all kinds of vehicles could be so guided without human intervention. However, the legal and ethical problems in regard to responsibility in case of malfunction will need study. Possible personnel displacement may also present problems. Systems analyses studies will be needed, as well as research on means (if needed) for coping with personnel problems and on the relative merits of replacing a multifunctional human with complex and expensive guidance equipment.

Since known by-product implications may take on new importance rapidly and by-products will be developing continuously, research should be begun now on:

- Means for establishing, maintaining, and operating "watchdog" groups to alert and inform appropriate authorities and organizations to the foreseen or discovered applications and consequences of space technology by-products. Thus appropriate research or action can be undertaken to maximize the benefit to mankind.

Because of the potential importance of reliability to the operation of our consumer economy, study should determine:

- By means of cost and benefits examination, the effects of increases in reliability at various steps in the production-consumption sequence.

Since the long-range implications of telemetry uses may well be profoundly good or bad, research on the combined impact of telemetry, micro-miniaturization, and compact mobile power supplies should begin to:

- Delineate as systematically as is now possible the specific economic, legal, social, and moral problems and opportunities implied in future society-machine relationships, so that opinion leaders and policy makers can be aware of what must be resolved and planned for before, during, and after major developments in this communication and control capability.

VI. IMPLICATIONS FOR GOVERNMENT OPERATIONS AND PERSONNEL USE

1. Space activities require an extraordinarily large number and variety of scarce professional personnel and very large funds (funds also desired by other federal agencies and programs in science and technology). They divert public attention from and direct it to other government scientific efforts; they obscure cherished organizational distinctions between science and engineering, and basic research and applied; and they are important for international as well as national goals, and military as well as scientific and commercial goals. Thus, they have significant implications for a variety of agencies in the government, and in turn they may be vitally affected by these agencies. These implications are expressed as an imposing set of demands for efficient personnel utilization, complex organizational arrangements, and the resolution of ambiguous relationships between space, science and technology, and policy making. Much research on these problems will be necessary to understand and meet these demands.

Manpower implications

1. NASA's needs for large numbers of highly specialized personnel put it in competition with industry and nonprofit institutions, which have similar needs, and all three groups compete with other social needs for these personnel. Efficient personnel use requires special study on how to train and up-date the experience of personnel associated with NASA as well as how to anticipate the more complex training requirements for new personnel for the years ahead. Certain very important experience and training can only be acquired in the field environment, where the research, construction,

and launching of space activities are actually under way. Since there are relatively few such environments, new legal and procedural means may have to be devised for exposing professional personnel to requisite experiences by circulating them within NASA and among other involved government agencies, and perhaps even among industries and nonprofit institutions.

2. Motivational factors that help to attract appropriate personnel include salaries, opportunities for professional advancement and stimulation, and the special work environment required to stimulate research. Research and development activities clearly require different kinds of organizational structure and managerial philosophy from those which are traditional for other large-scale undertakings in industry and in government. The uncommon degree of complexity in space research and development, combined with the fact that a research manager usually has a different range of relevant knowledge and skill from that of the professional group he leads, emphasizes the importance of undertaking research to find alternatives to a command system-for laboratory administration. At present, understanding is limited as to why professionals choose to join or leave government space research and development. Research can provide 4 more comprehensive understanding.

3. Efficient planning for space activity manpower needs requires studies providing methods for obtaining data on the types and numbers of personnel that might be available now and that will be needed in the future. Present manpower directories are inadequate in their coverage. NASA and other government agencies with complementary and supplementary personnel interests have need of a formal means for collecting and sharing knowledge about potentially available personnel and of a cooperative plan for their efficient use. Appropriate studies are necessary to meet this need.

4. Long-Range planning on space activity manpower needs would help to assure that the right number of students could be encouraged to seek careers in specific professional fields applicable to space activities. There is also a need to make balanced use of scarce human resources between this area and other fields of great social importance. In view of NASA's longer-range personnel needs, the implications of space activities for career aspirations in the younger generations are especially important to study. The glamour of space activities and the play given them in newspapers and magazines may affect the attitudes of parents, adolescents, and career advisers toward these career

possibilities compared to those of other areas, but study is needed to understand how information and sources of advice finally affect career choices. There is also a need to examine and indicate academic training requirements for space activity careers, in view of the special demands placed on such training by the very rapid and complex technological advances characteristic of the field.

Organization

1. NASA's wide-ranging needs and impacts present it with problems of organizational coordination, competition, and cooperation with other agencies which are at once new and at the same time characteristic of the conflicts always inherent in complex organizations. The problems are especially complicated by the large variations in size, political power, monetary resources, types of functions, and personnel composition of other government organizations having interests that are complementary or supplementary to NASA's.

2. Because of the growing costs and requirements for specialized resources for space programs, it will be worth while to explore means for more effective coordination and cooperation between agencies having related interests with NASA. For example, developmental, operational, jurisdictional, and policy considerations in connection with present and future specific space activities will involve the U.S. Weather Bureau, the FCC, Office of Civilian Defense Mobilization, the Department of Agriculture, the Department of State, the Defense Department, etc. Careful study will be necessary to discover the best means for arranging functions between agencies. Wasteful jurisdictional disputes over the control of related science and technology development can be expected unless research reveals means to avoid them.

3. If space activities expand and some development and launching facilities are established independently of military reservations, state regulations regarding siting and control of dangerous space operations or health hazards may affect space activity planning. States may promote testing, launching, and research facilities for space activities to attract and retain academic personnel and bring good students to the universities, and as inducement to industry. All of these possibilities may present federal-state regulation and control problems as well as opportunities to expand space activities; study should be undertaken to anticipate and resolve the problems.

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Implications for science advisory activities and government policy

1. Space activities have become inextricably intertwined with science in general at the government policy making level and vice versa. This is not new to science or government, but it has received special emphasis as a result of the special and spectacular role of space activities in domestic and international government policies. Probably more than any other scientific and engineering area, the space effort has emphasized and dramatized the complex and unresolved problems of assigning priorities to competing and cooperating scientific and technological efforts. it has also emphasized that the problems inherent in the many roles played by the scientist in government -- pure scientist, government adviser, special pleader, promoter, every-day citizen -- have become confused in the scientist's own eyes, in the eyes of non-scientists with whom he must work at the policy levels of the government, and in the eyes of those outside of government who report on and interpret the interrelated activities of scientist and non-scientist policy makers.

2. The role of the scientist as scientist and as citizen and its relation to his role as an adviser to the government is especially important in the space area, where national, international, and political factors become central to some policy positions, and where the scientist representing these positions may find himself in conflict with his personal values as a scientist.

3. Confusions and differences of opinion about the proper and useful roles for and relationships between science advisers, science administrators, science advisory groups, and non-scientist policy planners and policy makers must necessarily interfere with the effective performance of their functions. Research will be necessary to clarify this situation and to provide a basis for remedying it.

Studies useful for policy planning to assure adequately trained personnel for NASA can be initiated by research to determine:

- The present and foreseeable experience and training requirements for scientific personnel affiliated with space programs in the government. What are the legal and procedural means by which personnel could be exposed to the requisite experience and training in such ways as to benefit them and the government’s activities in the space field

mutually. Included should be examination of means for encouraging or discouraging turnover and circulation of personnel between and outside of government agencies as is appropriate.

As a first step toward increasing the opportunities for interagency cooperation and thereby the advancement of the scientific and peaceful space program, research should determine:

- The possible advantages and disadvantages of particular cooperative and coordinated arrangements for the use of manpower, money, and physical resources between specific agencies having interests in present and anticipated space research, developments, and applications.

Understanding the complex relationship between career selection, career advice, and information about space activities will require, as one major input to the problem, research which will show trends about:

- The evolving images, in the minds of parents, teachers, career advisers, and young people, of the space scientist and engineer, and how these compare with the images of other possible career models. In particular, what values (e.g., craftsmanship, dedication) are perceived as involved in particular careers? Are these seen as attractive or unattractive? What knowledge, ignorance, events or experiences alter or emphasize the nature of the images held?

Preliminary to studies on alternative means for resolving the problems involved in utilizing science advisers and science administrators in policy making in regard to space activities, case-study research is necessary to determine:

- The operating relationships between the science adviser, the science administrator, and their respective users in the area of space policy. Precisely in what ways do the missions and perspectives of the three groups complement or confound in specific circumstances, operating procedures, policy making, and administration?

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VII. IMPLICATIONS FOR SPACE INDUSTRIES

1. The high rate of change of space technology and the heavy government participation in stimulating, directing, and consuming this technology seem to have confronted some corporations, government, and other parts of society with economic, organizational, and social problems. Some of the problems may be new; some are old problems made acute by space activities; and some may be old problems exaggerated in the telling through the novelty of space activities. Much research will be required to clarify and resolve these problems, and the results may have significant implications for corporate philosophy and organization, government-industry relationships, and the allocation of certain national resources.

Many of the problems to be summarized derive from a background of military rockets and missiles rather than peaceful space activities. Differences in national purpose and, thereby, the allocation of national resources may affect the nature and importance of these problems as peaceful space efforts increase.

Corporate response to space activities

1. Characteristics of present space enterprise affecting corporate outlooks about investments and risks are: negotiated profits from limited production of custom-made space equipment; high pre contract competition costs from company-sponsored research and development and contract preparation costs; large proportions of professional personnel and corresponding problems in personnel management and utilization; and the need to continually adjust and evolve facilities to provide the capabilities for developing space equipment.

2. Estimates about what investment to make and risks to take depend in part on what view is held of the future of space activities for peaceful uses. Some feel that quasi-production line quantities of stabilized components useful for a series of space activities will permit better profits and more traditional operational organization. Some take the view that the many technological alternatives for ambitious space efforts will provide research and development support for many firms. Others feel that the industry will evolve until a very few companies produce all the major components and, in the process, will gain the know-how which will assure them the next series

of contracts, and so on. Research is necessary to make clearer the factors which are acting or may act -- tending to drive the evolutionary process one way or the other.

3. One response to these evolutionary alternatives has been heavy investment in broad-ranging research and development facilities intended to supply ideas for diversification into new markets, as well as to develop space-related items and ideas which will put the firm at the forefront of a new government-supported technological wave. These R & D activities pose three important questions needing study to understand their consequences.

a. Who should own the rights to developments produced under government funds -- and, if the government is the owner, how can it be sure it receives all pertinent information?
b. What research should the government do in-house and how much on contract to support and take advantage of these private capabilities, and what is the optimum mix of outside multipurpose R & D facilities to special purpose facilities?
b. What are the consequences for the over-all quality of industrial performance -- and for -,lie needs of the rest , of society -- of competition for scarce personnel "stockpiled" for capability demonstrating purposes as well as for doing wide-ranging R & D?

4. Under the prime contractor system, there is a question of whether small firms can compete and survive as the space industry evolves. Limited staffs, intermittent roles, small profits, and small financial resources, all seem to confront the small firms with special difficulties in the space field. These difficulties deserve clarifying study so that possible solutions could be suggested.

5. Government-industry R & D cost-sharing and public finance policy would benefit from research providing better measures of corporate costs and profits over the long run, which also involve public funds. Research is also warranted to develop means for measuring performance efficiency in the absence of a price mechanism.

6. One question assumes many guises in this area: what is the best way to allocate government and industrial funds for the development and production of space systems in the absence of conventional market relationships? The negotiated contract is not unique to space activities, but the use of this

form of cost arrangement presents special problems in reconciling, industries' interests in higher profits with the national interests in what is advisable in space activities.

Personnel utilization

1. Space activities use large numbers of engineers, scientists, and managers. Their special capabilities and the organizational problems of complex team activities involve managerial and personnel relations problems needing much more study to resolve them. In particular, research is necessary on means for operating complex research operators in a manner that will induce high levels of creativity. Certain rates of turnover and of circulation between industry and other types of research-environments may improve or degrade creative quality; study of this point should help clarify it.

2. Recruiting enough craftsmen with "watchmaker" quality standards or motivating workers to produce that quality of work may be a sufficient problem that it would be useful to conduct studies on means for improving the requisite motivation and performance among workers building space equipment.

3. There will be great competition for high-quality professional personnel in future years, since they will also b@ wanted by other industries and for other socially pressing areas. In view of these other needs and in view of the expected scope of future space R & D, much careful study is needed to determine whether there will be sufficient numbers of high quality professional personnel to fill later personnel utilization goals. Excessive competition with universities and nonprofit research organizations may weaken necessary teaching and- institutional research, thus jeopardizing the general state of social development as well as the supply of new high-class personnel for the space industry. However, intensive industry recruiting and competition for personnel may stimulate more people to become scientists and engineers and encourage quality attitudes toward craftsmanship. Study of these matters is well worth while, so that allocation needs, trends, and other implications may be better understood.

Government and industry relations

1. Government regulations that are related to space firms include the franchising of activities such as satellite operations and launchings. Sharing regulatory responsibilities between states and the federal government is

also possible (see Section VI). Also involved are regulations concerning international inspection, safety standards and traffic control (including those for launching and recovery areas), noise and, radio frequencies, and indemnity liabilities. These and other potential regulatory actions will require study to make them adjustable to the changing opportunities in:space activities while still providing the needed public protection.

2. Patent policy problems are not unique to space activities, but they have been emphasized by them. NASA so far owns the ideas developed under government contract (subject to waiver of these rights), but industry feels the ideas should be theirs for private exploitation, partially to compensate for the small return on space R & D. The patent problem is nevertheless; larger than this important issue, and needs to be clarified by further study so that effective solutions may possibly be supplied. For example, since the federal .- government itself is a major stimulator of space innovation, how important are patents now for the purpose they were originally intended to serve,? To what extent has dissemination of new knowledge, and hence the exploitation of new technology for the benefit of the United States, been helped or hindered by the patent system? What have been the effects on scientists and engineers who prefer more professionally straightforward means for disseminating new knowledge which they have acquired?

3. Some claim that space enterprise will encourage larger economic units, and in some cases, the pooling of capabilities. Already, exchanges of scientific and engineering information necessary for R & D make questions of collusion in restraint of trade difficult to resolve. The general question arises of-how much reliance needs be put on competition or regulation, and how much can be accomplished through the government's own purchasing policies. Study is recommended on the relation of antitrust philosophy to the needs of space developments so that the nation is able to protect its interests in both areas.

4. The European defense budget, other foreign markets, overseas manufacturing costs, and the opportunities to benefit from foreign professional competencies are contributing to American industrial space activity outside the United States. However, commercial goals and foreign policy goals may not always be congruent in this area, given space activity's close relations to military activities and other national policies. On the other hand, it may

be that in such areas as communications satellites, it would be in the national interest to support them, as it was in the national interest to aid our world maritime and airpower positions. The implications of the interplay of these private and public interests will be well worth studying for the insight they can provide for planning to assist the goals of all concerned.

As a basis for understanding the implications of more specific aspects of space industry problems and opportunities, and as a stimulus for the development of needed measures for designing efficient R & D organizations, research is recommended which will:

- Examine the history of technological change in an environment of government participation to (a) try to discover tendencies and directions in corporate adjustment to such change and (b) see if ouch discoveries can be applied to understanding and anticipating present and future changes in the space industry. In applying (b), study is necessary to attempt to foresee the factors which will contribute to the eventual thinning down or expansion of the number and variety of organizations producing prime space activity products. At least a preliminary study is in order on the advantages and disadvantages of various levels and kinds of apportionment of R & D between the space firms and NASA and the advantages and disadvantages of various mixes of multipurpose R & D facilities and special-purpose facilities.

Because regulation is related t o many aspects of government-industry space activities And to policy planning, and because of its importance in forwarding peaceful space activities and its implications for society at large, a continuing research effort should be begun soon on:

- The economic and political objectives of regulation of space activities. Major questions concern which space activities are to be regulated and what contingent factors are involved.

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VIII .GENERAL IMPLICATIONS FOR INTERNATIONAL AFFAIRS AND FOREIGN POLICY

1. Practical appreciation of the long-range international aspects of space activities from the viewpoint of the United States requires study of space plans and events in terms of: the technical features of space projects, United States policies on the user, of outer space and on the goals and conduct of foreign affairs, and the available and required characteristics of institutional arrangements for implementing these policies.

2. The need for increased numbers of individuals with the breadth of understanding for coordinating the international aspects of the technical, social, legal, economic, and political problems of space programs suggests study of the ways in which existing training for these tasks is adequate or can be improved. In particular, attention needs to be given to discovering means for incorporating pertinent knowledge from the behavioral sciences into the training and experience of natural scientists and administrators.

Technological characteristics, costs, and international participation

1. The many novel technical features of existing and proposed space projects can be expected to introduce unusual international situations. These features and conditions associated with them include: the technological requirements for world-wide telemetering and satellite tracking the relative dependence of specific programs on access to specific geographic areas; inspection and regulation through built-in technological characteristics of systems; operation of earth satellites launched anywhere in the world; transport-of men into outer space and their recovery; the possible uses of obsolete space hardware and related equipment abroad for non-space purposes. Each of these invites study to elucidate the international problems posed and to provide answers to them in the light of American space policies and foreign policies. A related area which merits special attention has to do with problems and opportunities pertaining to international sharing of costs, project planning, and operations,

Multinational personnel participation

1. The fact that great numbers of personnel will be needed to implement world-wide space activities presents the United States with opportunities to advance its space and foreign policies through the use of skilled foreign

personnel in connection with our own or multinational space projects. It may also be possible to provide training generally useful for other technological purposes, as well as for space activities, for nationals from countries presently developing their scientific and technical resources for the first time.

2. Certain problems, however, are implied in the use of multinational personnel in space programs. Complications could be introduced by differences in political and scientific procedures, security standards, and language. Equitable apportionment of professional recognition may be difficult, and interpersonal problems may arise from national differences in styles of team research and from differing ideal of the goals and means for space programs. Much research will be necessary to determine the specific potentialities for multinational personnel participation and to solve the problems involved in realizing these opportunities.

Space policy as related to foreign policy

1. The general objectives of United States foreign policy may be significantly affected by our space programs and space policy. Study is thus desirable concerning the implications policy of space activities that influence the attitudes of and the nature and degree of support or opposition forthcoming from international organizations, allies and adversaries, neutral nation--, and individuals and special groups, including scientists. The military aspects of some of our space activities and the actions of nations with competing space systems will be additional important factors affecting the application of space policy to foreign policy -- and these too will merit study. In particular, study is necessary on the inclinations or disinclinations of other nations to support or participate in U. S. space programs as a result or deliberate or inadvertent mixing of U. S, civilian and military space activities.

2. Opportunities to advance and coordinate the objectives of United States space and foreign policy may be provided by systematic advanced planning for legally based regulation and control and appropriate methods for inspecting, observing, an operating space projects and related activities. Such plans and methods require study. In particular, detailed examination is suggested of the operations of existing national, international, and non-governmental organizations which have had experience implementing and guiding

other technical-political activities. Research is also necessary to discover means of evaluating how new types of space pro-,rams and new forms of organization might further United States space and foreign policy objectives, including the possibility of multinational or totally international space programs. In connection with such research, it would be useful to reexamine the assets and liabilities of administrative and diplomatic distinctions such as those between private and official, technical and political, and military and peaceful activities or functions in the light of the profound interrelations of these factors and space programs and policies. There is also need to study the possibilities of using space activities to facilitate other needed international rules, regulations, or controls.

3. Scientists and engineers, acting in their various capacities as nationals, private scientists, and cosmopolitans, may have important roles in influencing space policy and various national reactions to our space policies and those of other nations. Whether or not such influence is likely to be an important factor, and, if so, under what conditions, needs examination.

4. The factors involved in assessing and interpreting, national prestige and in the behavior of other nations and individuals toward a nation assessed as having or not having prestige are poorly understood and would benefit from field studies and experiments. To the leadership and public of an underdeveloped nation, for instance, a display of our space activities may suggest only that United States' efforts and money might be better spent on further assistance in raisin-, their standard of living and in solving social problems that are more importantly pressing to them than the problems of space use. For other such nations, however, an opportunity to participate in the United States space program may be seen as a means for gaining or enhancing their own international prestige and for training personnel in technologies that would also be useful for other technical and scientific tasks of value to national development. More needs to be known about the effects of space activities on evaluations of our humanity and usefulness to other nations.

7. Specific space projects may confront some nations with problems which, given prevailing national attitudes, values, and social and institutional arrangements, they may not be able to manage easily. For example, adjusting to the requirements for applying scientific methods and for

operating functionally designed organizations may involve completely unfamiliar behavior patterns. Research begun now could help such nations to begin altering certain of their life ways so as to permit them to take advantage, with a minimum of disruption, of the future opportunities that space activities may provide.

8. To the extent that the United States intends to compete with the USSR in forwarding its space program in the international arena, it would be desirable to explore systematically the assets and liabilities in certain "asymmetries" in the international positions of the two nations. Such factors as secrecy vs. publicity, feasible alternative space programs, effective internal competitors for funds, relations with scientists in other countries, and access to other nations' territory may be of advantage or disadvantage to one side or the other in pursuing specific space programs for national policy purposes.

Because of the likelihood that international cost sharing may produce results useful for forwarding a peaceful space program, it is recommended that background research be initiated to determine:

- The size and nature of costs that may be sharable for facilities or pieces of hardware required for world-wide networks associated with contemplated space activities. Alternate means for such sharing should also be examined.

It is recommended that a study be made of the problems and opportunities which may be produced by those international organizations which by their purpose and procedures do not make clear distinctions between technical and political subjects (or the other distinctions mentioned above). Understanding of the possible unique contributions of a space program, or its planners and implementors, to the promotion of international cooperation would be Aided and policy planning benefited by a study of:

- The distinctive, complementary, or competing space roles played by existing international groups including the United Nations, UNESCO, the Committee on Space Research, the International Astronautical Federation and others in existence or proposed.

Long-Range planning for United States space activities as part of our foreign policy, and the advantages of optimum use of extranational resources for forwarding a peaceful space program make research desirable to produce:

- A systematic and comprehensive identification of significant political, legal, social, and technological asymmetries in the positions of the United States and the Soviet Union as they may affect the international implementation and effectiveness of possible space projects. (Such a study should include historical and theoretical analyses of the concept of political parity between the Soviet Union and the United States.)

As a prerequisite to further study of the effects of space activities on the attitudes and behavior of decision makers in other countries, research should determine:

- How, in other countries, particular types of space activity influence specific people and the institutions in the governmental decision making process. What other factors enter into the decision making process which may vitiate or amplify, to our benefit or detriment, the effects of particular space activities?

IX. ATTITUDES AND VALUES

1. Science and technology and space activities in particular have the potentiality of reinforcing or changing attitudes and values. A democratic government-sensitive to the implications of its public's opinions, especially in connection with government-sponsored pro-.rams, benefits from exploring and anticipating the impact of its programs on attitudes and values. A major product of space activities has been a variety of stated opinions about the present and future impact of space activities on attitudes and values. Whether or not these statements are valid, they have become common currency and hence can affect public opinion and the interpretation by decision makers of that opinion. Thereby, research on these supposed implications is warranted.

2. The impact of space activities on the attitudes and values of the more thoughtful members of the various publics discussed below is evidenced by their concern with problems of national goals and strategies: i.e., in

terms of national needs and world responsibilities, what is the proper apportionment of our aspirations, funds, and scarce creative manpower? Space, because of the great claims it is expected to make on all of these, thus becomes central to discussions about social, political, and moral priorities, and research is badly needed to supplement these concerns with knowledge and methods for setting priorities.

Selected publics

1. Many of the scientists and engineers directly associated with space activities are enthusiastic about their .work and the uses to which it is being put. Others show varying degrees of disillusion and cynicism, to which a number of factors apparently contribute; it is not known, however, how widespread such attitudes may be. The extent and specific aspects of the situation need study, as do the consequences it may have for space activities and for other activities which can also use these special competences. If the attitudes are widespread and persistent, creative personnel may leave and the type of personnel attracted to space activities may change. Research would help reveal the implications of such changes for the quality of creative work going into space activities. If the, situation is serious, research will be needed on how to produce a more satisfactory relationship between the scientists and engineers of the space community and those who have the responsibility of using their creations for various purposes.

2. The attitudes of astronauts now in training, and their perception of the attitude held toward them and their efforts, may have important implications for their training, their ultimate performance capabilities, and the selection and training of future astronauts. Research is needed on the relation of attitudes and values to aspiration and fulfillment's of performance requirements in this specific situation.

3. There is a range of reactions among scientists outside the space community to space activities. Some are delighted with them as tools for other areas of research; others are indifferent or hostile. If scientific space programs are to expand, they must depend partially on the ideas and support of many scientists -- including some of those in the latter group. Research is necessary to supply a better understanding of the reasons for and extent of these unsupportive attitudes and their implications for the harmony

of the science community, for research in areas other than space, and for space activities. Study is also warranted on means of encouraging participation in space activities by both the natural and social scientists who are favorable to space activities but unfamiliar with the opportunities for making contributions to their own fields through them.

4. Given the role of business in politics and economic life, the attitudes and values of business executives as affected by space events may have important consequences for the future direction and intensity of the space effort. Interviews indicate much enthusiasm, especially for the activities in which science plays a major part. However, further research is necessary to determine the tenacity and depth of enthusiasm and what expectations are held regarding the payoff from space.

5. The impact of space activities on the attitudes and values of today's children is likely to be much stronger than on those of today's adults. Space is "real" to them, since they are not encumbered by a lifetime of attitudes and values that had no need to consider the uses of space. Study of their attitudes and values now and as they change over time under the further impact of space activities and other events, should help in foreseeing the role of space activities in future years as these children become voters and doers.

The general public

1. As with other matters not central to day-to-day living, the public, considered as a whole, is probably only selectively attentive to and knowledgeable about space activities. The relationship between the impact of events on indifferent or only occasionally interested people and their attitudes and values is but partly understood and needs further study.

2. It has been alleged that the "public" is optimistic about space activities. If this is so and if the optimism is widespread, the present support it generates for the space program may not be lasting if the difficulties inherent in space efforts have not been appreciated enough to make the failure of specific projects understandable. The resulting disillusionment may be a serious factor in reducing public support as space efforts become more grandiose, the consequences of payoff more exciting, and the losses from failure more dramatic. On the other hand, this optimism, if it exists, may produce a state of mind tolerant of failures. The factors

affecting optimism, realism, and tolerance of frustration need more study as an aid in preparing for this situation. The roles of the promoter-spokesman and the mass media in encouraging expectations of great and imminent accomplishments are integral to this problem area and would benefit from research.

3. The conviction that space activities will broaden man's horizons are presently based on the perspectives and special interests of a relatively few people in western societies. The claim may be justified, but there is need for research to assist understanding of the conditions under which innovations broaden or narrow perspectives in various cultures. For example, sufficient emphasis on space as the proper expression of man's highest aspirations may result in the evolution of a broadly based belief that this is so. But whether or not this is likely to be the case cannot now be decided in view of our limited understanding of how new ideas disseminate through societies. If and as horizons were broadened as a result of space activities, other aspirations would compete with them for attention and resources, and continuous study would be required to evaluate the appropriate position of space in this competition.

4. Though intelligent or semi-intelligent life conceivably exists elsewhere in our solar system, if intelligent extraterrestrial life is discovered in the next twenty years, it will very probably be by radio telescope from other solar systems. Evidences of its existence might also be found in artifacts left on the moon or other planets. The consequences for attitudes and values are unpredictable, but would vary profoundly in different cultures and between groups within complex societies; a crucial factor would be the nature of the communication between us and the other beings. Whether or not earth would be inspired to an all-out space effort by such a discovery is moot: societies sure of their own place in the universe have disintegrated when confronted by a superior society, and others have survived even though changed. Clearly, the better we can come to understand the factors involved in responding to such crises the better prepared we may be.

5. Man-in-space programs in their early days will confront some groups with value conflicts over the proper circumstances for risking life, family integrity, etc. Arguments are already intense on the merits, or lack of them, of investing heavily in man-in-space efforts. Later efforts may expose astronauts to living conditions with which many of the public cannot,

or will be reluctant to identify. The threat and isolation of space thus emphasized may repel many people especially as urban living becomes ever more the life pattern, and support for these efforts, therefore, might be less forthcoming. In some people, however, the adventures of the astronauts may fire a latent pioneer spirit; support for man-in-space programs might be strong among this group -- but it also might be displaced by their newly stirred personal pioneer aspirations. There may be possibly profound effects on attitudes and values if through the astronaut experiences it is found that the extraordinary abilities sometimes displayed under conditions of extreme physical or emotional stress can be made available to man for use in more normal circumstances.

However, it should be kept in mind that intense solar radiation and heavy-particle cosmic rays may make more than an occasional manned sassy into deep space too dangerous to be practical during the time period under examination. If so, the consequences for attitudes and values are not clear. Understanding of the impact of the man-in-space program on attitudes and values in general, and on those toward the program itself in particular would benefit from a series of studies of public Expectations and beliefs as these change over time.

Since commitment of effort to competing programs for social betterment fundamentally depends on attitudes and values about their relative merits, a research area with potentially profound implications for society and space activities which is also urgent for policy purposes concerns the development of:

- Systematic methods for assigning priorities between competing scientific and social efforts (where competition may be over the long term and involve personnel, money, public support, and conflicting attitudes and values).

A variety of more specific studies on public opinion and values as affected by space activities will depend on research providing trend data describing:

- The state of knowledge, values, and attitudes regarding space activities, both on-going and contemplated; and what assumptions, expectations, and values underlie the attitudes and interpretations of this knowledge. What are the effects

over time of new knowledge and events on attitudes toward space activities, and what are the effects of the sources of information on the acceptability of the information?

In view of the conflicting attitudes and values so far expressed about the Mercury program, and in view of the possible favorable and unfavorable consequences of astronaut launchings, it is urgent to plan studies that would provide information on what the public needs to know And would assist in interpreting public reactions by determining:

- Present public knowledge and expectations about, and underlying attitudes toward, the Mercury program and the astronauts. These should be continuing studies so that the impact of events can be anticipated, evaluated, and planned for.

While the discovery of intelligent life in other parts of the universe is not likely in the immediate future, it could nevertheless happen at any time. Whenever it does occur its consequences for earth attitudes and values may be profound. Hence a long-term research effort, which would aid in preparing for this possibility, could usefully begin with:

- A continuing determination of emotional and intellectual understanding and attitudes regarding the possibility and consequences of discovering intelligent extraterrestrial life.

While space activities offer a special opportunity to study the relationship of innovation to social change, understanding the relationship will require examination of other innovation situations, too. Research is recommended to determine:

- What factors historically have entered into support or rejection of new ideas or technologies. What was and wasn't appreciated about the potentialities (or lack of them) in the innovation and under what personal and social circumstances did this occur? In particular, what were the roles of physical environment, politics, personalities, limited systems analysis capabilities, insufficient communications to decision makers, etc.?