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THE SPACE INDUSTRIALIZATION ACT OF 1979

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HEARINGS

BEFORE THE

SUBCOMMITTEE ON

SPACE SCIENCE AND APPLICATIONS

OF THE

COMMITTEE ON

SCIENCE AND TECHNOLOGY

U.S. HOUSE OF REPRESENTATIVES

NINETY-SIXTH CONGRESS

FIRST SESSION

ON

H.R. 2337

MAY 22, 23; JUNE 26, 27, 1979

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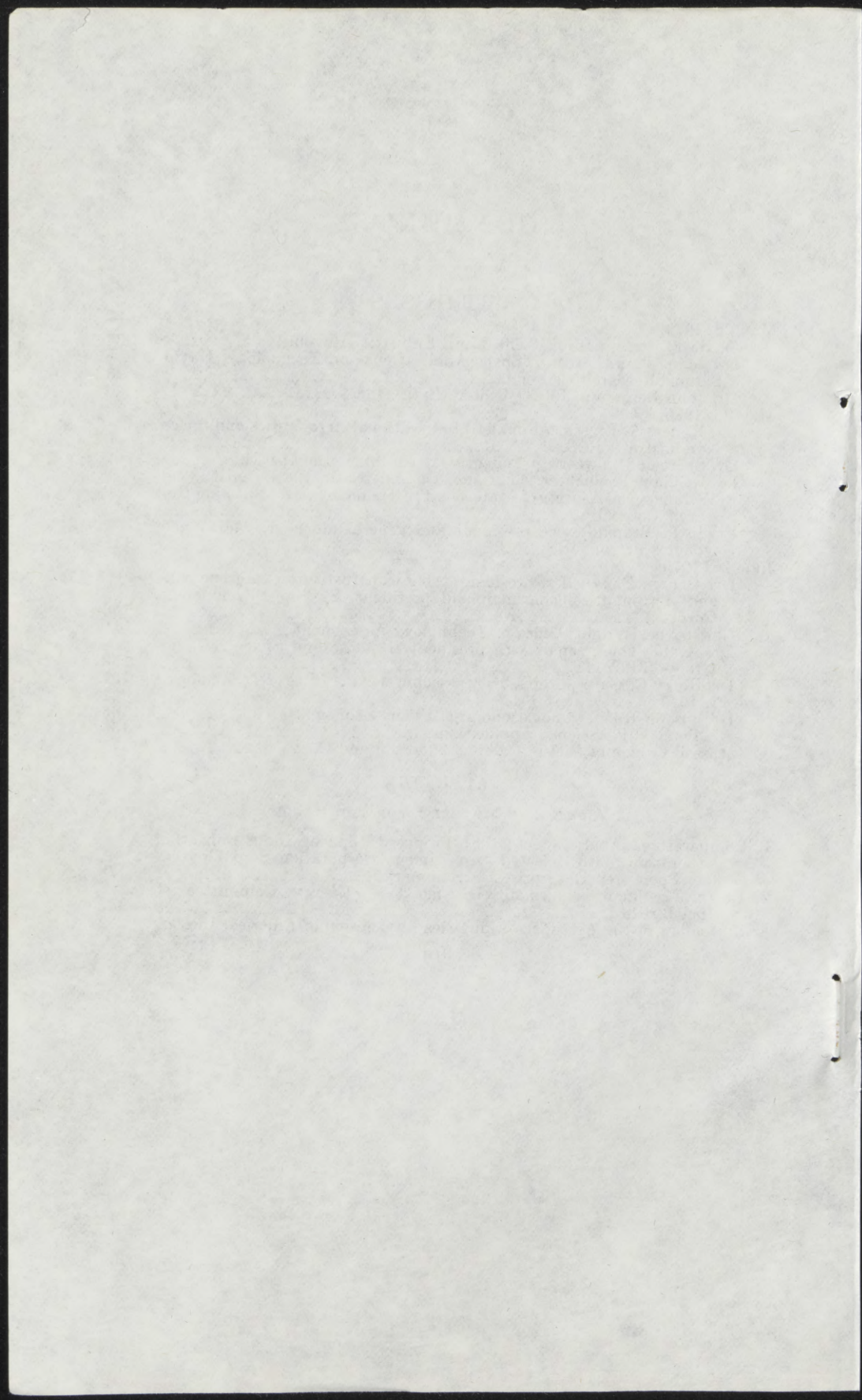
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THE SPACE INDUSTRIALIZATION ACT OF 1979

TUESDAY, MAY 22, 1979

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS,
Washington, D.C.

The subcommittee was convened at 2:10 p.m., in room 2325, Rayburn House Office Building, Hon. Don Fuqua, chairman of the subcommittee, presiding.

Mr. FUQUA. The subcommittee will be in order.

This afternoon we begin hearings on the Space Industrialization Act of 1979. The bill, H.R. 2337, would establish a Space Industrialization Corporation to provide a means for financing the development of new products, processes, and industries using the properties of the space environment.

The bill does not place limitations on the scope of space industrialization but recognizes that materials development and processing of terrestrial materials in space offer early opportunities for commercial applications. Indeed, we should not attempt to anticipate the ultimate commercial uses of space—we already have communication satellites and are moving, hopefully, in the direction of operational earth resource systems.

The important effects of microgravity on materials as demonstrated on Apollo, Skylab, and Apollo-Soyuz missions, as well as on unmanned sounding rockets, offer promise of unparalleled opportunities for developing new materials and material processes.

Space Shuttle and Spacelab will greatly expand these opportunities and provide access to near Earth orbit for extensive and routine space operations. We must insure that the utilization of these new space transportation systems for applications having commercial and industrial importance are pursued in a timely manner to further capitalize on the Nation's investment in the space program.

Private sector innovation and creativity in product and process applications, as well as understanding of market needs, dictate the importance to the Nation of early participation from broad and diverse industries and businesses. H.R. 2337 was introduced to address the problems of the private sector in developing space processing capabilities and to provide a thorough and orderly examination of the means to reduce the business venture risk of using space for commercial purposes.

The subcommittee is encouraged by NASA's efforts to incorporate private sector needs into NASA's materials processing in space program, and we look forward to Dr. Frosch's testimony tomorrow.

During the hearings the subcommittee will examine issues asso-

ciated with the prospects for commercial ventures in space, the role of the Federal Government, and the appropriate mechanism for fostering entry of the private sector, and we will assess the Federal initiative of the proposed legislation.

Our first witness this afternoon is Mr. Harry Stine who is the author of "The Third Industrial Revolution." Mr. Stine testified last year at the hearings on future space programs and we welcome him back today.

The second witness is Dr. John Clark, director of space applications and technology at RCA's David Sarnoff Research Center. Dr. Clark was formerly the Director of NASA's Goddard Space Flight Center.

Our last witness is Dr. John Benjamin, research manager of the metals department, INCO United States, Inc.

PREPARED OPENING REMARKS OF CONGRESSMAN GEORGE E. BROWN, JR., OF
CALIFORNIA

In the 22 years since the launching of Sputnik, we have seen marvelous advances in the field of space exploration. Man has orbited the Earth and walked on the Moon. Unmanned probes have landed on Mars and flown by Jupiter.

Today, satellite communications and remote sensing are so routine as to be taken for granted. Progress has been so rapid that we are still somewhat stunned by it all. The time has come for us to see in what directions we wish to go and what institutional structures are needed to proceed.

This committee made an excellent start last year with its hearings on future space programs. Today's hearings should be a most informative continuation of that learning process.

Last year we learned of some of the potential products of space manufacturing:

- (1) crystals
- (2) bearings
- (3) high strength alloys
- (4) fiber optics
- (5) cobalt/rare earth magnets.

We also learned of some of the barriers to progress in space industrialization. Some of these were:

- (1) The products are poorly defined at this time.
- (2) The markets are too indefinite yet.
- (3) Some terrestrial alternatives appear cheaper.
- (4) The experimental data is too soft for industrial use.
- (5) Many things taken for granted by space advocates are really theoretical and their basis is yet unsubstantiated.
- (6) The risks are very large relative to the capital outlay required.
- (7) The return on investment period is too long.
- (8) Space transportation costs are too high by a factor of 100 or more in most cases.

Many of these barriers are simply due to a lack of hard facts. How are space manufactured alloys superior? What will they cost? Will there be a market? An enormous amount of R. & D. must be done in this area. Cooperation between Government and industry is essential.

Mr. Chairman, I hope that the present hearings will give us guidance in the directions of the R. & D. and in the institutional arrangements necessary "to encourage innovation and creativity in the uses of space for the benefit of mankind."

Mr. Chairman, as important as these questions surrounding space industrialization are they are only a small subset of a broader set of questions we must address about the wide range of uses of near space. Given the limited amount of resources, of qualified people, budget authority and even of "air space" in near Earth orbits, it is important for this committee to consider carefully the priorities in using these scarce resources. It is my hope that the hearings today set the stage for these broader space policy questions.

Mr. FUQUA. We are happy to welcome Mr. Stine. Please proceed.
[The prepared statement of Mr. Stine follows:]

STATEMENT BY

G. HARRY STINE

616 West Frier Drive

Phoenix, Arizona 85021

THE SPACE INDUSTRIALIZATION CORPORATION:
MAKING THE THIRD INDUSTRIAL REVOLUTION HAPPEN.

Submitted to

The Committee on Science and Technology

U.S. House of Representatives

May 22, 1979

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BIOGRAPHY OF G. HARRY STINE

G. Harry Stine is an engineer, a high-technology marketing consultant, a futurist, and a science writer. He received his B.A. in physics from Colorado College in 1952 and went immediately to work at White Sands Proving Ground in New Mexico. He has been associated with astronautics for over a quarter of a century. He is the author of more than twenty books on science, technology, and astronautics including "The Third Industrial Revolution," published originally in 1975 by G. P. Putnam's Sons in New York and released this month in up-dated form by Ace Books in paperback. This is the first and only book about space industry published to date. As early as 1957, he was involved in forecasting and planning studies of future space programs. He has performed future studies for the Hudson Institute, the Institute for the Future, Booz Allen Applied Research, Inc., and Science Applications, Inc. He was science consultant to CBS-TV News Special Events for Apollo-11 and is consultant to the National Air and Space Museum of the Smithsonian Institution. He is a Fellow of the Explorers Club and the British Interplanetary Society, an Associate Fellow of the American Institute of Aeronautics and Astronautics, a member of the New York Academy of Sciences, and the Chairman of the Committee on Pyrotechnics of the National Fire Protection Association. He has been a private pilot since 1946 and owns his own aircraft. He has seen the space program from many vantage

points as a civil service engineer, engineer for an aerospace firm, president of the first company to manufacture model rockets for the hobby trade, manager of an industrial research laboratory, and marketing manager for a non-aerospace instrument manufacturing firm. On the Tenth Anniversary of the launching of Explorer-I, America's first earth satellite, he was awarded a silver medal by the Association of the United States Army as one of fifty American space pioneers. He is now a consultant in the field of high-technology marketing and one of the founders of the concept of space industry. He is currently writing a comprehensive book on space industrialization tentatively titled "The Space Enterprise," to be published by Grosset and Dunlap later this year and a book about life styles of the Twenty-First Century for another publisher. He resides at 616 West Frier Drive, Phoenix, Arizona 85021.

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The opinions and statements herein are those of the author and do not necessarily reflect the views, opinions, or policies of any organization to which he serves as a consultant, contractor, or volunteer.

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STATEMENT

The 1970 decade will be remembered in the annals of aerospace history not only for the feats of astronauts and cosmonauts and the outstanding successes of unmanned interplanetary probes, but also for the profound change that occurred in our outlook and concepts of space. This is not meant to belittle the achievements of Apollo, Skylab, Soyuz, Salyut, Pioneer, Mariner, Viking, or Voyager, among others, but to point out that people have now come to the realization that these are exploratory ventures into a new ecological niche. They provided data indicating that the Solar System was a useful place and that people could live and work in space to bring its benefits to our limited planet.

The Austrian space pioneer, Guido von Pirquet, once said, "With regard to large space projects, there are three things to do: one, get the money; two, get the right people on the job; and, three, get the wrong people off the job." He was eminently correct in his assessment of the situation, even as it exists today.

We now know from various studies and from actual experiences in space that (a) space is a useful place for doing things that will greatly assist us in solving many of our earthly problems, and (b) it costs and is going to continue to cost a great deal of money.

This is really nothing very new. Everything that we have ever attempted as a people and as a nation in the way of constructive activity has always been in response to the problems of the day and has always cost us a great deal of money.

The capital investment in every one of the 99 Major Groups of the "Standard Industrial Classification Manual" of the Office of Management and Budget staggers the imagination. We could not afford to replace the capital investment in even a single Major Group in less than many years because this investment represents many years of slow, patient and careful accumulation of capital with a continual evaluation of the risks involved and a reasonable assurance on the part of investors that there would be a good chance for a return on their investment within a ten to twenty year time period.

Nothing is different in this regard when it comes to the industrialization of space. Every businessman with whom I have discussed the subject of space industrialization has told me two things: (a) he wants to be kept informed, and (b) he might consider becoming involved if there was some way to reduce the risks involved because of all the presently unknown factors.

There is only one area of space industrialization today that possesses what financiers, planners, executives, and other businessmen look for: a proven track record. Space communications

via satellites is now a proven business proposition. In the other areas of space industrialization -- solar power from satellites and new products from space factories -- the data required in order to make rational business decisions isn't there. Businessmen still feel that the data is too "soft," that much of it is conjectural, and that much of it is taken for granted by advocates. High space transportation costs bother them greatly. Many of them have reported that some proposals for materials processing in space would not weather the standard new product reviews to which they routinely subject all new product ideas. On the basis of the data now in hand, they feel that the risk is too high in comparison with other ventures that are available to them. They also see capital requirements that appear to be very large, and they cannot see any possibility of a return on investment within an acceptable time period. An "acceptable" time period ranges from one to two years for some companies up to as much as ten years for some very large, highly diversified corporations.

However, American domestic industry intends to keep tuned in on this potentially profitable area. They will test the waters on a continual basis because each company does not want to be left out of the picture should the picture develop...especially if their competition is in the picture.

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There is therefore an expressed need in the mechanism of American governmental/industrial operations for some device to reduce the risks involved in the initial participation in space industrialization ventures.

This is not the first time such a situation has arisen in history. And, in each instance, some new type or form of social organization has been developed. This is especially true in American history where the federal government has usually been amenable to creating a mechanism to reduce industry's high risks in new ventures. There has emerged in this nation a unique government/business relationship aimed at reducing risk.

The long-term policy of the federal government in this regard may best be summarized by the statement of President Thomas Jefferson as he presented to Congress the report of the expedition of Lewis and Clark: "The interests of commerce place the principle object within the constitutional powers and care of Congress, and that it should incidentally advance the geographic knowledge of our own continent cannot but be an additional gratification."

One of the first actions of Congress was the funding of the construction of the National Road so that the farmers of the Ohio River valley could ship their grain to markets on the East Coast without having to convert the grain into more easily transported grain alcohol.

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Early in the Nineteenth Century, the federal government provided funds, loans, and guarantees for the construction of the canal system that was an important mode of transportation before the coming of the railroads.

When the capital requirements and subsequent financial risks associated with building extensive railroad systems became very large, the federal government stepped in again. The Pacific Railroad Act of 1862 was enacted in the midst of the Civil War. The Honorable Henry Wilson of Massachusetts said in the Senate at that time, "I would sink a hundred million dollars into opening a railroad and do it most cheerfully, and think that I had done a great thing for my country. What are seventy-five or a hundred million dollars in opening a railroad across the central regions of this continent that shall connect the people of the Atlantic and Pacific and bind us together?"

(The hundred million dollars of 1862 would be equivalent to seventy-five billion 1979 dollars.)

Congress recognized the need of domestic industry in America's heartland, the Mississippi River basin, for a more direct ocean shipping route to markets in the Orient. The result was the Spooner Act of 1902 which authorized the construction of the Panama Canal. More than any other factor, this better route to markets resulted in the development of America's industrial and agricultural heart.

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Ask yourself what the American Midwest and West would be like today without only two examples of congressional action to assist American industry. These examples are (a) the Morrill acts that set up the land grant colleges which, in turn, raised the educational level of millions of Americans which, in turn, made our broad prairies into the breadbasket of the world and also allowed educated people to create new products and industrial techniques; and (b) the Reclamation Act of 1904 that not only encouraged the development of America's lumber and paper industries, but also created vast new farmlands and whole new cities where only prairies and deserts had stood before. These two actions of Congress changed our country, assisted American industry, and created extensive environmental conservation long before the environmentalists gained attention. Look at old photographs of the American West; sparse saplings and scrub brush are visible where verdant stands of timber exist today.

The United States Postal Service may be the object of considerable criticism today. But, without its predecessor, the Post Office Department, it is exceedingly doubtful if the United States would be the world leader in commercial aviation today. It was the Kelly Act of 1925 that took the actual flying of the air mail out of the hands of the Post Office Department -- who had been trying to fly the mails with a small, inadequate fleet of Curtis "Jennies" and DeHaviland DH-4 aircraft -- and

put the transportation of the air mail up for contract bid by commercial firms. Without these contracts for flying the air mail, the early airlines might not have survived. Today's major trunk airlines can trace their roots back to those first 1925 air mail contracts.

American industrial output today moves by ship, by rail, by air, and by road. It was Congress who gave the impetus to the trucking industry through the Highway Revenue Act of 1956. This established the interstate highway system and its financing trust fund. There was more than commercial need involved; the interstate highway system impacted defense needs as well as personal transportation needs. It was the greatest road-building program in history. It took the Roman Empire about 500 years to build about 50,000 miles of narrow, brick-surfaced roads. In a mere quarter of a century, Americans have more than equalled that mileage with four-lane, high-speed divided interstate highways.

Even in the new area of space industrialization we find an important historical precedent: the Communications Satellite Act of 1962. It is not possible to determine the financial and intangible benefits that have accrued to American industry from the worldwide audio, video, and data transmission capabilities resulting from communications satellites. And it is totally impossible to assess the long-range impact of instantaneous worldwide communications on the political, economic and cultural aspects of human life on this planet. Many people

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now take comsats for granted. Eric Hoffer remarked, "Despite the drastic changes all around us, it is remarkable how rare is the sense of newness." And Robert A. Heinlein has reminded us, "There is nothing as commonplace as a ninety-day wonder on the ninety-first day." It is now possible to make a direct-dialled telephone call to sixty-four countries for less than ten dollars from any telephone in America...and there is now one telephone for every two people in the United States.

Historical precedence exists for government assistance to American industry. These historical precedents have had a major impact on our nation, our industry, and our people. The "spin offs" have far exceeded the most sanguine expectations of those who proposed and supported these measures. There is no reason to believe that we cannot continue this historic trend. The expressed need of American industry is there. The time is ripe. We must only determine how to do it...and then do it.

Rudyard Kipling advises us:

"There are nine-and-sixty ways
Of writing tribal lays
And every single one of them is right!"

I recently participated in a study for the Department of Energy concerning ways to finance and manage a solar power satellite system, one area of space industrialization. Kipling was right. There are a lot of ways that we could do it. All of them will probably work. But some will work better than others.

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It is a truism in the business world that ownership and control of a business enterprise are two distinctly separate and different things. It is possible to own something without controlling it, and vice-versa. It is also true that financing and managing a company are two different things. And "ownership" may be equated with "financing," while "control" is equivalent to "managing." One should always look at the operation of any social organization with this in mind. The permutations and combinations of these two factors creates a continuous spectrum of organizational entities ranging from total socialistic collectivism on the far left to laissez faire capitalism on the far right. However, when considering how a large, high risk, long term, capital intensive space industrialization enterprise might be financed and managed, we had only the time and the funding to consider ten possible organizational forms. The details may be found in Reference 1. Briefly, they are as follows:

1. Existing government agencies as operational government owned and managed monopolies.
2. A new government agency analogous to the Tennessee Valley Authority such as the "Space Utilization Authority" proposed by Philomena G. Grodzka (Reference 2).
3. The "taxpayer stock corporation" such as proposed by George E. Fredericks and Richard D. Stutzke; this would be a

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government-chartered corporation whose common stock would be issued to a taxpayer on the basis of an equated portion of his Federal Income Tax, stock which the taxpayer is free to hold as a long-term investment if he favors the goals of the corporation or sold on the open market if does not. (Reference 3)

4. A trust fund analogous to the Federal Highway Trust Fund supported by taxes on energy and communications and dispersed by a government agency to support and encourage activities in space industrialization.

5. A new federal agency supported by long-term bonds backed by the Treasury, an analogy to the Federal National Mortgage Association which might be called the Federal National Space Projects Association, or "Fanny Spray" for short.

6. The staging company concept already incorporated in the State of Delaware on August 3, 1978 as International Satellite Industries, Inc. by attorney Christian O. Basler of New York who first proposed this new concept (Reference 4.)

7. A government-chartered monopoly analogous to the Communications Satellite Corporation with ownership divided between the general public and participating industries.

8. A consortium of private companies which has been the "classical" and highly successful method of tackling such large, expensive and risky projects as the Trans Alaska Pipe Line.

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9. The "corporate socialism" model patterned after the Union Pacific Railroad Company which was chartered by Congress and given the authority to construct and operate the first transcontinental railroad financed by a combination of equity capital, government loans, government grants, and government guaranteed loans. (Most people think of the infamous Credit Mobilier when this organizational format is mentioned, but it is only fair to point out that the United States government got back every penny, plus interest, before 1895.)

10. The "universal capitalism" model proposed by Louis O. Kelso (Reference 5) as an economic reform permitting wider participation in ownership of common stock by workers on the program.

Of course, we must now add an eleventh organizational form to this list, the proposed Space Industrialization Corporation of H.R. 2337 which is an innovative synthesis incorporating some elements of numbers 2, 4, 5, 6 and 7 in the above list.

When considering any organizational form to handle the financing and management of such very large, risky, long-term and expensive programs, one must subject each concept to an evaluation against specific criteria consisting of characteristics that should be possessed by a successful organization capable of handling all the factors. There were neither time nor funds available for evaluating any of the proposed organizational forms

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against any criteria, but this did not prevent the establishment of the criteria. Briefly, these may be summarized as follows:

A. Ability of the organizational form to obtain the necessary capital for complete implementation of the total program, probably on a time-phased basis, without the threat of undercapitalization which causes the failure of so many ventures.

B. Appropriate distribution of both the risks and the benefits.

C. Possibility of the broadest sort of participation in the financing and the rewards.

D. Continuity, stability, and flexibility of the organizational form in order to react in a timely and appropriate fashion to rapidly-changing and fast-developing new technologies, some of which will not proceed in forecast directions, while at the same time adhering to a less rigidly defined long-term goal.

E. Ability to capitalize on spinoff technologies.

F. Possibility for foreign sales and participation.

G. Lack of obvious domination by either "big government" or "big industry" while at the same time protecting the technological advantages to be gained.

H. Minimum identification with military activities.

It is interesting to note that initial, "quick-look" evaluations by individuals were heavily biased by the individual's political/economic ideology.

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My own bias is summarized in the following statement by historians Will and Ariel Durant from their book, "The Lessons of History" (Reference 6):

"The experience of the past leaves little doubt that every economic system must sooner or later rely upon some form of the profit motive to stir individuals and groups to productivity. Substitutes like slavery, police supervision, or ideological enthusiasm prove too unproductive, too expensive, or too transient. Normally and generally, men are judged by their ability to produce..."

The proposed Space Industrialization Corporation of H.R. 2337 amounts to an innovative synthesis of the very best features of historic American examples of government-industrial cooperation tailored to the needs and conditions of today. It is a well-conceived response to the expressed need of American industry for reduction of the high risk of initial participation in space industrialization. It includes opportunities for wide participation by private enterprise and by individuals as well as by established corporations. Unlike many government programs, it contains within its legislative mandate the requirement that all tax monies expended by the Corporation during its formative period be reimbursed over the long term. It is designed to pay for itself. As an American taxpayer, I applaud this feature. Since there are never 100% successes in any venture into new

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areas, the proposed Corporation possesses the necessary policies from the start for handling unsuccessful attempts and for disseminating the data to prevent "re-inventing the wheel." The Corporation is a concept that is balanced between government and private participation. It is proposed with operating policies designed to encourage participation, accountability, control, and eventual phasing-over into an integral part of our private enterprise system. The proposal reveals an exceptionally astute knowledge of modern management techniques.

Furthermore -- and most important in these times of demand for reduction in government spending -- the cost is trifling. The proposed annual budget for the Space Industrialization Corporation of a mere fifty million dollars is roughly one-fifth of the cost of our first earth satellite launch program, Project Vanguard, of little more than twenty years ago. Although Explorer-I was first, out of Project Vanguard came most of the elements of today's space launch vehicles, comsats, weather satellites, and earth resources satellites, a fact which belies the poor public image which has unfortunately been attached to this pioneer program. The proposed Space Industrialization Corporation budget is similar seed money because even the most conservative market studies in the area of space materials processing indicate that, twenty years from now, annual revenues from space materials can be as much as

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ten times the total amount budgeted as seed money over the same twenty-year time period.

I am especially encouraged by the "looseness" of the Space Industrialization Corporation as proposed in H.R. 2337. I have often expressed serious reservations about a government corporation being established in the area of space industrialization, but I do not have these reservations with respect to the proposed Corporation. It is not a government monopoly, but a device for ground-breaking -- or perhaps "space breaking" is a better term. This "looseness" is an absolute requirement for any organization that will deal with the future. Anthropologist Carleton S. Coon has stated, "Our overwhelming problem is not to plan the future in detail, but to tackle these key problems and to follow each of them through to its natural conclusion." (Reference 7)

One thing is, however, of greatest overriding importance. Over the past two years, the nation's most creative thinkers, philosophers, writers, futurists, planners, and businessmen have told you and your colleagues in the Senate that the time is ripe for action in the utilization of space. It is obvious and encouraging that H.R. 2337 shows that you have listened and taken action. We can fervently hope that Congress and the Administration will also listen and act on this.

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I have discussed history not because I am wedded to the past, but because I am interested in the trends of the past that are leading us to tomorrow. A people that does not know its own past will have no future. And history tells us that a vacuum draws people, commerce, nations, and civilizations into it. We now know that there is a vacuum in the Solar System -- literally and figuratively. If it does not draw into it the industrial strength of the United States, it will most certainly draw in others. The time for contemplation has passed. It is now safer to be a bit reckless and make a few mistakes than to be fearful and sink into inaction.

We can do it.

We will do it.

We must do it.

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REFERENCES

1. Vajk, J. Peter, et al, "Satellite Power System (SPS) Financial/Management Scenarios," Report HCP/R-4024-03, U.S. Department of Energy, October 1978, NTIS, Springfield VA 22161.
2. Grodzka, P.G. and Tevepaugh, J.A., "Expanding NASA's Charter To Facilitate Space Utilization," Advances in the Astronautical Sciences, Volume 36, Part 2, pp. 627-645, American Astronautical Society, P.O. Box 28130, San Diego CA 92128, 1978.
3. Fredericks, George E., and Stutzke, Richard D., "Space Colonization: Its Inevitability and Its Financing," copyrighted mimeo, 1977, available from R.D. Stutzke, Science Applications, Inc., 2860 South Circle Drive, Suite 2224, Colorado Springs CO 80906.
4. Basler, Christian O., "Space Industrialization, the Challenge to Private Enterprise Capitalism," Advances in the Astronautical Sciences, Volume 36, Part 2, pp. 1063-1079, American Astronautical Society, P.O. Box 28130, San Diego CA 92128, 1978.
5. Kelso, Louis O., and Hetter, Patricia, How To Turn Eighty Million Workers Into Capitalists on Borrowed Money, Random House, New York, 1967.
6. Durant, Will and Ariel, The Lessons of History, Simon and Schuster, New York, 1968.
7. Coon, Carleton S., The Story of Man, Third Edition, Revised, Alfred A. Knopf, New York, 1969.

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STATEMENT OF G. HARRY STINE, AUTHOR, "THE THIRD INDUSTRIAL REVOLUTION"

Mr. STINE. Thank you, Mr. Chairman. I would like to offer an apology. "The Third Industrial Revolution" has just come out in paperback and there are 20 copies of it somewhere between the publisher in New York and the committee. I am sorry they did not arrive in time so that each member of the committee could have a copy. I will certainly see to it that you have a copy before the day is up.

I will not repeat my written statement, sir, but I would like to add a few suggestions and caveats if I may, especially with regard to the organization and operation of the proposed Space Industrialization Corporation. These comments come from some 25 years experience in both government and private organizations, and from a great deal of training and experience in management. There are three basic principles of management that I am sure most of you are well acquainted with. The first of these is delegation of responsibility for carrying out a given duty. The second is the delegation of authority to accompany the delegation of responsibility. And the third is the requirement for control, which is usually exercised in some form of restraint detailed in policy statements or budgetary amounts. This is old hat to anyone who has ever been in a management position.

It is this third area of control to which I would address my suggestions today. I feel there should be some limit placed upon the management of the Corporation while it is still a wholly-owned Government organization in order to forestall the possibility that the Corporation might grow into some huge, expensive, and unwieldy bureaucracy that would be difficult for domestic industry to approach, to work with, or to communicate with.

I feel a limit should be placed upon the amount that could be expended on "administrative and other expenses." Perhaps this could be a percentage of the annual budget for the Corporation; say, 10 or 15 percent. This would give Congress some control over the situation, and it would permit you to limit the natural growth of this new Government entity.

It is a natural propensity of managers, whether they be in government or industry, to engage in a certain amount of empire building. There is probably less of this in domestic industry than in government, because domestic industry's management is sharply attuned to the marketplace, to the profit-and-loss statement, and the desires of stockholders. However, empire building exists in large companies, too, where cash flow and capital requirements are not the critical problems that they are in small companies.

I would think you would want the proposed Space Industrial Corporation to be lean, trim, and efficient, particularly because you want it to pay back its seed money as quickly as possible. So move now to keep it a little lean and a little hungry. It will work better, a lot better.

I believe there is another limit that should be included in the act and this should be a time limit in which to achieve success. As it stands, now, the Corporation could go on forever as a Government-financed entity. Give the corporation a time limit to make the grade and to convert itself into a public corporation. Also, sweeten the pot a little bit for

becoming successful in less than the time limit. Give the managers of the corporation an incentive to succeed as quickly as possible. Now, what sort of time limit should be imposed?

I would say that if the Space Industrial Corporation does not make the grade and turn itself into a public corporation by the 21st century, it just has not done its job well. Give it until 11:59 p.m., eastern standard time, December 31, 2000 A.D., the final moment of the 20th century. That gives it about 22 years. We expect any child to grow up and be able to cut it for himself in 21 years. Why not the Space Industrialization Corporation?

Now if space industrialization is not a reality by the 21st century, either America has completely lost its will and its nerve and its ability to take a risk—and is therefore on the skids—or space industrialization has turned out to be a chimerical dream that would not work anyway. If that's the case, let's put it out of its misery.

One final point: If you want this act to become reality, if you want the resulting Space Industrialization Corporation to succeed and pay back everything you put into it as seed money, communicate. Get the word out to American industry; not just the aerospace industry but American domestic industry. Use the Department of Commerce. It has contact with most American industry. Use the industrial news media, the thousands and thousands of industrial management and trade magazines that reach into every nook and cranny of all of the parts of the Standard Industrial Classification Manual. Now this isn't difficult, but you've got to have people who know what they're doing when it comes to communicating with industry. Domestic industry talks a different dialect of the English language than Government agencies.

Domestic industry is interested in different aspects, and industrial managers just simply don't have time to read or listen to anything that does not offer them ways to solve their pressing, everyday problems or to do anything except to read about the news of a threat from the competition or to their business, because time is money. The whole story of the Space Industrialization Corporation and what it can do for domestic industry must be boiled down into one single-spaced, typewritten page that will grab the industrial manager's attention and convince him he should look into it further and tell him how to get involved. Put it in the Federal Register if you must, but also get the story into Forbes, Business Week, Wall Street Journal, and Fortune. Let the world of business know that you want to help them into this new frontier, and then let them know what the Space Industrialization Corporation can do for them once it becomes a reality.

I recently had several articles on space industrialization and space tourism that appeared in Omni Magazine with a circulation of 1.2 million. The feedback I got from those articles was rather fantastic—telephone calls saying, "Mr. Stine, you're not with NASA, are you?" "No, sir, I'm not." "Are you with any corporation?" "No, sir, I'm not. I'm all by myself as a consultant." "Oh, good, then we can talk to you, but please don't mention that we did talk to you. What is it about the space industrialization thing?" Macv's doesn't tell Gimbel's. There are a lot of small companies out there, big companies, too, that are interested. They want to know more about it. They want to know how to get involved, but they don't want to let their competition know.

I think you have a winner here, sir. With some fine tuning, it is going to work very well. It really faces a reality that has been summarized by Robert A. Heinlein as follows: "Never appeal to a man's better nature. He may not have one. Invoking his self-interest gives you more leverage."

Mr. STINE. Thank you, sir. I would be happy to answer questions.

Mr. FUQUA. Thank you very much, Mr. Stine, for very interesting and informative comments about the bill. You have made a couple of points that intrigue me and that I think have a great deal of validity. One you mention is the time frame and I think that is a very valid point, some type of sunset provision should apply so that it is reviewed and an accurate assessment can be made of its progress, potential progress, where it is going and where it is coming from. I think that is a very valid point. I am wondering if the year 2000 is not maybe too far a time limit and maybe it should be evaluated some time after 10 years of operation, if it can go on its own at that point.

Mr. STINE. I think there should be almost a continual evaluation of it, sir, but certainly there should be an ultimate limit. I chose the date because it is the end of the 20th century. It could be sooner, and I would hope it would be sooner. It can be sooner. I think it can be much sooner.

Mr. FUQUA. Mr. Winn?

Mr. WINN. I just have one question. Thank you, Mr. Chairman.

On the timing, Mr. Stine, why do you think now is the time? I'm not advocating this, but could it wait 5 or 10 years?

Mr. STINE. Oh, it could wait 5 or 10 years, and we could have waited 5 or 10 years to build a transcontinental railroad or the Panama Canal or to pass the Kelly bill for airline subsidies of mail contracts. We could have waited 5 years for the communications satellites, but Americans are known for taking action, and we can take action now. If we don't take action, we may sink into inaction.

There's really no horrible rush to this. As Dennis Meadows and Forester and some of the people at MIT have pointed out as to the limits of growth, that certainly doesn't drive us to do space industrialization, unless we don't do it at all. If we haven't done something by the year 2000 or 2010, then we are in trouble. But 5 or 10 years wouldn't make that much difference—except the West Germans or the Soviets or the Japanese may be ahead of us by that time. The Soviets are up there now doing it. They are doing something. I don't know what they are doing, and I'm not so sure that if we asked them that they would tell us.

Mr. WINN. You really just want to get on with it as soon as possible because you want us to be No. 1?

Mr. STINE. Yes, sir, I do. And I think furthermore that there is an opportunity here for creating new jobs, for creating new industries, for creating an accumulation of capital and along with that, of course an increase in taxes. The time is ripe. The feedback I get from American industry says, "We're interested, we'd like to know more about it, but it's a little bit too risky at this point for use to really commit to it. First of all we want to see the Space Shuttle fly and we'll be a little happier. But if there were some way that the Government could even out this risk, assume some of the risk, perhaps change some of

the tax laws to allow us to do a faster writeoff on our R. & D. costs, tax incentives or something like the Space Industrialization Corporation, I think we would see some progress." I am sure you are aware that the West Germans have pretty much committed to space industrialization and space processing. I'm sure the Japanese are in there, too. And, as I say, the Russians are up there right now in Salyut.

Mr. WINN. How do you envision the role of the institution say 10 or 20 years after its inception?

Mr. STINE. By 10 or 20 years after its inception, sir, if it has been successful and if space processing and materials processing of products from space is a reality, it will, of course, be a public corporation. If it is not, we should have some form of sunset law that puts it out of its misery.

Mr. WINN. Some type of termination clause.

Mr. STINE. Yes, sir. In other words, go public before a certain date or go out of business.

Mr. WINN. Thank you very much, Mr. Chairman.

Mr. FUQUA. Mr. Stine, you mentioned another part that I thing is very important and that is that it should be lean. We don't want it to become a bureaucratic organization. Do you have any idea what size this should be and how many people should it be, not that we should put a limit on it—maybe we should—but how big an organization would you envision it would take to operate this?

Mr. STINE. Well, if you're going to fund it initially—

Mr. FUQUA. Like officers and so forth?

Mr. STINE. You are going to fund it initially, sir, at around \$50 million per year, which is paltry. That is about one-quarter the cost of Vanguard—a miniscule sum, really—and if you want to hold your administrative and overhead costs down to 10 to 15 percent of that, this means you're going to have to have a president, vice president, a secretary, a treasurer, and secretaries to help them out and perhaps a chief scientist. I would say certainly no more than 20 to 30 people to start with. Keep it lean. Take that seed money that you are putting in there and don't put it into administrative expenses. Get it out to American industry where it will do the job it is intended to do. Keep it lean—20 to 30 people. I once ran a research laboratory with only 20 people. We were turning out two or three patent applications a week. Keep it lean deliberately, perhaps by putting some sort of limit on what they can spend for administrative expenses.

Mr. FUQUA. I thank you very much for your contribution. We appreciate it.

Mr. STINE. Thank you, sir. It has been an honor and a privilege to see you again and to testify.

Mr. FUQUA. Thank you very much. Our next witness is Dr. John Clark, director of space applications and technology with RCA.

STATEMENT OF JOHN F. CLARK, DIRECTOR, SPACE APPLICATIONS AND TECHNOLOGY, RCA CORP.

Dr. CLARK. Mr. Fuqua, Mr. Winn, gentlemen, it is a real pleasure to return here under somewhat different circumstances.

Mr. FUQUA. I was just going to say I thought this was the first time you had been sitting in the position you are sitting in now.

Dr. CLARK. In my capacity with RCA that is correct.

I would like, if I may, to summarize the statement I have submitted to you and I look forward to the discussion that I hope will follow.

[The prepared statement of Dr. John F. Clark is as follows:]

STATEMENT ON THE "SPACE INDUSTRIALIZATION ACT OF 1979"
BEFORE THE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
John F. Clark, Director, Space Applications & Technology RCA Corporation

Mr. Chairman and Members of the Subcommittee:

Thank you for the invitation to testify today concerning H. R. 2337. This bill proposes to establish a Space Industrialization Corporation to promote, encourage, and assist in the development of new products, processes, and industries using the properties of the space environment. Its key provision provides front-end funding for promising but high-risk proposals. After both promise and risk are more clearly defined by the results of actual tests in space, the fund recipient may either retain his proprietary commercial rights by repaying the fund advance plus a share of his profit, or discharge his obligation to the Corporation by publishing full details of his work.

In my view, the proposed Space Industrialization Act of 1979 should be enacted into law because it embodies a very innovative and constructive approach for our nation to more fully realize the benefits of America's many and varied space research and development activities.

In supporting H. R. 2337 today, I represent four constituencies. First, as RCA's Director of Space Applications and Technology, I speak for that Corporation. RCA has long been an innovator, participant, and supporter of the exploration of space and its use for the benefit of our citizens and our neighbors throughout the world.

As you may know, RCA has a key role in this nation's space communications, navigation, atmospheric research, and meteorological satellite programs, both manned and unmanned. More than 100 RCA spacecraft have been launched successfully by the U. S. Government, starting with Project SCORE in 1958. Every one of these satellites has achieved the operational objectives set for it, before launch, by its sponsor, or is now in the process of doing so.

What some of you may not know is that RCA was the first and only private satellite manufacturer to pay for the development of a more powerful version of its rocket launcher, so that RCA Americom's privately-owned domestic communications satellites could be boosted into geostationary

orbits. The Delta launch vehicle manufacturer, McDonnell-Douglas Astronautics Corporation, also participated in funding the upgraded booster, and the NASA Goddard Space Flight Center provided technical support at no cost to the taxpayer.

These communications satellites are in their fourth year of service. They provide efficient, economical, and profitable means for the distribution of television programming and other communications (telephone and data) throughout the fifty states.

I cite RCA's private development of boosters and ownership of communications satellites not to boast, but to emphasize that RCA (and private industry in general) is not looking for handouts from the government. We have in the past taken large risks in high technology fields, including satellite communications and color television. We are equally prepared to do so in the future. But as a publicly-owned company, we must evaluate our opportunities and risks with our obligations to the quarter million owners of RCA stock in mind.

So, RCA is supporting H. R. 2337 because we believe that even though there will be significant payoffs and a substantial cumulative return from both known and new commercial applications of the space environment, the investment risk of many of these individual projects is too great to be borne by the shareholders of any single publicly-owned company. I feel sure that this view would be shared by most American aerospace and electronics firms.

My second constituency is the National Aeronautics and Space Administration. As you may know, I served as Director of NASA's Goddard Space Flight Center from 1965 to 1976, when I joined RCA. I have been deeply involved in space research since 1945, first with the Naval Research Laboratory until 1958, then at NASA Headquarters as Deputy Associate Administrator of Space Science and Applications.

NASA has the key role in America's civilian space program. I would be the first to object if I felt that H. R. 2337 were in conflict with NASA's role.

But I feel just the opposite. The enactment of H. R. 2337 and the establishment of the Space Industrialization Corporation would, in my opinion, be positive steps towards ensuring that the opportunities provided by NASA's space know-how and facilities will be used for the benefit of our citizens and neighbors throughout the world.

My third constituency is the technical community. It may sound trite to some, but it is nonetheless true that one of the major factors that has made America a leading power is the contributions of America's scientists, engineers, and entrepreneurs.

I am confident that the technical achievements and the knowledge gained through the operation of the proposed Space Industrialization Corporation will contribute significantly towards keeping our country a leading industrial nation. It should be emphasized that the technical contributions supported by the Corporation will come from both our industrial development and academic research institutions.

My fourth constituency is the most important. It is the one which stands, and deserves, to gain the most from the proposed Space Industrialization Corporation -- the American taxpayer. By financing high-risk research and development, the Space Industrialization Corporation will make it possible for the taxpayer to receive a larger return on the substantial investment America has already made in space exploration and application.

In discussing the return to the taxpayer, I am not thinking primarily of the profit that the Space Industrialization Corporation may derive from specific ventures. I am thinking of the new jobs, new businesses, and new industries that these successful ventures will create. The ultimate result will be new and improved products and services, an improved standard of living for the taxpayer to enjoy, a larger tax base, a higher Gross National Product, and a more favorable balance of payments. Indeed, the most important word in the Corporation's title is not "Space," but "Industrialization."

I shall not speculate here on specific products, processes, or services which might be developed under the sponsorship of H. R. 2337. The whole point of this Act is to encourage such ideas to be pursued with assurance that their successful fruition will benefit their creators as well as society at large.

It is interesting to contrast space application with space science in this regard. The reward for a space scientist is recognition -- by his peers and, for the select few, by the public. The reward for a space entrepreneur is profit -- for himself, his company and, ultimately, for the public as an improvement in the standard of living. Consequently, it should not be surprising that many examples of potential space applications seem either much less exciting or much more far-fetched than the space applications systems of the present. I refer to communications systems such as Intelsat, RCA Satcom, and Westar; weather satellites like DMSP, SMS, and TIROS; and earth resources monitors such as Landsat and Seasat.

I recognize that the focus of H. R. 2337 is on space processing. Tomorrow you are scheduled to hear from Bell Labs' Dr. William Slichter, the distinguished NRC Space Applications Board (SAB) Chairman of STAMPS, the Committee on Scientific and Technological Aspects of Materials Processing in Space. In reviewing this thoughtful report, it must be remembered that this field is still in its infancy. Skylab provided the first really useful combination of adequate materials laboratory volume and sufficient time in essentially free-fall ("zero-gravity") conditions. Leads discovered in Skylab will not be able to be followed up until Spacelab is operational in the early eighties.

In any event, experience teaches that in substantially different environments, many anticipated applications will turn out to be only marginally attractive, or even fatally flawed. But the more radically different the environment, the more opportunity for serendipity to come into play. I doubt that anyone can correctly anticipate today the most exciting space applications of 1989.

To sum up, I believe that the proposed Space Industrialization Act of 1979 provides an excellent mechanism for the United States to unleash the ingenuity of American free enterprise to discover the most useful space processes, products and services, and put them to use to help our country and our people. It also provides a role for our universities and other nonprofit research organizations to become involved in this important task.

I should now like to point out two ways to improve the proposed mechanism. My first suggestion is that the proposed Space Industrialization Corporation be limited to a single activity -- the evaluation and financing of proposed projects for investigating potential applications of the space environment. I believe it would reduce the effectiveness of the proposed Corporation if, as H. R. 2337 now proposes, the Corporation is permitted to conduct its own experiments. Should the proposed Corporation be permitted to engage in in-house experiments, then the people running the Corporation are bound to have a vested interest, albeit subliminal, in making certain that their own efforts are supported at least as adequately as are those from outside the Space Corporation.

To put it another way, if RCA, or any other outside group, were considering a particular approach and learned that the Space Corporation planned to do work in the same technical area, RCA might well be reluctant to compete with the people who were controlling the funds. In a sense, the Space Corporation might be viewed as acting both as prosecutor and judge.

I recognize the need of the Space Industrialization Corporation for talented people to competently evaluate the outside proposals. I believe that this need can be best satisfied by drawing such qualified individuals into the Corporation for limited periods of service, in many instances as consultants.

The second possibly larger obstacle to reaching the objectives of H. R. 2337 in the long run is the provision that the Space Corporation, if it is financially successful, become a publicly-owned corporation. As we

all know, a major responsibility of a chief executive officer of a publicly-owned company is to avoid taking imprudent risks that unduly endanger the shareholder's investment.

If the Space Industrialization Corporation becomes publicly owned, its officers and directors will face a dichotomy. Their charter would call for them to finance projects that are too risky for private enterprise to undertake, yet they would be a private enterprise. So, I fear that making the Space Industrialization Corporation a publicly-owned company would in the long run eviscerate it. To protect their shareholders, the Corporation managers would bet only on "sure things" of the type that existing private industry will underwrite on its own. The end result would be just the opposite of what is intended by H. R. 2337.

We must be sophisticated enough to realize that the Space Industrialization Corporation can benefit its true owners -- the taxpayers of America -- only by being willing to underwrite large risk projects. If this were not so, then there would be no reason for establishing the Corporation. America's free enterprises have been, are now, and in the future will be, willing to take reasonable risks in space or anywhere else where they have a reasonable chance of benefiting their shareholders.

H. R. 2337 recognizes that the financial risks involved in developing some commercial applications of space might be too large for an individual company or institution to undertake them. It provides an innovative and positive solution to this problem. But to permit the Space Industrialization Corporation to become publicly-owned would, in my view, be like building into the Act a self-destruct feature.

The Corporation can best serve America by functioning solely as an evaluating and financing agency of large-risk projects designed to take advantage of the space environment.

Dr. CLARK. My conclusion is that the Space Industrialization Act of 1979 should be enacted into law. It really is a very innovative and constructive approach for our Nation to more fully realize the benefits of this country's many and varied space research and development activities.

I applaud you for formulating this concept. I am speaking today for four constituencies. The first of these, of course, is RCA. I would like to recall for you that more than 100 spacecraft have been launched by the U.S. Government for our corporation starting with Project Score 21 years ago. Each one of these satellites has achieved its operational objectives set forth prior to its launch, or is even now in the process of doing so, where the lifetime requirements are such that they have not yet reached that point. This is true of our two domestic communications satellites.

What some of you may not realize is that RCA was the first and only private satellite manufacturer to actually pay for the development of a more powerful version of its rocket satellite launcher. In our case this was so that RCA Americom's privately owned domestic communications satellites could be boosted into geostationary orbits. The Delta launch vehicle manufacturer, McDonnell Douglas Astronautics Corp., participated with RCA in funding that upgraded booster and the NASA Goddard Space Flight Center provided technical support, at no cost at any time in that program to the taxpayers.

I cite RCA's private development of boosters and ownership of communications satellites not to boast but to emphasize that RCA, and private industry in general, is not looking for handouts from the Government. We have in the past taken large risks in high technology fields, for example, satellite communications. Another example further in the past is color television.

We are equally prepared to do so in the future. But as a publicly owned company, we must evaluate our opportunities and risks with our obligations to the quarter million owners of RCA stock in mind.

So why do we support this bill? We believe that even though there will be significant payoffs and a substantial cumulative return from both known and new commercial applications of the space environment, the investment risk of many of these individual projects is too great to be borne by the shareholders of any single publicly owned company. I would like to reemphasize, the greater the payoff for some of the higher risk projects, the higher the investment risks before the fact.

I feel sure that this view would be shared by most American aerospace and electronics firms.

Let me turn to my second constituency, that of the National Aeronautics and Space Administration. NASA has the key role in America's civilian space program. I would be the first to object if I felt that H.R. 2337 were in conflict with NASA's role. But I feel just the opposite. The enactment of H.R. 2337 and the establishment of the Space Industrialization Corporation would, in my opinion, be positive steps toward insuring that the opportunities provided by NASA's space know-how and facilities will be used for the benefit of our citizens and neighbors throughout the world.

My third constituency is the technical community. It may sound trite to some, but it is nonetheless true that one of the major factors

that has made America a leading power is the contributions of America's scientists, engineers, and entrepreneurs.

I am confident that the technical achievements and the knowledge gained through the operation of the proposed Space Industrialization Corporation will contribute significantly toward keeping our country a leading industrial nation. It should be emphasized that the technical contributions supported by the Corporation will come from both our industrial development and academic research institutions.

My fourth constituency is closest to your hearts and to mine, and I think it is the most important. It is the one which stands, and deserves, to gain the most from the proposed Space Industrialization Corporation—the American taxpayer. By financing high-risk research and development, the Space Industrialization Corporation will make it possible for the taxpayer to receive a larger return on the substantial investment America has already made in space exploration and application.

I am not thinking primarily of the profit that the Space Industrialization Corporation may derive from specific ventures. I am thinking of the new jobs, new businesses, and new industries that these successful ventures will create. The ultimate result will be new and improved products and services, an improved standard of living for the taxpayer to enjoy, a larger tax base, a higher gross national product, and a more favorable balance of payments. Indeed, the most important word in the Corporation's title is not "space" but "industrialization."

I shall not speculate here on specific products, processes, or services which might be developed under the sponsorship of H.R. 2337. The whole point of this act is to encourage such ideas to be pursued with assurance that their successful fruition will benefit their creators as well as society at large.

I would like to contrast space application with space science in this regard. The reward for a space scientist is recognition—by his peers and, for the select few, by the public. The reward for a space entrepreneur is profit—for himself, the company and, ultimately, for the public as an improvement in the standard of living. Consequently, it should not be surprising that many examples of potential space applications seem either much less exciting or much more farfetched than the space applications systems of the present. I refer to communications systems such as Intelsat, RCA Satcom, and Westar; weather satellites like the defense meteorological satellite program, SMS, and TIROS; and Earth resources monitors such as Landsat and Seasat.

I recognize that the focus of H.R. 2337 is on space processing. Tomorrow you are scheduled to hear from Bell Labs' Dr. William Slichter, the distinguished NRC Space Applications Board (SAB) Chairman of STAMPS, the Committee on Scientific and Technological Aspects of Materials Processing in Space.

In reviewing this thoughtful report, it must be remembered that this field is still in its infancy. Skylab provided the first really useful combination of adequate materials laboratory volume and sufficient time in essentially free-fall (zero-gravity) conditions. Leads discovered in Skylab will not be able to be followed up until Spacelab is operational in the early eighties.

In any event, experience teaches that in substantially different environments, many anticipated applications will turn out to be only

marginally attractive, or even fatally flawed. But the more radically different the environment, the more opportunity for serendipity to come into play. I doubt that anyone can correctly anticipate today the most exciting space applications of 1989.

To sum up, I believe that the proposed Space Industrialization Act of 1979 provides an excellent mechanism for the United States to unleash the ingenuity of American free enterprise to discover the most useful space processes, products, and services, and put them to use to help our country and our people. It also provides a role for our universities and other nonprofit research organizations to become involved in this important task.

I should now like to point out two ways to improve the proposed mechanism. My first suggestion is that the proposed Space Industrialization Corporation be limited to a single activity—the evaluation and financing of proposed projects for investigating potential applications of the space environment.

I believe it would reduce the effectiveness of the proposed corporation if, as H.R. 2337 now proposes, the Corporation is permitted to conduct its own experiments in house. Should the proposed Corporation be permitted to engage in in-house experiments, then the people running the Corporation are bound to have a vested interest, albeit subliminal, in making certain that their own efforts are supported at least as adequately as are those from outside the Space Corporation.

To put it another way, if RCA, or any other outside group, were considering a particular approach and learned that the Space Corporation planned to do work in the same technical area, RCA might well be reluctant to compete with the people who were controlling the funds. In a sense, the Space Corporation might be viewed as acting both as prosecutor and judge, regardless of what the true facts are. Viewpoint, as we all know, is sometimes as important as facts.

I recognize the need of the Space Industrialization Corporation for talented people to competently evaluate the outside proposals. Having an in-house capability is one way of assuring this. But I believe that this need can be best satisfied by drawing such qualified individuals into the Corporation for limited periods of service, in many instances as consultants.

The second possibly larger obstacle to reaching the objectives of H.R. 2337 in the long run is the provision that the Space Corporation, if it is financially successful, become a publicly owned corporation. As we all know, a major responsibility of a chief executive officer of a publicly owned company is to avoid taking imprudent risks that unduly endanger the shareholder's investment.

If the Space Industrialization Corporation becomes publicly owned, its officers and directors will face a dichotomy. Their charter would call for them to finance projects that are too risky for private enterprise to undertake, yet they would be a private enterprise. For this reason I fear that making the Space Industrialization Corporation a publicly owned company would in the long run eviscerate it. To protect their shareholders, the Corporation managers would bet only on "sure things" of the type that existing private industry will underwrite on its own. The end result would be just the opposite of what is intended by H.R. 2337.

What's the answer? I think we've got to be sophisticated enough to realize that the Space Industrialization Corporation can benefit its true owners—the taxpayers of America—only by being willing to underwrite large-risk projects. If this were not so, then there would be no reason for establishing the Corporation. America's free enterprises have been, are now, and in the future will be, willing to take reasonable risks in space or anywhere else where they have a reasonable chance of benefiting their shareholders.

H.R. 2337 recognizes that the financial risks involved in developing some commercial applications of space might be too large for an individual company or institution to undertake them. It provides an innovative and positive solution to this problem. But to permit the space industrialization corporation to become publicly owned would, in my view, be like building into the act a self-destruct feature.

I believe the Corporation can best serve America by functioning solely as an evaluating and financing agency for large-risk projects designed to take advantage of the space environment.

That concludes my prepared testimony, Mr. Fuqua. I might make one additional comment. In discussing this with some of my colleagues, I found very strong agreement that the objectives of this act were very much worth while from the point of view of the American taxpayer, and from the point of view of the American industry.

I did find some disagreement as to the best way of accomplishing these purposes. I would hope at this stage of the game we would keep our eyes firmly upon the broad concept rather than on some of the minor details. The concept is magnificent, and I sincerely hope you are successful in implementing it.

Mr. FUQUA. Thank you very much, Dr. Clark.

Let me say that we are not fixed in concrete as to the method that we feel is the best approach. That is why we are having you here to try to listen to the views and opinions of people who have an interest in this as to how we should best proceed.

As you pointed out, we are trying to keep our eyes on the road but not lose sight of what our ultimate destination will be. We have not formed any final conclusions about any of this.

You were talking about the agency should not conduct its own experiments and so forth. With NASA's role in the past in materials and materials processing, do you think they can effectively address the commercial needs and still be consistent with their peer review process. It has been a rather traditional thing in the basic research area.

Dr. CLARK. I'm not sure if I'm answering the question you intended. I think it is very important that NASA have a substantial in-house capability in order to be capable of maintaining a long-range grasp of the program that will permit them to assess wisely what work needs to be done under contract, whether it be housekeeping at the cape or new experiments to be done in space. I'm just addressing the particular needs of the Space Industrialization Corporation.

Because of the extraordinary sensitive matters of proprietary information and the mode of operation which is exempt from the Freedom of Information Act, I think in this area that there is a closer analogy with the proposal evaluation process of the National Science Foundation. I think here it has been found best over a period of years

to rely upon a cross section of the community at interest in evaluating proposals and deciding which are meritorious without conflict of interest with the funding organization itself. I believe that this is the type of organization which in the long run will have the trust of the applicants for funding and therefore the maximum chance of getting the best ideas on the table and available to the public.

Mr. FUQUA. You mentioned—I think it is on page 5—that you thought the organization should remain a Government organization. Do you think that a Government organization could effectively evaluate commercial ventures or commercial proposals as well as a private organization?

Dr. CLARK. This is a very tough question. I have done some soul searching about this one.

Mr. FUQUA. You've been on both sides, haven't you?

Dr. CLARK. Yes; I've been on both sides. I feel that the worst situation would be if a commercial organization had to go for front-end funding to an agency which would be an organization which was a competitor. So I think a publicly owned corporation which had its own stockholders and its own in-house research, development, and entrepreneurial activities would almost inevitably be viewed as a competitor. That to me is the worst of the choices.

I am not in any way saying that this activity either should not or could not make a profit. I think it will make a profit, and I would like to see that profit go to the taxpayers. What I am concerned about is an attitude, or mind set, in which, as I said in the prepared testimony, the responsibility of the chief executive officer of a public corporation is very clear. He should act in a way that will benefit his shareholders.

This is what the American free enterprise system is all about. At that point I can see no difference between the criteria by which any other publicly owned company would go in deciding whether or not to invest risk capital in such an enterprise. If this new entity, whether it be Government or private, has nothing new to contribute to the economic system, then it is excess baggage which we should not create in the first place.

In 1958, we in NASA faced a similar problem in setting up first the space science and then the space applications programs within NASA. The solution was to set up very close advisory committees for each subject area which had executive secretaries who were Government employees. The members were from the community served, in this case largely academia, and they usually elected their own chairman. What I believe is that one can leave such a Space Industrialization Corporation in the Government domain with Government responsibility and still have effective control of the selection of the projects to be supported in the hands of people who know the most about what their peers are doing.

If this does not answer the question, please explore it further with me.

Mr. FUQUA. Well, another point along the same lines is in the trust fund. If the space industrialization trust fund could be managed as effectively so as not to inhibit private industry initiative—it gets back to the other question, too, I think, but I wonder if you have any thoughts along those lines.

Dr. CLARK. With the two routes available to the recipient of the support of either publishing complete results so that others will not reinvent the square wheel, or taking advantage of the information learned to go ahead and build a thriving business, repaying the funds and sharing the profits—this is what I think is the beauty of this proposal. A corporation will not make a proposal which they believe will be a money loser, and they will not want to invest any more of the Government's money into such a proposal than they feel is absolutely essential, because if their scenario is correct, they are going to be repaying that money to the Government and paying back some of the profits from that activity. They will deal with that money as carefully as they would if it were their own from the outset. What it will do is to provide essentially a safety valve so that if both they and the reviewers are wrong, the tab could be picked up out of what I would hope would be merely a self-insuring fund.

So the most important aspect here is the same as it was when the NASA programs were being built and participants were feeling their way along to find the most efficient routes to go. I think even with the benefit of hindsight, that was a good route in terms of the science and applications programs of NASA. It will come down to the caliber of the people who are managing the corporation. If they do a competent and unselfish job, if they get the best advice they can, and if people are honest with each other in these evaluations, then it is going to be successful. And it would be successful whether this were an area of space or oceanography, or any other area of high technology.

Mr. FUQUA. Mr. Winn?

Mr. WINN. Thank you, Mr. Chairman.

Doctor, I'm trying to get some things clear in my own mind. I'd like to go back to when RCA made the decision to get involved in satellite communications. There was no proven track record, so to speak, in that field, and as a consequence it was a substantial financial risk which was taken. I'm trying to figure out what's the difference between that decision and the decision to invest in space industrialization.

Dr. CLARK. If I agreed with your premise, I would agree with your conclusion, Mr. Winn. In this particular case, I must take another look at the premise. Prior to the communications research programs of NASA, thinking now of the three options of the passive reflector, the large Echo balloon; the low altitude repeater satellites; and finally the geostationary satellites, the Syncoms; there was a lot of controversy as to which, if any, of these routes would be of any commercial significance.

Specifically, there was a lot of concern on the part of the telephone company about the time delay required to go to the satellite and back down to the Earth.

The NASA-funded and Hughes-built Syncom satellite showed that this delay was in fact not important and that reliable, high-quality communication could be provided nearly halfway around the world very conveniently, very cost effectively, and very appealing to the customer. Then the risk involved to RCA in deciding to enter the field was a purely technical risk. It was one which we as a corporation could assess on the ground, making sure that the hardware we were

putting together was reliable. It was not a risk that the service itself would not be useful. NASA and the American taxpayer had taken that risk.

It was the taking of that risk that made the Comsat Corp. such an instant success when its stock went public. One of the problems of NASA leaving the area of spaceborne communications research, involving experiments in the space environment itself, has been that thus far private industry has not been able to take the substantial risks that would have been involved in making major steps forward into new space communications programs.

At the present time, for example, there are concepts of very large, very complex, very heavy space platforms involving many different entities. I doubt very much if we will see any private industry or any consortium of private industries ready, willing and financially able to take such risks until some of the basic conceptual aspects have been proven out. So that is my answer. The risk is not comparable.

Mr. WINN. So you can't compare the two, because you feel that in telecommunications enough groundwork had been done and there was no financial risk at all?

Dr. CLARK. Once Syncom had been done I think there was minimal financial risk in entering the domestic communications satellite business.

Mr. WINN. You're saying once that was done. But I'm talking about prior to that. There was a financial risk assumed by somebody.

Dr. CLARK. Prior to Syncom private industry did not step up to that risk, and I think the logic was valid. I think were private industry faced with that risk today, that where there are alternatives where money can be invested to achieve an adequate after-tax return, that that is where the money will go.

Mr. WINN. So you are saying that the Government has got to get more involved and put up the front money.

Dr. CLARK. Yes; but only in cases where the financial risk of each of these individual steps is too great. Really, it is self insurance. But the individual projects are too large for one company to afford them, with only the narrow base of a single project.

Mr. WINN. Thank you very much. Nice seeing you again.

Mr. FUQUA. Thank you very much, Dr. Clark. We appreciate your testimony. The subcommittee will take a 10-minute recess while we go and vote.

[Recess.]

Mr. FUQUA. The subcommittee will be in order. I apologize for being late. We thought there was going to be another vote right after that but it did not materialize. The third witness will be Dr. John Benjamin with INCO, United States, Inc. We are pleased to welcome you here this afternoon and I hope we have not inconvenienced you.

**STATEMENT OF DR. JOHN S. BENJAMIN, RESEARCH MANAGER,
INCO RESEARCH AND DEVELOPMENT CENTER, INCO, UNITED
STATES, INC.**

Dr. BENJAMIN. It is a pleasure to be here.

Mr. Chairman and Mr. Winn, my name is John Benjamin. I am research manager of the metals department at the Inco Research & De-

velopment Center. Accompanying me are Mr. Peter P. Hydrean, who is senior process analysis engineer at the center and Mr. Edward A. Dembitz, whose position is tax attorney at Inco, United States, who can provide additional information.

Thank you for the opportunity to discuss certain aspects of H.R. 2337, the Space Industrialization Act of 1979. In the interest of brevity I will make a shortened presentation this afternoon. I have prepared and am making available to the subcommittee staff a more detailed working paper. In my presentation this afternoon, I will make use of slides to help illustrate some of the points.

Specifically, this afternoon I will discuss the effect of the time value of money on decisions by private business to fund R. & D. projects. I will emphasize long-range, so-called high technology, R. & D. projects such as those dealing with space industrialization.

I understand that the American Bar Association uses the term "high technology" to refer to long-term projects. This is not a definition I like to use since many long-term projects are not especially high in technology. In my presentation today it is the length of time between start and payoff which is important. I will use the description "long-term" when the time is great.

Viewed as a discretionary expenditure, industrial R. & D. projects compete for corporate capital with other investment opportunities. Various project proposals must compete with one another based on their ability to earn satisfactory rates of return on investment using the discounted cash flow technique.

At the risk of covering familiar ground, I should explain what I mean by discounted cash flow. A dollar invested in a project today is expected to earn a reasonable rate depending on the risk involved. The longer the time before that return is realized, the greater the proceeds must be in order to return at the expected rate.

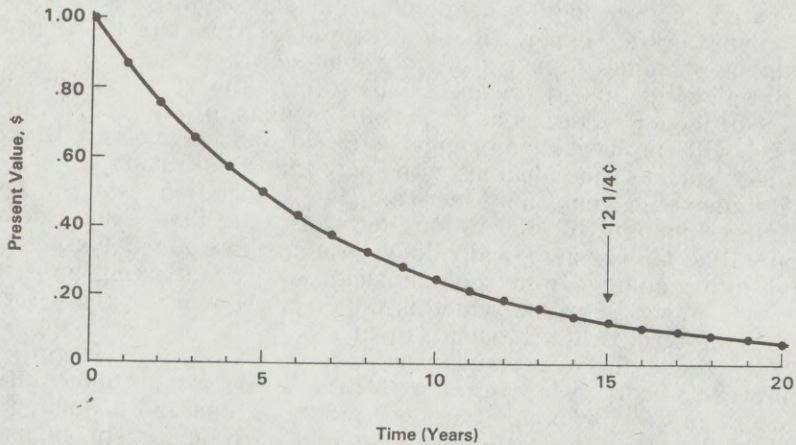
Turning that concept around we can speak of the dollar earned far in the future as being worth less than one earned today. We discount it to the amount we would have to invest now to grow a dollar at that future time. The discount rate is like interest in reverse. For example, with a 15-percent discount rate, a dollar earned 15 years in the future is worth only about 12 cents in today's money.

The first slide (slide 1) shows the net present value of dollars earned in future years at a 15-percent discount rate. This graph very clearly shows that a dollar earned, say 20 years in the future, is given very little financial value today. The 15 percent discount rate that we have used here is one that is commonly used in making such financial decisions today.

I think it's important to recognize that, in the case of space industrialization projects, we are talking of relatively long times. Here I would like to talk in terms of the development time for a project. I'll define this as the total time from the beginning of the research on an idea until significant sales of the product of that research.

These development times for Earth-based projects are longer than commonly thought; 5 to 15 years is probably optimistic. For example, Inmetco, an Inco project for converting steelmaking wastes into remelt alloys for manufacture of stainless steel, required about 7 years of development and was not based on a particularly radical technology.

NET PRESENT VALUE OF A DOLLAR EARNED IN FUTURE YEARS
AT A 15% DISCOUNT RATE



SLIDE 1

Mechanical alloying, another Inco development, is a higher technology, powder metallurgy process for producing high temperature alloys for jet engines. It has had over 12 years of development to date, and will probably require about 3 more years before significant earnings are realized.

In the latter case, Inco has sought to soften the financial impact of developing these materials for longer term applications by using Government contract funding from agencies such as NASA and Navair.

In the case of potential space industries, I feel we are talking about even longer times. Consider the present state of space industrialization and how much work is needed before a going venture is likely to emerge. Experiments performed to date, while intriguing, are by no means adequate to justify major private investment in a specific space industrialization project. Experiments have been on a small scale and frequently have involved model systems, rather than those of actual industrial importance. This has been a natural consequence of the limitations of the equipment involved. It will require the larger scale capability of the Space Shuttle/Spacelab combination, supplemented later by the power module, to take the next necessary step toward the development of space-based industries.

Many years of investigation on industrially important processes and systems are necessary. Sufficient quantities of space-produced products must be made for extensive testing to demonstrate their advantages.

For example, one cannot adequately perform the tests required to assess a gas turbine blading alloy with only 10 to 15 grams of metal.

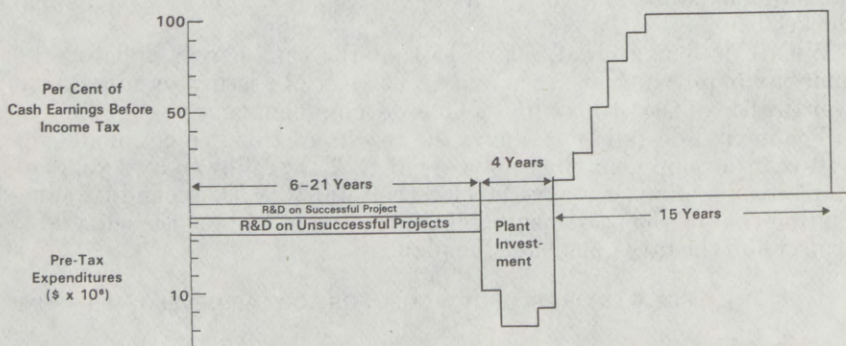
Hundreds, or even thousands, of pounds of metal are needed for adequate characterization of such a product.

Beyond this, the economics of a space-based process must be thoroughly investigated. The economies of scale must be determined by increasingly larger experiments to permit full assessment of the financial viability of the commercial venture.

Due to the competition for room in the Spacelab, the timing of the development of equipment such as the power module, the need for many series of experiments, and the vagaries of Murphy's Law, it is easy to see that many years of work remain to define a venture to the point when private businesses want to build manufacturing facilities.

To show the nature of this problem in detail we have set up a model to compare modest-sized industrial projects with varying development times. Details of this model are shown in the next slide (slide 2). In this model, we consider research expenditures and plant investment and the cash earnings before income tax required to earn 15 percent on that investment (DCF-ROI). This is the sort of discipline that businesses go through in deciding which projects to fund.

GENERALIZED PROJECT MODEL



SLIDE 2

We considered R. & D. projects that will require a research expenditure of \$1 million a year. This would be a full-time team of 5 to 10 scientists and technicians, not at all unusual. This is an important, but by no means large, effort.

Of course, not all research projects that you undertake are successful. We have assumed that three projects will be funded in an equal amount to assure one successful project in the end of the research period. We have examined research phases, lasting from 6 to 21 years.

After the R. & D. state, we've assumed an investment of \$50 million spread over 4 years to build the manufacturing facility for the successful project. A \$50 million expenditure for a space-based manufacturing facility is probably modest when you bear in mind that a fully dedicated Shuttle launch flight costs nearly \$30 million, without considering the cost of the object being launched.

For an early space industry we could be talking about a privately owned module to be attached to a permanent national orbiting space facility. This module might be designed to manufacture pharmaceuticals or high value chemicals. It might be launched by some derivative of the Space Shuttle at below the present cost.

Following the completion of the manufacturing facility, we have assumed that the cash earnings before income tax of the business will rise to a maximum level over a period of 5 years, and that the venture will be successful and will last for 15 years. This venture life is reasonable, considering the rapid rate of obsolescence of high technology equipment and the time value of money, of which we spoke previously.

PROJECT MODEL

15 percent DCF, ROI "Hurdle Rate"
 10 percent Investment Tax Credit
 14 Year Depreciation
 33 percent R. & D. Success Rate
 100 percent Venture Success Rate
 15 Year Market Life

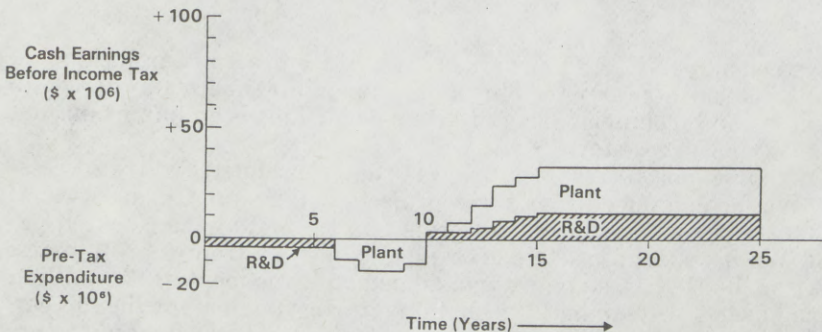
SLIDE 3

The next slide (slide 3) summarizes the assumptions in the project model. A 15-percent DCF, ROI "hurdle rate," 10-percent investment tax credit, 14-year depreciation of plant and equipment, a 33-percent R. & D. success rate, a 100-percent venture success rate and a 15-year market life.

With this background, let us look at the cash earnings before income tax required to insure a 15 percent after tax return on investment over the life of the project for various development times.

The next slide (slide 4) shows the results of this project model for a 10-year development time—6 years of R. & D., followed by 4 years of plant construction. We have labeled the total R. & D. expenditure, including that of the two unsuccessful projects, as well as the successful project and the investment for the plant.

RESULTS OF PROJECT MODEL FOR 10-YEAR DEVELOPMENT TIME

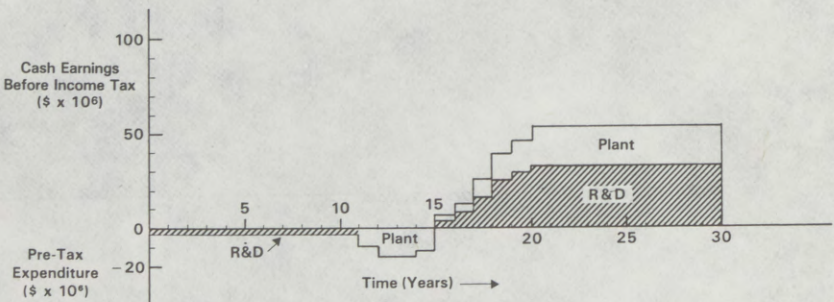


SLIDE 4

We also show the amount of cash earnings before income tax required to recover the plant investment and the amount required to show cash earnings before income taxes of a little bit over \$30 million a year to be attractive at the 15-percent discount rate. Two-thirds of this is to recoup the investment in the plant and only one-third for the R. & D. expenditures.

The next slide (slide 5) shows the results for a project with a 15-year development time. Here the required cash earnings before income tax are not only higher, over \$50 million, but are now dominated by that amount required to pay off the R. & D. expenditures.

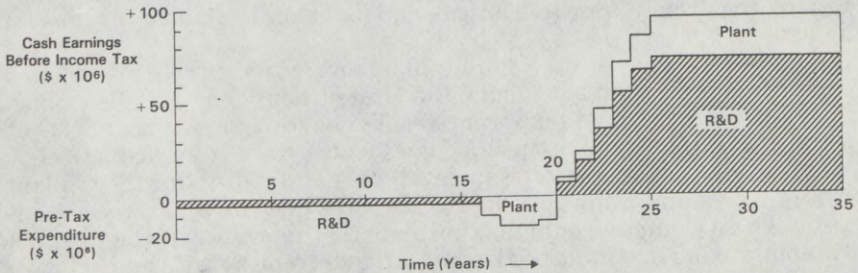
RESULTS OF PROJECT MODEL FOR 15-YEAR DEVELOPMENT TIME



SLIDE 5

As you might expect, in the next slide (slide 6), the project with the 20-year development time requires even more cash earnings before income taxes, over \$90 million, of which \$74 million is required to recoup the R. & D. expenditure.

RESULTS OF PROJECT MODEL FOR 20-YEAR DEVELOPMENT TIME

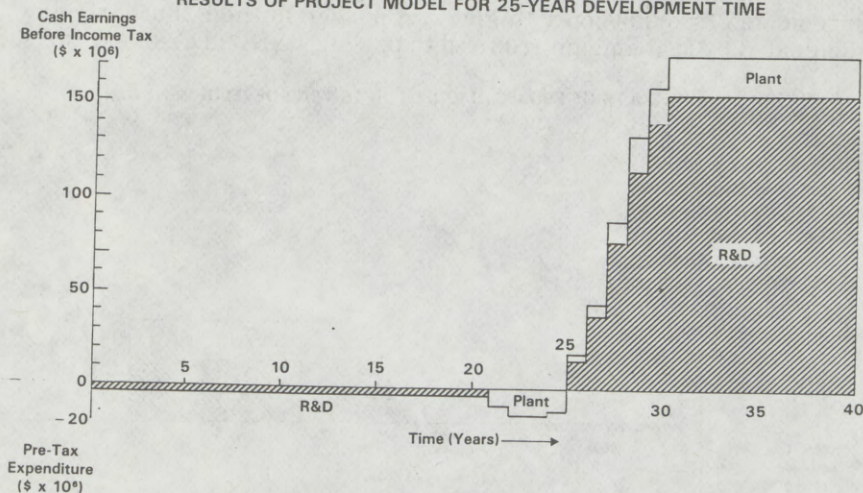


SLIDE 6

Considering that the total sales would be three to five times the peak cash earnings before taxes, we are talking about a business of between \$285 million and \$475 million a year in sales. This is a pretty big industry.

Finally, the results for a 25-year project are shown in the next slide (slide 7). Now we find an earnings level sufficient to cover the R. & D. expenditures alone of over \$150 million a year.

RESULTS OF PROJECT MODEL FOR 25-YEAR DEVELOPMENT TIME



SLIDE 7

Each added 5 years of research time has approximately doubled the earnings level required to make this an attractive proposition. Obviously, the changes of generating such huge businesses from modest research expenditures are quite low. Surely decisionmakers are going to consider this a rather shaky proposition, compared to shorter term ones.

If we wish to foster such long-term propositions as space industrialization, the situation must change. There are many ways to make these long range R. & D. projects more attractive to private industry. For example, having Government provide a predetermined fraction of the front-end research money, with private industry providing the rest of the money, research talent and later on the plant investment money.

Another way, as has been employed by several industrially developed countries (for example, Canada, the United Kingdom, and Belgium), is providing additional tax incentives. We have examined the effects of three changes in the existing tax laws as they apply to deductibility of R. & D. expenditures, the level of tax credits for new plant expenditures and allowable depreciable lifetimes of plant and equipment. These changes would maximize market relevance of the research by maximizing an industrial sense of involvement by the exclusive use of private money. The changes we examined are shown in the next slide (slide 8).

POTENTIAL CHANGES IN TAX REGULATIONS TO FOSTER LONG-TERM PROJECTS

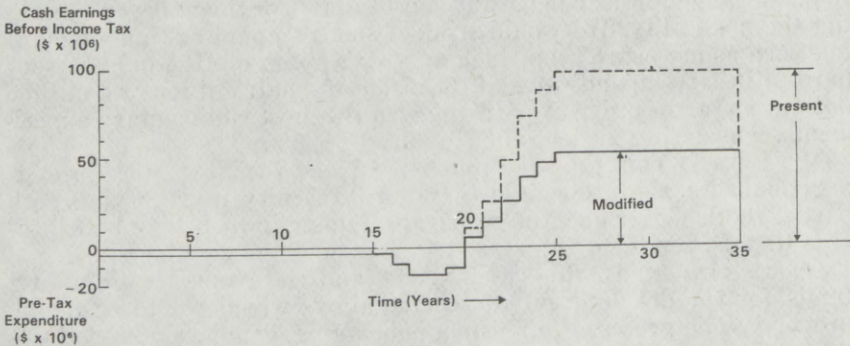
- Increase R&D Deduction From 100% To 150%
- Increase Investment Tax Credit From 10% To 25%
- Decrease Depreciable Life Of Plant And Equipment From 14 years to 5 Years

SLIDE 8

First, an increase in the allowable deduction for current R. & D. expenditures from 100 to 150 percent. Second, an increase in the investment tax credit from 10 percent to 25 percent; and third, a decrease in the depreciable life of plant and equipment from 14 years to 5 years.

The results of these changes on the model for a 20-year development time are shown in the next slide (slide 9).

EFFECT OF TAX LAW MODIFICATIONS ON PROJECT MODEL



SLIDE 9

These changes have almost cut the required earnings level in half. They have made the 20-year development time project almost as attractive as a 10-year development time project under present tax laws. Certainly, something of this nature is needed.

SUMMARY

- R&D Projects Must Compete For Funds
- Basis For Competition—Time Value Of Money
- Long Term Projects—Financially Less Attractive
- Space Industrialization Projects—Very Long Term
- Corrective Action Needed

SLIDE 10

To summarize then in the last slide (slide 10): R. & D. projects must compete with other projects for corporate capital funds. Recognizing the time value of money, long-term projects are financially less attractive than short-term projects. Space industrialization projects, as very long-term high-technology projects, look especially unattractive in these terms. Some corrective action is possible and needed to foster private business involvement in space industrialization.

Beyond this we have other concerns with the bill but, as the subcommittee has requested, I have focused my remarks on one particular aspect. There are other issues such as specific tax policy that we would

like to deal with in more detail. We are very interested in the continuing development of this legislation and would be pleased to remain in touch with the subcommittee.

Mr. Chairman, this concludes my prepared statement. My colleagues and I will be happy to respond to any questions the subcommittee may have.

Mr. FUQUA. Thank you very much, Dr. Benjamin.

You indicated that development projects such as mechanical alloying take 12 to 15 years before significant earnings are realized. Does a company like yours make a conscientious decision to venture into such long-term development projects, or is it a question of not understanding the work involved that it takes so long?

How would it apply to what we are talking about with the Space Industrialization Corporation? How should they respond to a question like that?

Dr. BENJAMIN. I think, at present, that such a project would be too long range for us to make any substantial investment beyond tracking the possibility. We would spend a small amount of time of someone such as myself to keep track of what's going on. It would be very hard to justify expenditures of the order of a half million or a million dollars a year in order to perform even the most rudimentary experiments, considering the long time involved.

Mr. FUQUA. You indicated that NASA and the Navy were providing funds for the project. Is there any difficulty in satisfying both parties, both Government and private industry, when they both provide R. & D. funds?

Dr. BENJAMIN. In this case, NASA and the Navy are providing funds for the development of specific alloys which would be public property. The process itself which is being used to develop the alloys is already covered by previous INCO patents. So in a sense, both parties are satisfied, INCO with respect to the proprietary nature of the process, and the Government with respect to making freely available the results of the research.

Mr. FUQUA. You mentioned the difficulty of cash flow and the burden that it carries on a commercial project when you charge R. & D. to it. Are there other criteria used in selecting the basic research or long-term development projects in addition to this discounted cash flow?

Dr. BENJAMIN. Certainly, the question of technical feasibility is a very strong factor. I think that in the case of space industrialization, we are faced with the fact that we don't know the answers to any of those questions. I do not believe that I or anyone on the Earth can predict what advantages will exist in manufacturing alloys such as my company manufactures in zero G. I would very much like to be able to find out.

If I were involved in a project on the ground, I could send a scientist into the laboratory and he could run an experiment very easily and relatively inexpensively. Unfortunately, as far as space industrialization is concerned, the laboratory hasn't been built; when it is built, it will be 270 miles in space and will be very expensive to get to. We are still extremely interested.

Mr. FUQUA. Mr. Winn?

Mr. WINN. Thank you, Mr. Chairman. I know we are kind of pressed for time, but I think some of my questions are amenable to a yes-or-no answer.

In your statement you mentioned you had some other concerns with the legislation other than the tax phase. What are those concerns?

Dr. BENJAMIN. I think these are very specific concerns with respect to some of the features of the bill itself which I understand are in a state of flux. In fact, these were comments by my colleague, Mr. Dembitz. We would be happy to provide you with those comments.

Mr. WINN. I was going to say we would be more than glad to have any suggestions from you or your colleagues.

Mr. FUQUA. Yes.

Dr. BENJAMIN. Perhaps we could provide those in writing after the meeting.

Mr. FUQUA. We would welcome them.

Dr. BENJAMIN. Fine. We'd be very happy to provide them.

[The information follows:]

TAX COMMENTS ON H.R. 2337

I. There are several areas of potential tax concern with H.R. 2337, the "Space Industrialization Act of 1979" ("Bill"). The first area of concern is the creation of income to a class of fund recipients. The second is a lack of economic incentive to invest in shares of Space Industrialization Corporation ("Corporation"). Finally it is unclear if the Corporation (in its public ownership phase) is to be subject to the normal corporate tax treatment.

A. Section 102 of the Bill authorizes the Corporation to provide "assistance" in the form of funds to applicants who propose projects involving the conduct of industrial processes in space. If the project is unsuccessful, funds provided to the applicant need not be repaid. Section 102(g). If successful, the funds must be repaid plus a negotiated profit amount. Section 102(a).

The funds provided to the applicants bear a closer resemblance to a loan than to a specific grant, since successful applicants must repay the advance. However, Section 61(a)(12) of the Internal Revenue Code provides that the cancellation of indebtedness produces taxable income. At the point in time that the Corporation determines a project to be unsuccessful and cancels the repayment obligation, the applicant receives taxable income in the amount of the funds previously advanced. This result could be avoided by having the obligation to repay arising *only* at the point in time that the Corporation finds the project successful.

B. The second area of concern is that there is little economic motive to invest in stock of the Corporation. Because of the highly speculative nature of the Corporation's projects and the fact that the Corporation is not likely to pay substantial dividends for many years, purchase of Corporation stock is likely to produce an extremely low return on capital. The low capital return combined with the speculative nature of the operation will not encourage investment in the Corporation's stock. Some additional incentive is necessary to make the purchase of the Corporation's stock economically attractive.

One way of providing the necessary incentive would be to allow the purchasing shareholders to currently deduct the cost of their shares for income tax purposes. This would give the shareholders a zero basis in their stock for tax purposes. This means that the shareholder would recognize gain to the extent of any amounts received in a later sale. Such treatment would also tend to restrict active trading of the shares and would promote the long-term holding of these shares by investors.

C. It is not evident from the Bill whether consideration has been given to granting the Corporation tax-exempt status. Such status would normally not be available in the Corporation's public ownership phase since it is intended that the Corporation earn a profit and pay dividends. However, due to the presidential appointment of Board members and the nature of the Corporation's charter, its primary purpose will never be the same as that of an ordinary corporation—to maximize profits.

For these reasons and because the Corporation will benefit U.S. commerce and industry as a whole, it should be granted exemption from federal, state and local income taxes. To the extent the Corporation is an employer, it should be subject to the relevant payroll-type taxes.

Mr. WINN. Do you feel that a tax incentive program is more desirable than establishing another Government entity?

Dr. BENJAMIN. I think it is. I have been involved in Government-supported research, and I have read the results of others who have been involved in such research. I think there is a tendency, when money is free, not to be too careful in selecting the research topic. Whereas if it's my money, provided I am free to spend it without the penalty of the time value of money, I make very sure that it is aimed at a real market and has a maximum probability of success.

Mr. WINN. Some surveys have shown a basic reluctance about establishing another segment of bureaucracy. I gather that you personally feel the same way?

Dr. BENJAMIN. Yes; I do. I feel that it may be possible by changing the charter of NASA, perhaps, to set up an arm within NASA to operate on a businesslike basis with private industry. Certainly we feel the immediate need for a period of experimentation at increased scale on industrially important processes. NASA certainly has the capability necessary to supplement industrial capability.

Mr. WINN. You'd rather use the present structure we have rather than start in a new direction?

Dr. BENJAMIN. Yes. However, I think as it develops we may see a need for such a corporation at a later time.

Mr. WINN. Do you agree with Mr. Stine's figures that the corporation should be public by the year 2000.

Dr. BENJAMIN. I think it is possible that there will be a going operation by them. I would not preclude the possibility but I feel that the major market development or major payback will not occur for 20 to 25 years. That's my best guess.

Mr. WINN. Thank you very much and thank you, Mr. Chairman.

Mr. FUQUA. Thank you very much, Dr. Benjamin. We are going to have to conclude the hearing because of other votes on the floor.

We want to thank you and apologize again for keeping you so long.

The subcommittee will adjourn until tomorrow morning at 10 o'clock in this room where we will continue the hearings on the Space Industrialization Act of 1979.

Thank you, gentlemen.

[Whereupon, at 4 p.m., the subcommittee was adjourned to reconvene at 10 a.m., on Wednesday, May 23, 1979.]

THE SPACE INDUSTRIALIZATION ACT OF 1979

WEDNESDAY, MAY 23, 1979

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10 a.m., in room 2325, Rayburn House Office Building, Hon. Don Fuqua, chairman of the subcommittee, presiding.

Mr. FUQUA. The subcommittee will be in order.

This morning we continue the hearings on the proposed legislation to establish the Space Industrialization Corporation, H.R. 2337.

The prospects for utilizing the space environment for industrial purposes are sufficiently great to warrant national attention. The bill before us, H.R. 2337, was introduced in order to provide a means for fostering entry of the private sector into developing capabilities in space and assuring that in the national interest opportunities are pursued in a timely manner.

Yesterday the subcommittee heard stimulating testimony which gave insight into a number of important areas which must be considered in furthering the commercialization of space. This morning we expect to be further enlightened.

Our first witness will be Dr. Robert Frosch, Administrator of the National Aeronautics and Space Administration.

We want to welcome you, Dr. Frosch. I know you have been on a long journey—a quick round trip to China and you got in late last night. I hope we are not imposing on you too much by asking you to be here this morning to testify.

You may proceed, Dr. Frosch.

[The prepared statement of Dr. Robert A. Frosch follows:]

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Statement of

Robert A. Frosch
Administrator

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the

Subcommittee on Space Science and Applications
Committee on Science and Technology
House of Representatives

Mr. Chairman and Members of the Subcommittee:

I am happy to appear before this Committee this morning to present NASA's views on H.R. 2337, the "Space Industrialization Corporation Act of 1979." The proposed legislation addresses an area that has been of great interest to NASA since its very earliest days. By virtue of the National Aeronautics and Space Act of 1958, NASA is directed to conduct its activities so as to contribute to the preservation of the role of the United States as a leader in aeronautical and space science and technology and their applications. In addition, the President directed in his October 1978 Space Policy Declaration that ways be found to get the private sector involved in space activities. Other studies are now underway with respect to involving private firms in the utilization of remote sensing.

NASA and its predecessor organization, the National Advisory Committee for Aeronautics, has a long history of working with the industrial community to promote and maintain U.S. technological superiority. The development and application of the aeronautical sciences by the NACA in cooperation with industry provides an example of the effectiveness of such an approach. These involvements have contributed in large measure to the continuing success of the United States aircraft industry.

In the area of space, an outstanding example of the transfer of the products of NASA research leading to space industrialization is the use of communications satellite

technology by the commercial communications industry, both to handle the increasing volume of communications requirements and to provide types of service not envisioned before the development of the communications satellite. The financial success of the COMSAT Corporation provides striking evidence of the maturity and economic viability of this new industry which did not exist two decades ago. As we described during this year's authorization hearings, NASA is now planning to resume selected activities in communications satellite research directed to assisting U.S. industry in maintaining its technological superiority. These efforts will be focused primarily on high risk and long lead time items.

Another area of NASA involvement with the industrial community is found in the programs conducted by the Technology Transfer Division and the Technology Utilization Office. Over the last several years, NASA has been a leader in the Federal establishment in developing techniques for making aerospace technology developed through taxpayer funds available to American industry and particularly the non-aerospace community. Under the auspices of the technology transfer organization, the Agency has entered into cooperative arrangements with industrial concerns for the development of new product technologies which make available in the commercial marketplace products and services which would not have been possible without the application of techniques learned through the space program. One example of the many products that have been introduced is the implantable, rechargeable heart pacemaker which has eliminated the requirement for surgically replacing these devices at the end of the expected battery lifetime.

One fact that has become evident throughout these endeavors is the necessity for positive and innovative action on the Agency's part to bring the possibilities of utilizing space technology and space flight opportunities to the attention of industrial concerns. Large segments in the marketplace have no experience in dealing with the Federal government other than as an occasional vendor of supplies and materials. Often they don't speak the same language that we do. Very real communications barriers exist. A conscious effort on NASA's part has been required to bring together those in industry with NASA or aerospace engineers so that the problems and resources of these diverse groups can be properly interfaced. A great deal of NASA's effort has been devoted to understanding and then working around many of these barriers to the effective transfer of technology.

Most recently, and I believe of particular relevance to the interests of this Subcommittee, NASA has been pursuing mechanisms for encouraging industrial participation in its Materials Processing in Space Program. There are a number of reasons for desiring industrial cooperation as we develop our activities in this field. One very important reason for close coupling with industry is to insure that the program objectives are in line with industrial requirements. While valuable and original research can be conducted in this interesting area, its full potential for economic benefit will only be reached if these processes are not only developed but ultimately exploited by the industrial community. By working with appropriate segments of industry, we believe we will speed up the transfer process and reduce the learning time for the non-aerospace segment of the industrial community which constitutes a great majority of those who may ultimately exploit this technology.

Our near-term research objectives are directed to the use of zero or near zero gravity conditions which will prevail on Shuttle flights in the near future. The absence of significant gravitational effects over extended periods of time can give new insights into a number of fluid and metallurgical processes and can offer a degree of process control not now feasible. We have achieved promising preliminary results on sounding rocket experiments which can provide a zero-g environment for five or six minutes, in drop towers which provide these conditions for a few seconds, and in experiments that were conducted during the Skylab program. The absence of significant gravitational acceleration results in a suppression of settling sedimentation and buoyancy driven or natural thermal convection which allows the enhanced control of temperature fields. This permits us to produce crystals of increased compositional uniformity and to process materials in a containerless fashion. These techniques show great promise for exploitation of selected processes.

Because of the specific charge contained in the Space Act that the Agency conduct its activities so as to contribute to a technology leadership role for the United States and, in part, from our experience in stimulating industry in our many ongoing programs such as I have described above, we are continuing to identify those factors which inhibit our ability to work effectively with the industrial community in other than our normal fashion, which is to write

a contract and fund a program in its entirety. Specifically, NASA is attempting to develop effective mechanisms to work jointly with industrial counterparts both to further our space research and applications program goals and at the same time to arrange for the country to exploit the potential commercial advantages which we anticipate will shortly result from the capability of the Space Transportation System and the Spacelab which will provide an extended capability in space.

We have conducted a number of studies and analyses to identify those factors that tend to inhibit commercial or corporate participation in these activities. We have solicited advice from leaders in this field, including Dr. William Wilkie of the Graduate School of Business of the University of Florida, who is an expert in marketing and regulatory practices; Dr. Herbert Kierulff of the Graduate School of Business of the University of Southern California whose specialty is new business ventures and entrepreneurship; the late Dr. Carlton A. Pederson of the Graduate School of Business of Stanford University, who advised us on management policy; and a team of graduate students at the Harvard Business School who studied industry's perceptions of materials processing in space and made recommendations on problems and ways for improving approach and communication. We have supported a number of studies by various universities, commercial concerns, and non-profit institutions to identify those factors which impede greater interest on the part of industrial concerns in the potential benefits to be obtained from the space environment. Moreover we are sponsoring, in collaboration with the AIAA, ways to encourage the private sector to look seriously at space alternatives.

As part of our overall effort, we created in late 1977 a special task team devoted primarily to working with commercial interests in this field. The purpose of this team was to provide information and assistance regarding opportunities in materials processing in space and to understand the motivations and problems that a non-aerospace company faces in doing business with NASA. Members of the team have talked to representatives of well over 100 companies, both large and small.

The results of these studies and conferences indicate to us that many elements of the business community perceive

a number of impediments to cooperation with the government in the development and exploitation of the space environment. These include a concern that they may lose any patentable rights that result from cooperative programs and that proprietary data may be made available to their competitors; and that association with a governmental or quasi-governmental organization will expose their records to government auditors.

In addition to these perceived impediments, many business leaders have stated that financial pressures due to inflation, interest rates, more stringent product and environmental regulations, and predatory competition (both foreign and domestic) have reduced their interest and capacity to undertake long-term, high-cost, high-risk ventures. For these activities, the risk adjusted rate of return on the initial investment must be high in order to compensate for the above factors. At this time, few space ventures are attractive to industry.

Another related consideration is the fact that some industrial organizations state that they have adapted a "second to market" strategy. They have concluded that it is more profitable to be second into a market than to bear the high risk and high cost that goes with the initial development. By monitoring the progress and activities of their competitors, they hope to ascertain which products or processes are furthest along in development. Thus, by starting product development several years later they hope to achieve acceptable market penetration with minimal risk.

Because of these concerns, and in accordance with its statutory mandate, NASA has for some time now been reviewing alternatives and options for a program to encourage the industrialization of space and insure the maximum benefit to both our citizens and the economy in general.

NASA will shortly promulgate guidelines regarding early usage of space for industrial purposes. These guidelines will establish the broad framework under which NASA will be able to engage in cooperative projects with the private sector of the U.S. economy. Specific ground rules will be developed for various areas where NASA program interests coincide with those of the private sector. We anticipate engaging in joint arrangements with U.S. domestic firms in research programs directed to the development or enhancement of U.S. commercial leadership by utilizing the space environment. We will continue to conduct NASA research programs

having as an end objective the enhancement of U.S. capabilities by developing space-related high-risk or long-lead-time technology. An example of this is our reentry into the communications program which I described earlier. We will also enter into transactions with U.S. firms which will be designed to encourage the commercial utilization of NASA space flight systems.

NASA, through its technology utilization, technology transfer, and other similar programs has made available to industry the results of our research. We now envision, in selected research areas which satisfy certain predetermined criteria which I will discuss shortly, and after a determination by NASA, entering into arrangements which will provide flight time on the Space Transportation System on other than fully-reimbursable conditions. We will also provide technical consultation, data, equipment, and facilities to participating organizations, and enter into joint research and demonstration programs where each party funds its own participation.

By directing our activities to those areas where NASA has a programmatic interest, this new endeavor will be a continuation of or supplement to ongoing NASA activities, and to a significant extent will complement them. Thus, we do not believe it will be necessary that specific additional funds be requested at this time. By engaging in joint ventures where each party pays for his own participation, we will have the flexibility to negotiate arrangements under which the legitimate rights and interests of both the government and the private concerns are protected. In some cases, NASA's contribution may be the provision of flight opportunities on the Space Transportation System.

Although each discipline will develop specific guidelines for the selection of program participants tailored to the particular needs of both the government and the community involved, our basic policy statement contains a number of factors which will be used in developing selection criteria. These factors include the need for the expected technology development, the contribution which the proposed development is expected to make to the maintenance of the U.S. technological superiority, the benefits expected to accrue to the public from sharing in the results, the enhanced economic exploitation of NASA's capabilities such as the Space Transportation System, the desirability of private sector involvement in specific NASA programs, the merit of the proposed research or anticipated application,

the degree of risk or financial participation offered by the commercial firm, the amount of proprietary data or background information to be furnished by the firm, the rights in data to be granted to the firm in consideration of its contribution, the ability of the firm to project a potential market, the willingness and ability of the firm to market and sell any resulting new or enhanced product on a reasonable basis, the impact that NASA sponsorship might have on a given industry, provisions for any form of exclusivity that may be required to promote innovation, recoupment of the NASA contribution, if appropriate, and, finally, the support of general socio-economic objectives of the U.S. government. Only after a determination that the conditions appropriate to a given agreement have been met will the Agency enter into joint ventures.

Let me now turn to the Space Industrialization Act of 1979. It provides for the establishment of a government corporation with a board of directors, half of the members and the chairman being appointed from the private sector. The bill authorizes appropriations for the Space Industrialization Trust Fund at a level of \$50M per year, for at least the first two years. The appropriated funds would be used to promote the development of new processes and industries in space and to encourage private industry to become involved in the development of space technology. It further provides that when the corporation has demonstrated an ability to operate successfully, effectively, and profitably that the corporation can, with the approval of the President, become wholly publicly owned. Provisions for dealing with private sector concerns include a review of the proposal, the establishment of appropriate intermediate goals and milestones, a continuing review of the project's progress, a requirement for repayment of assistance, including the profit on a corporation's investment if the project is economically successful, and provisions for protecting the proprietary rights of the applicants. The corporation is specifically directed to assure that activities of a particular or specific interest to NASA, the DOD, or any other Federal agency will be funded by that agency rather than through assistance under the act. NASA is directed to advise and consult with the corporation on the technical characteristics of space industrial systems, cooperate in research and development activities, provide launch services on a reimbursable basis, and provide on a reimbursable basis other systems, facilities, and services as may be feasible.

The Administration's position on the proposed legislation is certainly supportive of its general intent, that of maintaining U.S. leadership in space technology by realizing the potential inherent in space industrialization. We believe that actions bringing the opportunities of space utilization to the attention of the private sector are worthwhile. In fact, this is the direction set forth in the President's space policy. The Administration, however, has some reservations regarding the concepts contained therein. We believe that legislation in this area is premature and unnecessary for a variety of reasons. First, we believe it is critically important that front-end money be put up by the commercial firm involved. This is a necessary demonstration of seriousness on the part of the firm and also will insure appropriate management attention to the project during its life. The firm's willingness to fund a portion of the required investment will insure that sound business judgement will prevail and that programs are not proposed solely because of the availability of government funds.

We also believe that the mandatory repayment provisions may be a significant obstacle to participation by some classes of industry. As mentioned earlier, the repayment provision can provide for access by government auditors and raise very complex questions regarding what was profitable, what caused the profitability, and which portion is attributable to the corporation's financial support. In the program proposed by NASA which I have described above, we anticipate that NASA's own interest in the research or application will justify NASA's involvement and that recoupment will be considered for special circumstances where the commercialization process would not be precluded.

We are also concerned that the potential availability of Federal funds may inhibit companies which are now ready to invest private capital into limited-risk situations in joint ventures with NASA from proceeding at this time since a separate avenue will be available with even less risk. In essence, Federal funds would be competing with private capital.

Our discussions with industrial representatives to date indicate that under proper conditions and with appropriate participation by NASA they are willing to proceed with their own risk capital to conduct necessary investigations leading to commercial industrialization of space.

We concur with the specific provisions included in the proposed legislation that provide for adequate protection of a proposer's patents and proprietary data. Because of the unique nature of the joint ventures in which we propose to engage, where each party will pay for its own activities and no exchange of funds will take place, we believe that NASA will, under its existing statutory authority, be able to afford adequate protection to the cooperating sponsors as well as to the public.

For the reasons mentioned above, the Administration opposes enactment of the bill, although we are encouraged by the concern expressed by this Subcommittee for insuring the maximum utilization of the advantages of space by the American private sector.

Mr. Chairman, this concludes my prepared statement. I will be happy to respond to any questions.

STATEMENT OF DR. ROBERT A. FROSCH, ADMINISTRATOR, NASA

Dr. FROSCH. Thank you, Mr. Chairman.

I am happy to be here this morning to testify. We think this subject is important and that holding hearings on this subject will be very helpful in documenting for the official record our discussion of a number of the aspects of the problem.

The proposed legislation addresses an area that has been of great interest to NASA since its earliest days. By virtue of the National Aeronautics and Space Act of 1958, NASA has conducted activities to contribute to the preservation of the role of the United States as a leader in science and technology.

In addition, the President directed in his October 1978 Space Policy Declaration that steps be taken to involve the private sector in space activities and studies in the utilization of remote sensing. NASA has a long history of working with the industrial community to promote and maintain U.S. technological superiority. Application of the aeronautical sciences by the NACA in cooperation with industry provides an example of the effectiveness of such an approach.

These involvements contributed in large measure to the continuing success of the United States aircraft industry. In the area of space technology an outstanding example of the transfer of the product of NASA research leading to space industrialization is the use of communications satellite technology by the commercial communications industry to handle the increasing volume of communications which provide types of service not envisioned before its development.

One fact that has become evident, throughout NASA's endeavors, is the necessity for positive innovative action on the agency's part to create awareness of the possibility of utilizing space technology and the space flight opportunities available to the attention of industrial customers.

Large segments of the marketplace have no experience in dealing with the Federal Government other than as occasional vendor of supplies and materials. Of course, they don't speak the same language as we do. A very real communication barrier exists.

A great deal of NASA's effort has been devoted to understanding and working around many of these barriers to effective transfer of technology. Most recently, and I believe of particular relevance to the interest of this subcommittee, NASA has been pursuing mechanisms for encouraging industrial participation in its materials processing in space program.

There are a number of reasons for desiring industrial cooperation as we develop our activities in this field. One very important reason for close coupling with industry is to insure that the program objectives are in line with industrial requirements.

While valuable and original research can be conducted in this area, its full potential for public benefit will only be reached if these processes are not only developed but ultimately exploited by the industrial community.

By working with the appropriate segments of industry, we believe we will speed up the transfer process and reduce the learning time

for the nonaerospace segment of the industrial community which constitutes a great majority of those who may ultimately exploit this technology.

Our near-term objectives are directed toward the use of zero or near-zero gravity conditions which will prevail on Shuttle flights in the near future. The absence of significant gravitational effects over extended periods of time can give new insights into a number of fluid and metallurgical processes, and can offer a degree of process control not now feasible.

We have achieved promising preliminary results from experiments conducted on sounding rockets which can provide a zero-g environment for 5 or 6 minutes, in drop towers which provide these conditions for a few seconds, and in the Skylab and Apollo-Soyuz missions.

The absence of significant gravitational acceleration results in a suppression of settling sedimentation and buoyancy driven or natural thermal convection which allows the enhanced control of temperature fields. This permits us to produce crystals of increased compositional uniformity and to process materials in a containerless fashion. These techniques show great promise for exploitation of selected processes.

In addition to this direct research and development, we are continuing to identify those factors which inhibit our ability to work effectively with the industrial community in other than our normal fashion, which is to write a contract and fund the program in its entirety.

Specifically, NASA is attempting to develop effective mechanisms to work jointly with industrial counterparts to further our space research and applications program goals and, at the same time, to arrange for the country to exploit the potential commercial advantages which we anticipate will shortly result from the extended capability in space of the space transportation system and the Spacelab.

We have conducted a number of studies and analyses to identify factors that tend to inhibit commercial or corporate participation in these activities. We have solicited advice from leaders in this field, including Dr. William Wilkie of the Graduate School of Business of the University of Florida, who is an expert in marketing and regulatory practices; Dr. Herbert Kierulff of the Graduate School of Business of the University of Southern California, whose specialty is new business ventures and entrepreneurship; the late Dr. Carlton A. Pederson of the Graduate School of Business of Stanford University, who advised us on management policy; and a team of graduate students at the Harvard Business School who studied industry's perceptions of materials processing in space, and made recommendations on problems and ways for improving approach and communication.

We have supported a number of studies by various universities, commercial concerns, and nonprofit institutions to identify the factors that impede greater interest on the part of industrial concerns in the potential benefits to be obtained from the space environment.

Moreover, we are sponsoring, in collaboration with the AIAA, ways to encourage the private sector to look seriously at space alternatives.

As part of our overall effort in late 1977, we created a special task team devoted primarily to working with commercial interests in this field. The purpose of this team was to provide information and assist-

ance regarding opportunities in materials processing in space, and to understand the motivations and problems that a nonaerospace company faces in doing business with NASA. Members of the team have talked to representatives of well over 100 companies, both large and small.

The results of these studies and conferences indicate to us that many elements of the business community perceive a number of impediments to cooperation with the Government in the development and exploitation of the space environment. These include a concern that they may lose any patentable rights that result from cooperative programs; that proprietary data may be made available to their competitors; and that association with a governmental or quasi-governmental organization will expose their records to Government auditors.

In addition to these perceived impediments, many business leaders have stated that financial pressures due to inflation, interest rates, more stringent product and environmental regulations, and predatory competition, both foreign and domestic, have reduced their interest and capacity to undertake long-term, high-cost, high-risk ventures.

For these activities, the risk adjusted rate of return on the initial investment must be high in order to compensate for the above factors. At this time, few space ventures are attractive to industry.

Another related consideration is the fact that some industrial organizations state they have adopted a "second to market" strategy. They have concluded that it is more profitable to be second in a market than to bear the high risk and high cost that goes with the initial development.

By monitoring the progress and activities of their competitors, they hope to ascertain which products or processes are furthest along in development. Thus, by starting product development several years later, they hope to achieve acceptable market penetration with minimal risk.

Because of these concerns, and in accordance with its statutory mandate, NASA has for some time now been reviewing alternatives and options for a program to encourage the industrialization of space and insure the maximum benefit to both our citizens and the economy in general.

NASA will shortly promulgate guidelines regarding early usage of space for industrial purposes. These guidelines will establish the broad framework under which NASA will be able to engage in cooperative projects with the private sector of the U.S. economy.

Specific ground rules will be developed for various areas where NASA program interests coincide with those of the private sector. We anticipate engaging in joint arrangements with U.S. domestic firms in research programs directed to the development or enhancement of U.S. commercial leadership by utilizing the space environment.

We will continue to conduct NASA research programs with the objective of enhancing of U.S. capabilities by developing space-related, high-risk or long-leadtime technology.

An example of this is our reentry into the communications program which I described earlier. We will also enter into transactions with U.S. firms designed to encourage the commercial utilization of NASA space flight systems.

We envision entering into arrangements which will provide flight time on the space transportation system on other than fully reimbursable conditions. We will also provide technical consultation, data, equipment, and facilities to participating organizations, and enter into joint research and demonstration programs where each party funds its own participation.

By directing our activities to those areas where NASA has a programmatic interest, this new endeavor will be a continuation of, or supplement to, ongoing NASA activities, and to a significant extent will complement them. Thus, we do not believe it will be necessary at this time to request specific additional funds.

By engaging in joint ventures where each party pays for his own participation, we will have the flexibility to negotiate arrangements under which the legitimate rights and interests of both the Government and the private concerns are protected. In some cases, NASA's contribution may be the provision of flight opportunities on the space transportation system.

Although each discipline will develop specific guidelines for the selection of program participants tailored to the particular needs of both the Government and the community involved, our basic policy statement contains a number of factors which will be used in developing selection criteria. These factors are listed in my prepared statement.

Let me now turn to the Space Industrialization Act of 1979. It provides for establishment of a Government corporation with a board of directors, consisting of eight members and a chairman to be appointed from the private sector. The bill authorizes appropriations for the Space Industrialization Trust Fund at a level of \$50 million per year for at least the first 2 years.

The appropriated funds would be used to promote the development of new processes in industries and space and to encourage private industry to become involved in the development of space technology.

It further provides that when the corporation has demonstrated an ability to operate successfully, effectively and profitably, the corporation can, with the approval of the President, become wholly publicly owned. Provisions for dealing with private sector concerns include a review of the proposal, the establishment of appropriate intermediate goals and milestones, a continuing review of the project's progress, a requirement for repayment of assistance, including a profit on the corporation's investment if the project is economically successful, and provisions for protecting the proprietary rights of the applicants.

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The administration's position on the proposed legislation is certainly supportive of its general intent to maintain U.S. leadership in space

technology by realizing the potential inherent in space industrialization. We believe that actions bringing the opportunities of space utilization to the attention of the private sector are worthwhile.

In fact, this is the direction set forth in the President's space policy. The administration, however, has some reservations regarding the concepts contained therein. We believe that legislation in this area is premature and unnecessary for a variety of reasons.

First, we believe it is critically important that front-end money be put up by the commercial firm involved. This is necessary to demonstrate proper intent on the part of the firm and, also, to insure appropriate management attention to the project during its life.

The firm's willingness to fund a portion of the required investment will insure that sound business judgment will prevail and that programs are not proposed solely because of the availability of Government funds.

We also believe that the mandatory repayment provisions may be a significant obstacle to participation by some classes of industry. As mentioned earlier, the repayment provision can provide for access by Government auditors and raise very complex questions regarding what was profitable, what caused the profitability, and which portion is attributable to the corporation's financial support.

In the program proposed by NASA, which I have described above, we anticipate that NASA's own interest in the research or application will justify NASA's involvement, and that recoupment will be considered for special circumstances where the commercialization process would not be precluded.

We are also concerned that the potential availability of Federal funds may inhibit companies—which are now ready to invest private capital into limited-risk situations in joint ventures with NASA—from proceeding at this time, since a separate avenue will be available with even less risk. In essence, Federal funds would be competing with private capital.

Our discussions with industrial representatives to date indicate, that under proper conditions and with appropriate participation by NASA, they are willing to proceed with their own risk capital to conduct necessary investigations leading to commercial industrialization of space.

We concur with the specific provisions included in the proposed legislation that provide for adequate protection of a proposer's patents and proprietary data. Because of the unique nature of the joint ventures in which we propose to engage—where each party will pay for its own activities and no exchange of funds will take place—we believe that NASA will, under its existing statutory authority, be able to afford adequate protection to the cooperating sponsors as well as to the public.

For the reasons mentioned above, the administration opposes enactment of the bill, although we are encouraged by the concern expressed by this Subcommittee for insuring the maximum utilization of the advantages of space by the American private sector.

Mr. Chairman, this concludes my prepared statement. I will be happy to respond to any questions.

Mr. FUQUA. Thank you.

Dr. FROSCHE. I think we can furnish a draft, as long as it is clear to everyone that it is a draft and subject to some change. It is very close to finalization.

Mr. FUQUA. Thank you.

You mentioned on pages 7 and 8 some objections that the administration may have. One concerns front-end money being provided by commercial firms. Do you see any reason why the space and industrialization corporation's agreement with commercial firms can not be structured to include providing some front-end money?

Dr. FROSCH. No. I don't see why not. I think it is important that some front-end contribution by the firm be established as a principle. But, whatever mechanism is finally adopted for dealing with firms could include that.

Mr. FUQUA. You also mentioned another point on page 8 that it might inhibit companies from investing private capital in joint ventures, and Federal funds would be competing with private capital. Since the Corporation is specifically directed away from activities of a particular or specific interest of NASA, that NASA would probably only enter into joint ventures in which it had a programmatic interest, can we strengthen this part of the bill to take care of those concerns?

Dr. FROSCH. I think the question at issue is not so much one of competition between NASA and the Space Industrialization Corporation, but of the competition between Federal funds available through the Space Industrialization Corporation in the early part of its life and the investment of private funds.

I think it is fair to say that if Government funds are available through the Space Industrialization Corporation or through any other means, it is likely that investors will tend to go to the Space Industrialization Corporation for all the money, since it is available from the Government rather than going at commercial rates and commercial investments. Therefore, in the early period there would be a tendency to look for Government funds rather than private funds. It is a little bit difficult for us to foresee how a transition would be forced by which the Space Industrialization Corporation could become a private corporation, on normal investment bases.

One way to deal with this, presumably, would be to insist upon some kind of a cooperative venture with the Space Industrialization Corporation from the very beginning; that is, some private money should be mixed with Space Industrialization Corporation money, creating the establishment of that principle at the very beginning.

Mr. FUQUA. Another point you mentioned was the requirement for part of the profit to be returned to the trust fund and we can always raise a question of what is profit. What kind of alternative would you propose for a commercially viable project that doesn't meet the requirements of joint NASA ventures?

Dr. FROSCH. The problem seems to be exactly a question of deciding what is profit, and which part of the profit is attributable to what is put in either by the Space Industrialization Corporation or by NASA. One of the inhibitions would be that of entering what is intended to be a commercial venture and then having the Corporation discover that in effect it is what the Government regards as a Government venture. Therefore, it is subject to governmental regulations, including potentially the exposure of corporate accounts and proprietary data.

I think we will have to devise a way in that area, if necessary, to recoup. There is a way to do this—please understand, this is an idea conceived by me in the course of the morning while looking at the testimony to see what the problems might be—by establishing some

kind of regular payments from profits to repay the investment by the Corporation or by NASA. If the result was profitable, to have an arrangement whereby the payments are, in fact, made, when the private concern says yes, we have made a profit and, as agreed, we are making payments on it. This would be an internal affair and the books would not be subject to examination.

But if the Corporation said they had broken even and hadn't made enough profit to pay back any of the original investment, then the Government would have the right to inspect the books to determine that, in fact, there was no profit. This would give a double incentive or clear incentive for repayment if, indeed, there was a profit.

Mr. FUQUA. Could not that language be perfected and included in the bill and also included in the contract with—

Dr. FROSCH. I think some such scheme could be refined and used for that purpose. This kind of problem is one of the reasons why we have thought in terms of NASA cooperative programs being ones in which NASA would contribute launch services, with the private concern supporting the experiment, thus creating a very clean division where one could decide what to do later.

Mr. WINN. Yesterday, Dr. Frosch, comments were made regarding expanding the NASA charter to allow for space industrialization. Do you have thoughts on that? Do you think it is necessary? Does NASA need any changes in the charter to get into space industrialization?

Dr. FROSCH. Well, Mr. Winn, as far as we can see, what we need and want to do now is covered under the existing Space Act, under the provisions that I mentioned in my testimony. We do not see any reason for further action at this time in cooperation with industry which would restrict us under existing authority. It doesn't seem to us that it would affect things at this stage.

Mr. WINN. Would it in any way affect your research efforts?

Dr. FROSCH. No. Currently, that which needs to be done can be accomplished under existing authority.

Mr. WINN. Nothing from a legal standpoint.

Dr. FROSCH. Nothing from a legal standpoint, unless counsel wants to advise me differently. That is the way we have been proceeding.

Mr. WINN. If a space industrialization entity were established outside of NASA, what impact would it have upon similar research at NASA? Could they be out-and-out head-on competitors? How would you control the possibility?

Dr. FROSCH. I think we would have to establish a mechanism for coordination with the outside entity. I guess my concern would be if NASA decided to do some research of interest to NASA—either by itself or in cooperation with an outside firm—ignorant of the fact that the entity was engaged in negotiations with some other outside firm to do substantially the same work.

We would need to know this to avoid situations resulting in a joint venture with the government via NASA or a nonjoint venture or different kind of joint venture with another kind of quasi-government entity.

We would have to devise a mechanism to prevent that. In our present situation NASA is essentially doing all the work in the space processing area, coordinating internally to insure there is no duplication in that sense.

Mr. WINN. I doubt that you have had a chance to review the testimony of the three witnesses from yesterday. Have you had that chance?

Dr. FROSCH. I have just seen a very short summary of it.

Mr. WINN. I didn't get any feeling that there was going to be any rush, particularly by industry, to put up the front money.

Dr. FROSCH. I think that is pretty much our impression, too.

Mr. WINN. Is it true of the industrial people that you said you had met with?

Dr. FROSCH. We are now negotiating several cases of industry interest to fund their portion or at least part of the money as a cooperative effort.

Mr. WINN. Have you had in your discussions with industry the feeling that any one large corporation or manufacturer is going to come forward by themselves?

Dr. FROSCH. I don't think we have any indication of somebody coming forward and fully funding the whole venture.

Mr. WINN. So then NASA is going to have to take the lead.

Dr. FROSCH. Yes. At least to the extent of cooperation in funding the launch and launch services. It is fair to say we have several cases now, as I indicated in the testimony, of real industrial interest in doing something; however, uncertainty of the risk is large enough that the companies are not willing to take the full investment burden. There is interest enough to put money into it in a cooperative way, given that we can resolve some questions of proprietary rights and patents and so on, which I think we can resolve.

Mr. WINN. I also got the feeling yesterday that they were waiting for the Space Shuttle to be launched. They are sort of waiting for NASA to prove itself.

Dr. FROSCH. I think it is reasonably prudent to want to see the vehicle you are going to work on. There is another kind of psychological factor involved here which puzzles me and I have observed it certainly within some of the scientific community. I call it the exotic factor.

Somehow it is related to the fact that the laboratory concerned is 200 miles up instead of 200 miles outside of town. If I said I had a room in western Maryland or in Kansas, or wherever, in which you can go and do an experiment—where I can turn gravity to be anything you like and give you high vacuum to boot, and it is kind of expensive—I expect we would have a bigger lineup of people wanting to do experiments than we do now, simply because the laboratory is 200 miles up and not 200 miles out of town.

I don't know what to attribute this to other than that as a psychological factor which will probably go away very rapidly after we have flown a few times and after some people have done some real experiments so that it becomes something rather straightforward instead of something somewhat exotic.

It is important in that regard to remember that we are trying now to deal with industry which is outside of the aerospace industry, and industry has not had very much to do with our kind of business. They are uncertain about it, and not really quite sure what it would be like: A, dealing with the Government; and B, dealing with NASA.

Mr. WINN. Yesterday several witnesses came up with the figure of front money of around \$50 million. I can't really figure out where

they got that kind of figure unless they just pulled it out of the air. I don't know what it would be based on.

Dr. FROSCH. I need to know what it was for to determine whether it was a reasonable estimate.

Mr. WINN. That is what some of the estimates were that it would cost the private industry to participate.

Dr. FROSCH. Certainly, some efforts could cost that much. I can conceive of some way to do experiments that would be markedly cheaper. It is clear there are some materials processing things that one can do on a getaway special basis, for very little money.

Mr. WINN. It has been pointed out that \$50 million was in the bill to start with, so I guess they are working around that. That is the starting point. I don't know where we got it, either.

Dr. FROSCH. I guess it was an estimate of approximately what one would need in the kitty to start for the first couple of years.

Mr. WINN. Thank you.

Mr. FUQUA. Thank you, Mr. Winn. Mr. Brown.

Mr. BROWN. Mr. Chairman, I missed yesterday's session. I had a short statement that I wanted inserted in the record, and I don't know whether it got inserted or not. May I ask permission to insert it?

Mr. FUQUA. We sure will. Without objection, it will be inserted in the record yesterday following my opening statement.

Mr. BROWN. Thank you.

Dr. Frosch, I am not exactly clear what NASA's level of effort is that you would identify as being related to industrial activities in space. Could you offer or hazard a guess at that?

Dr. FROSCH. The materials processing part of the research and development is about \$20 million a year. The reentry into communications technology is in the 1980 budget, as I recall, for \$8 million. I would include some of the use of Landsat for commercial purposes as being part of space industrialization, but I think we regard that as a separate budgetary question.

Mr. BROWN. So you identify about \$20 million in the materials and processing program. And that is the main area in which you see the immediate potential for industrial activities in space?

Dr. FROSCH. That is the next thing that we believe has to be looked at seriously.

Mr. BROWN. What about corollary activities related to such things as the erection of space structures in the operation of industrial facilities or laboratories in space? Does that sort of run into other activities like Spacelab and so on?

Dr. FROSCH. Well, the \$20 million, of course, does not include Spacelab. It presumes the existence of Spacelab and funds its special experimental equipment and the marginal operational cost for the payload to use the Spacelab systems. The question of structures research and development, and the engineering program for larger structures, is also a separate program and is being carried in several places in the budget.

I can't give you, off my head, an estimate of the total amount, but we could sum that up and provide it for the record.

Mr. BROWN. Wouldn't you consider that the work devoted to an analysis of the problems of erecting structures in space and outfitting

them and operating them could be logically considered a part of the space industrialization process?

Dr. FROSCH. I would consider it to be the buildup of the infrastructure of technology that would then be used for industrial purposes among other purposes.

Mr. BROWN. It could be used for scientific purposes. For example, the erection of a large space telescope—if it were erected in space, as opposed to being made on Earth and shot into space—could contribute knowledge about how to solve these problems of making the infrastructure. Some of the studies with regard to solar power installation in space would also be construed as related to the industrialization.

Dr. FROSCH. It could be taken that way; yes.

Mr. BROWN. What have you projected in the near term for the use of the Space Shuttle that might be related to industrialization in space? Maybe you have listed that in your statement, but I didn't catch it. What portion of the space or whatever measure you use for the Shuttle that you have projected so far that could be identified as related to industrialization activities?

Dr. FROSCH. As I recall, we are planning in terms of about the equivalent of one or two Spacelab flights per year. We would start out with about one per year in the earlier years, and possibly going to two per year that might be said to be associated principally with materials processing and related matters.

Mr. BROWN. Do you mean the capacity of an entire flight would be devoted to industrialization?

Dr. FROSCH. We would, essentially, be programing a Spacelab mix, most of which would be involved with materials experiments and materials-related experiments. It might be anywhere from, effectively, full utilization of the flight to splitting a flight between materials processing and some other scientific uses.

Mr. BROWN. Getting to the problem of the relationship between NASA and industry, you cite the example of the communications field in which NASA developed this marvelous communication satellite technology and out of that grew Comsat, and NASA sort of got out of the field, and now they are getting back in at the level of \$8 million a year. Is there anything that we can learn from this experience? Did we do the right thing in getting NASA out of the communication satellite research area to begin with? Was there some reason why Comsat couldn't do what you are projecting NASA to do, to get back into it? What is the background on that?

Dr. FROSCH. I think NASA got out of communications research, if I understand the history, as much from budget pressure as anything else, and the feeling that something needed to drop out of the budget in those years. At the time, it appeared the best way to accommodate the budget pressures was not to clip everything but to find some program package that we could eliminate.

The idea was that the communications business had been effectively commercialized and it was reasonable to say that perhaps the commercial industry would do the research and development. What happened was that the industry continued to do what I would call the short-term research and development; that is, the immediate product improvement. What industry appeared not to be pursuing was the

technology, research, and development that was needed on a long-term basis.

The long-term R. & D. work is needed to change the nature of the system, perhaps 10 years out. That is something which, in spite of annual budgeting, is easier for a Government agency to talk about doing than for a commercial industry which has even stronger pressures for short-term investment and payoff.

So it looks as though there may be quite a reasonable split of roles, provided the Government is careful to stay in the technology research and development area and not to go into the commercial service business in the sense of not actually building commercially viable communication satellites.

Mr. BROWN. This is what I am trying to learn from, because we have the same identical situation in a number of other fields. The question is, what is the appropriate division of roles between Government and industry? Could you give us a few examples of the type of long-term research that you see NASA better able, equipped, to carry out?

Dr. FROSCH. In the communications area, the specific problem we have undertaken is to develop those pieces of technology, along with industry, which are required for more efficient utilization of the geostationary orbit and frequencies that are possible with current technology. With the current line of technology we will probably—in a period variously estimated as 5 to 10 years—use all of the available space. I don't mean that the satellites will be shoulder to shoulder, but only if we put them any closer the ground stations transmitting to neighboring satellites would interfere with each other and individual ground stations would get interfering signals from satellites other than the ones intended to transmit them. By going to more sophisticated techniques in terms of higher frequency, multiple beam-forming, time-synchronized beams, and so on, one can greatly increase the available channel capacity. That is a technology development venture we can undertake with industry, because we can view it as having a long-term payoff for the taxpayer.

Industry tends to be more constrained in working on projects with long-term benefits, partly because it is long term and doesn't show an immediate evident payoff, and partly because it is an expensive kind of research. Now, I must say that I am not sure I think industry is always being as long sighted as it ought to be when it makes those decisions but it is clear at any rate that this is what has happened.

In the materials area, I think that the requirement will continue to exist for the Government to undertake the riskier and fancier experiments, ones which are perhaps closer to pure physics and materials science and chemistry than those which are closely connected with product development. That is likely to go on.

Mr. BROWN. Let me get back to Comsat for just a moment. I hope I am not belaboring this too much, but Comsat was supposed to be a unique institution. We refer to it as industry, or you refer to it as industry, but basically it is a quasi-public corporation, 50-50.

Dr. FROSCH. Yes.

Mr. BROWN. Presumably this was intended to imbue its board of directors with concern for the public need and interest, and a commit-

ment to longer range goals than possibly industry in its exclusive need for short-term profitability could mount. Has that worked out in practice, or have in fact the policy decisions of the board been dictated by the industrial partner in the operation?

Dr. FROSCH. Well, I am not sure I know all the details. My impression is that Comsat R. & D. has not been markedly longer range in its outlook than the rest of the industry. Of course, the stock in Comsat is 100 percent private, although the directorship is still split. I think part of the problem with Comsat is that they have spent a good deal of their life so far growing into a position of profitability and good business status that it might have been imprudent of them to take too many long-term risks in the early years.

Mr. BROWN. Well, it has been rumored, shall we say, that Comsat has failed to exploit even the immediate opportunities available to it for the expansion of satellite services, and it has been hinted that this may be due to institutional constraints arising out of the need to protect the existing investment in ground-based communication facilities. Is it conceivable that this might be true?

Dr. FROSCH. It is conceivable. I have no idea whether or not it is the case. I am not sure why Comsat would operate in that way because they don't, to my knowledge, deal in other forms of communications than satellite communications.

Mr. BROWN. Isn't a major portion of its stock held by the existing ground-based communication companies?

Dr. FROSCH. I simply don't know. It could well be. I just don't know.

Mr. BROWN. I wonder if you could supply that for the record. Not that it is necessary for you to do so, but I am sure some of your loyal staff can do that for you.

Dr. FROSCH. We will attempt to supply it for the record.

[Questions and answers submitted for the record follow:]

QUESTION:

You indicated in your statement that NASA was establishing a basic policy statement which outlines the conditions under which NASA would share costs with firms of commercial ventures. When it is complete, could it be provided for the record?

ANSWER:

A copy of the "NASA Guidelines Regarding Early Usage of Space for Industrial Purposes," dated June 25, 1979, is submitted herewith.

NASA GUIDELINES REGARDING EARLY USAGE
OF SPACE FOR INDUSTRIAL PURPOSES

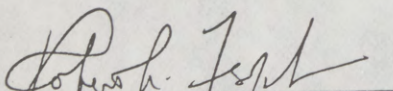
NASA, by virtue of the National Aeronautics and Space Act of 1958, is directed to conduct its activities so as to contribute to the preservation of the role of the United States as a leader in aeronautical and space science and technology and their applications.

Since substantial portions of the U.S. technological base and motivation reside in the U.S. private sector, NASA will enter into transactions and take necessary and proper actions to achieve the objective of national technological superiority through joint action with United States domestic concerns. These transactions and actions will be undertaken in the context of stated NASA program objectives and after a determination by the Administrator. They may include, but are not limited to: (1) engaging in joint arrangements with U.S. domestic concerns in research programs directed to the development of enhancement of U.S. commercial leadership utilizing the space environment; (2) conducting research programs having as an end objective the enhancement of U.S. capability by developing space-related high-risk or long-lead-time technology; and (3) by entering into transactions with U.S. concerns designed to encourage the commercial availability of products of NASA space flight systems.

NASA incentives for these purposes may include in addition to making available the results of NASA research: (1) providing flight time on the space transportation system on appropriate terms and conditions as determined by the Administrator; (2) providing technical advice, consultation, data, equipment and facilities to participating organizations; and (3) entering into joint research and demonstration programs where each party funds its own participation.

In making the necessary determination to proceed under this policy, the Administrator will consider the need for NASA funded support to commercial endeavors and the relative benefits to be obtained from such endeavors.

As major areas for NASA enhancement of total U.S. capability, including the private sector, may become apparent from time to time, the factors to be considered by NASA prior to providing incentives may include, but not be limited to, some or all of the following considerations: (1) the public or social need for the expected technology development; (2) the contribution to be made to the maintenance of U.S. technological superiority; (3) possible benefits accruing to the public or the U.S. Government from sharing in results; (4) the enhanced economic exploitation of NASA capabilities such as the space transportation system; (5) the desirability of private sector involvement in NASA programs; (6) the merit of the research, development or application proposed; (7) the degree of risk and financial participation by the commercial concern; (8) the amount of proprietary data or background information to be furnished by the concern; (9) the rights in data to be granted the concern in consideration of its contribution; (10) the ability of the concern to project a potential market; (11) the willingness and ability of the concern to market and sell any resulting new or enhanced products on a reasonable basis; (12) the impact of NASA sponsorship on a given industry; (13) provision for a form of exclusivity in special cases when needed to promote innovation; (14) recoupment of the NASA contribution under appropriate circumstances; and (15) support of socio-economic objectives of the Government.


Robert A. Frosch
Administrator

25 June 1979
Date

QUESTION:

Isn't a major portion of its (COMSAT) stock held by the existing ground-based communication companies?

ANSWER:

In the early days, half of COMSAT's shares were held by communications common carrier companies, and the other half of the shares were publicly held. Since then, the carriers have sold almost all of their shares so that today none of the large carriers owns any shares and the remaining ones own a total of less than 15,000 of the 8,000,014 shares outstanding.

In the beginning, six directors were elected by the carriers, six were elected by shareholders other than common carriers, and three were appointed by the President, with the advice and consent of the Senate. Today, there are still three Presidential appointee positions on the Board, but carriers which still own COMSAT stock do not separately elect COMSAT directors. An amendment of the Communications Satellite Act, adopted in 1969, provides in substance that when carriers hold less than 8 percent of COMSAT's shares, they are not entitled to elect directors separately but instead vote with all other shareholders in the election of the 12 shareholder-elected directors. Today, carriers hold less than $\frac{1}{4}$ of 1 percent of the total shares outstanding.

QUESTION 1:

Much has been said about the relative immaturity of materials processing in space. Could you please give us your views and tell us what roles you see being played now by industry in the program?

ANSWER:

On the evolutionary scale of materials processing technology, time periods of 15 to 25 years are not uncommon for new concepts to be innovated for the marketplace. Materials processing in space is at the beginning of this evolution and is, therefore, constructing an extensive base of knowledge and people to initiate subsequent innovation. However, the end user of this new technology will be private industry and not the U.S. government. The resulting benefits will be made available to the public through private industry's utilization of the new technology. In order for successful generation, adoption and diffusion of this new technology to occur, it is essential that industry work closely now with NASA to build and provide inputs to the knowledge base of materials processing in space. It is anticipated that such interactions will allow successful projects to be continued by private industry when indicated by the risk and readiness assessments.

QUESTION 2:

What longer range roles do you envision for NASA and the private commercial sector in future applications programs?

ANSWER:

In NASA's applications programs, the basic science and generation of new technological capabilities will probably continue to be principally undertaken by NASA while the provision of associated goods and services to the public will be the responsibility of the private sector. In the maturing and transition of this technology, NASA will establish working relationships with innovators and entrepreneurs from the private sector. It is expected that such joint arrangements will include commitments by all parties to mutual endeavors involving space processing. In this way, the private sector will be encouraged in the earlier stages of the technology evolution to contribute essential technological inputs while, at later stages, the private sector will be well-prepared to assume responsibility for successful demonstrations which are economically self-sufficient or fully operational.

QUESTION 3:

Do you have any interested partners in your cooperative program with private industry? If so, what is the status of your dealings with them?

ANSWER:

Three private companies have proposed joint endeavors to NASA in materials processing in space, and based on indications of interest from other firms, we expect to receive two or three further offers before long. We have held informal clarifying discussions with the three offerors and are now in the final stages of establishing policies and procedures to implement joint endeavors within the framework of the policy outlined in our testimony. In the near future, therefore, NASA will be ready to negotiate seriously with all offerors in joint endeavor proposals and initiate projects if mutually acceptable terms can be arranged.

QUESTION 4:

You indicated that NASA is establishing a basic policy statement which outlines conditions under which NASA would share costs with firms for commercial ventures. Would you provide this document for the record?

ANSWER:

A copy of the "NASA Guidelines Regarding Early Usage of Space for Industrial Purposes," dated June 25, 1979, is submitted herewith.

QUESTION 5:

You indicate that NASA would be interested in joint endeavors with private industries in areas which are consistent with NASA's program objectives. How consistent do you believe NASA program objectives should be and will be to needs of the private commercial sector? How will you determine what the private commercial sector needs are?

ANSWER:

In the program areas where the participation of private enterprise is essential to the innovation and adoption of new space-related technology, NASA will establish and maintain a close dialogue with the private commercial sector. Experience has shown that the long lead times and costs of supporting such activities are not acceptable to the private sector alone. Our information about the needs of private industry comes from contracted studies, advisory committees, and informal day-to-day contacts. We believe that joint endeavors between NASA and the private sector will be a further valuable way to gauge private needs because they will give us a direct index of the space-related areas where private capital sources are willing to invest.

QUESTION 6:

Do you believe there may be important commercial applications of material and material processes which deserve national attention but which NASA will not support for programmatic reasons?

If NASA feels it is not premature to fund joint endeavors with commercial firms in areas of NASA's interest why is it premature (page 8) for the federal government to support other commercial ventures in the national interest?

ANSWER:

NASA's programmatic decisions in materials processing in space are conditioned by the need at this time to build the enabling technology for non-NASA space activity economically and in pace with the development of space flight capabilities. The Agency is carrying on a research and development program that is sufficient to develop the basic technology and techniques that will be needed later for general use by space-related businesses. At present, this effort appears to be satisfactory for the present level of knowledge and interest in this technology. When the technology matures and interest increases in its use, it will be necessary to consider arrangements that are more suitable to expanded use of the spaceflight environment.

There are a few specialized cases where commercial ventures can be developed simultaneously with the basic technology of materials processing in space. These early ventures should be encouraged and deserve public support because their experiences and the things NASA learns from them will benefit all later space investors. However, we believe that during the current technology-building phase the proper way for the government to support these ventures is through joint endeavors with NASA rather than by investment through a separate entity, because their main contributions will be to the Nation's technology. At a later stage, with this technological base and more extensive involvement, economical advantages should follow.

QUESTION 7 (a):

On page 7 you list three Administration objections to H.R. 2337. With respect to the first point that some front-end money should be provided by the commercial firm, can you see any reason why the Space Industrialization Corporation's agreement with commercial firms could not be structured to include their providing some funds, as well as other resources of the firm?

ANSWER:

Naturally, there is no reason why the Space Industrialization Corporation could not do this, and we believe that it

ought to do so if it is established. However, we believe that the Corporation would in effect be functioning as a middleman between NASA and the commercial private sector at a time when the technology base and techniques are still being established. At a later stage when interest in the capabilities of space increases, the government's relations with space-related commercial activities could require different arrangements, such as those being considered by the creation of the Space Industrialization Corporation.

QUESTION 7 (b):

Another objection you raise is that the Space Industrialization Corporation could inhibit companies from investing private capital on joint ventures with NASA and therefore Federal funds would be competing with private capital. Since the Corporation is specifically directed away from activities of a particular or specific interest to NASA (as you point out on page 7) and NASA will only enter into joint ventures in which it has programmatic interest, if necessary, how could the bill be strengthened in this regard?

ANSWER:

Our position is that there is literally nothing that can be done to contribute productively to space industrialization for the next several years except technology development and scientific research, which is the mission assigned to NASA by the Space Act. In cases where industry wishes to take a share in investing in this research and development, joint projects with NASA will be the most efficient and appropriate type of arrangement; to create another government agency to do the same thing at this time would only interfere with NASA's performance of its mission. It will become possible to define a separate, non-interfering sphere of action for the Space Industrialization Corporation when space technology has developed to the point where orbital enterprises can be business ventures in the sense that the terms apply to terrestrial businesses.

QUESTION 7 (c):

The third objection is the requirement for some part of the profit being returned to the trust fund. Although this provision will undoubtedly raise questions of what is profitability, what alternative would you propose for commercially viable projects which do not meet the criteria for NASA joint endeavors?

ANSWER:

Since one of the usual criteria of commercial viability is that a business is able to meet its financial obligations, there must be a very wide range of legitimate repayment plans that the Space Industrialization Corporation could negotiate with space entrepreneurs. In our opinion the Corporation should have wide latitude regarding the terms and conditions of repayment it is allowed to negotiate in particular cases, but it should not function as a grant-in-aid program or a subsidy to unprofitable businesses.

QUESTION:

Will the patent provisions of the National Aeronautics and Space Act of 1958 apply to joint endeavors that private concerns might undertake with NASA?

ANSWER:

With respect to joint endeavors as defined in the attached memorandum dated June 15 from the Assistant General Counsel for Patent Matters, the patent provisions of the National Aeronautics and Space Act, and specifically section 305 of that Act, will not apply for the reasons set forth in that memorandum.



National Aeronautics and
Space Administration

Washington, D.C.
20546

June 19, 1979

TO: G/General Counsel

FROM: GP/Assistant General Counsel for Patent Matters

SUBJECT: Applicability of Section 305 of the Space Act
to Joint Endeavors

This responds to your request that I address the issue of whether "section 305 of the National Aeronautics and Space Act of 1958, as amended [hereinafter "Space Act"] applies to inventions made in the course of joint endeavors; for example, endeavors undertaken in the Materials Processing in Space Program."

In this memorandum I will review the legislative history of section 305, discuss NASA's interpretation and application of the section over the years, summarize the experience gained, and state the conclusions to be drawn therefrom.

The basic legal issue is whether a "joint endeavor" is a contract of the Administration for the performance of work within the intent of section 305, such that any inventions made in the course of the endeavor are subject to the ownership requirements of subsection 305(a).

For the purposes of this memorandum, a joint endeavor is defined as follows:

A joint endeavor is an arrangement between NASA and a party or parties in which each undertakes to contribute to or participate in a project of mutual benefit, and which usually involves the use of equipment, facilities, services, personnel or information made available by one or more of the each parties for use by the others. Such endeavors do not involve the transfer of funds or title to property between the parties, and are not considered a procurement or an assistance transaction within the purview of P.L. 95-224. Services which may be involved do not constitute the employment of one of the party's employees by the other.

In answer to the legal issue raised, it is concluded that a joint endeavor is not subject to the legal constraints of section 305. This conclusion is based on the Space Act and the long-standing administrative interpretation of section 305 by NASA that there are many arrangements which NASA may enter into, a joint endeavor being one such arrangement, that are not contracts covered by subsection 305(a).

1. Section 305 of the Space Act

The pertinent language in the Space Act¹ dealing with the allocation of property rights in inventions is as follows (emphasis added):

o Subsection 305(a) requires that [w]hensoever any invention is made "--in the performance of any work under any contract of the Administration, and the Administrator determines that -

(1) the person who made the invention was employed or assigned to perform research, development, or exploration work and the invention is related to the work he was employed or assigned to perform, or that it was within the scope of his employment duties, whether or not it was made during working hours, or with a contribution by the Government of the use of Government facilities, equipment, materials, allocated funds, information proprietary to the Government, or services of Government employees during working hours; or

(2) the person who made the invention was not employed or assigned to perform research, development, or exploration work, but the invention is nevertheless related to the contract, or to the work or duties he was employed or assigned to perform, or was made during working hours, or with a contribution from the Government of the sort referred to in clause (1)"

such invention becomes the exclusive property of the United States unless the Administrator waives rights thereto in conformity with the provisions of subsection 305(f).

o Subsection 305(b) specifies that "[e]ach contract entered into by the Administrator with any party for the performance of any work" is to contain effective provisions for the reporting of inventions "which may be made in the performance of such work."

o Section 305(j)(2) defines the term contract as meaning "any actual or proposed contract, agreement, understanding, or other arrangement, or sub-contract."

It is the meaning, interpretation and application of the phrase "in the performance of any work under any contract of the Administration" when considered in the context of the whole statute, its legislative purpose and intent, and its long standing practical interpretation by NASA, that determines whether a joint endeavor, which meets the literal definition of "contract" as set forth in subsection 305(j)(2), comes under subsection 305(a).

2. Legislative Purpose and Intent Behind Section 305

The legislative purpose and intent underlying section 305 is not set forth in the Space Act;² however, the legislative history of section 305 does provide insight in this regard. Although the legislative history of section 305 has been characterized as "extremely thin" and not providing guidance, or as "very scanty," requiring NASA to use "its best judgment as to what Congress had in mind" with regard to the interpretation of such difficult and complicated legislation,³ a careful review of the report of the House-Senate Conference on the bill,⁴ and the transcripts of the floor debate prior to its passage⁵, does reveal a consistent thread of legislative purpose and intent underlying section 305.

The report of the conference, for example, after briefly setting forth the previous House and Senate actions that led up to the need for conference on the issue, states:

"Operating on the theory that the Government's interests must be protected, but with the concomitant purpose of protecting private interests and of keeping private incentive and initiative at a high level, the Committee of Conference adopted entirely new patent provisions."⁶

The report then continues with a very brief explanation of Subsection 305(a), indicating that inventions are to become the property of the United States "according to a specified standard." (Emphasis in report). This standard is set forth in subparagraphs (1) and (2) of subsection 305(a), and is based on a relationship of inventions made to both the duties of the contractor employee performing under the contract and contract requirements.⁷

During floor discussion prior to final passage of the Space Act, Rep. McCormack stated in his opening address:

"The patent provisions of the House bill is the only part of the bill extensively revised by the conferees. The Senate version carried a patent provision closely similar to the provision of the House bill. This was dropped by floor amendment just before passage in the Senate to allow this section to go to conference. The review and redrafting were wise. The select committee created a special subcommittee to study the matter, and after talking with many experts in and out of Government arrived at a new version, drawing upon Senate and House suggestions. The original patent provision was too closely patterned after the stringent requirements of the Atomic Energy Act which are not fully applicable to the space field. The substitute provision agreed to by the conferees protects both the interests of the Government and affords enough flexibility to the Space Administrator to let him meet needs for preserving inventions of the individuals and companies whose efforts it is public policy to encourage."⁸

Rep. Keating also commented rather extensively on the patent provisions. Included in his summary of section 305 was the statement:

"The conferees recognized that research and development in aeronautical and space sciences will not be comparable, in most respects, to that in the field of atomic energy, and hence that there is no necessity for a Government monopoly of rights or interests in all inventions and/or discoveries relating to space exploration.

"And the patent provisions in this conference report do not automatically, as I understand the Atomic Energy Act does, give all property rights in inventions to the Government."⁹

The above-noted comments from the conference report and statements made during floor debate, viewed in light of drafting changes that culminated in the final version of section 305, clearly suggest that there was a legislative intent not to follow the restrictive and stringent approach taken in the field of atomic energy, which approach automatically created a "Government-monopoly" on inventions in the entire field based on some rather broad and generalized contractual relationships.¹⁰ To the contrary, the Congress-

sional intent behind the redrafts that became section 305 was to loosen the grip of government ownership of technology resulting from the space program. This was accomplished by incorporating the "standard" of subparagraphs (1) and (2) into subsection 305(a) wherein the Government acquires rights to inventions only in specified situations in which contractors and employees thereof are required to perform work of an inventive nature for the Administration.

Thus, even though the legislative history lacks a detailed analysis of the various provisions of section 305 and their interplay, two key points are evident from the conference report and the floor statements, quoted above. First, there was an underlying legislative purpose to maintain private incentive and initiative; and second, there was a legislative intent that the restrictive provisions of the Atomic Energy Act, which essentially preempt private ownership of patent rights in an entire field of endeavor, were not to be carried over to space activities. Accordingly, NASA has from the onset adopted a liberal administration of section 305 and has made this known to Congress.¹¹ This is illustrated by the numerous examples discussed below.

3. NASA Interpretation and Application of Section 305

Consistent with the pronouncement to liberally administer section 305, and in harmony with the aforementioned legislative purpose and intent, NASA has over the years taken a more restricted interpretation as to the type of contracts that are subject to the title-taking constraints of subsection 305(a) than is literally suggested by the broadly worded definition of subsection 305(j)(2).¹² Accordingly, it has been the long standing official interpretation and administrative practice of NASA to limit the application of subsection 305(a) to activities performed for NASA that have the potential for making inventions.¹³ This is reflected in NASA's regulations and practices over the past two decades, as the following review illustrates. This review covers a number of arrangements that NASA determined were not covered by subsection 305(a), a joint endeavor being one such arrangement. In each instance the determination made by NASA, and relied on by the other party, has had a direct effect on the vesting of property rights to inventions made by that party.¹⁴

a. Proposals Submitted to NASA

A literal interpretation of subsections 305(a) and 305(j)(2), taken together, would require the Government to take title to any privately funded inventions made in the course of preparing a proposal (i.e., a "proposed con-

tract") for submittal to NASA. Such interpretation, however, is manifestly at odds with the legislative purpose of section 305(a) to protect private interests and to maintain private incentive and initiative. Thus, NASA took a restrictive interpretation of the phrase "any... proposed contract" appearing in subsection 305(j)(2), and limited it to work performed upon an understanding that a contract would be awarded, such as when a written authorization is given to proceed with the work pending formalization and execution of a contract.¹⁵

b. Contracts for Supplies, Construction and Utility Services

In developing NASA's procurement regulations, interpretations of section 305 were made to determine the types of contracts that were subject to subsection 305(a), and therefore required the inclusion of a provision as specified in subsection 305(b). NASA concluded that the legislative intent was to apply section 305 only to those types of contracts requiring the performance of inventive type work for NASA, and so advised Congress.¹⁶ This interpretation is reflected in the NASA Procurement Regulations, which limit the use of a patent rights clause that would invoke section 305 to specified types of contracts having a prospect of inventive work being performed.¹⁷

c. Launch Service Agreements

NASA has provided launch services to non-NASA entities during most of its history. Many of the launches have been provided on a reimbursable basis for private domestic concerns, wherein the launched spacecraft has been developed and owned by the concern for whom NASA provided such services. In addition, there have been numerous reimbursable launches for other U.S. Government agencies, foreign countries and international organizations.

(i) The AT&T Launch Agreement

The first launch service agreement was with American Telephone and Telegraph (AT&T) (July, 1961) to launch the experimental Telstar communication satellites. This agreement differed considerably from the typical research and development contract entered into by NASA since the satellites were to be designed, built, funded and owned by AT&T, and AT&T was also to reimburse NASA for its "out of pocket launch costs." Thus, the roles of the parties were reversed from the normal contractual situation in that NASA was being paid to perform work for AT&T.

The agreement was made subject to section 305, and NASA took, and then waived back, title to all inventions made by AT&T in the design and development of the Telstar satellite, but retained a worldwide, royalty free license for governmental purposes. In addition, NASA acquired the right to grant licenses to others for the practice of such inventions throughout the world for any purposes whatsoever upon such terms and conditions as the Administrator may prescribe. This right to license others was unrestricted as to both the parties to be licensed and the purposes for which the inventions may be practiced.

The rationale for acquiring these rights under the AT&T agreement was the existence of exceptional circumstances; that is, the desire to keep options open in an uncertain area until such time as the Congress and the President acted on an approach to be taken in establishing a communication satellite system.¹⁸

(ii) Subsequent Launch Agreements

The next launch service agreement where the applicability of section 305 was raised was in 1964, when NASA negotiated an agreement with the Communications Satellite Corporation (Comsat) to launch on a reimbursable basis, Comsat's funded and owned satellites. In formulating a patent policy for this agreement note was made, and consideration given, to the position previously taken by NASA with respect to NASA/AT&T Telstar launch agreement. It was concluded, however, the reasons that gave rise to the particular NASA/AT&T patent policy no longer existed.¹⁹ It was observed that while the NASA/Comsat launch agreement was a "contract for the performance of work" and hence could be construed to be covered by section 305, under the specific terms of the agreement NASA was to perform the work for Comsat, as contrasted with the typical situation where the contractor performs work for NASA.²⁰ In other words the conventional roles were reversed under this type of agreement.

NASA made the interpretation that the launch service agreement with Comsat was not subject to section 305 because no work was to be performed for NASA, and thus there was to be no transfer of NASA funds to Comsat. However, to insure against a later amendment of the agreement calling for the performance of work by the corporation for NASA it was decided to include a section 305 patent clause in the agreement as a precautionary measure. To this end, the clause began with the language "If and to the extent that any work is performed for NASA under this agreement..."²¹ Thus, NASA made the further interpretation that, in addition, inventive type work had to be performed for NASA in order for section 305 to apply.²²

The interpretation that a launch service agreement does not constitute a contract for the performance of work for NASA, and hence not a contract subject to subsection 305(a), has been consistently followed since 1964.²³ In fact, experience has shown over the years that the standard launch service agreements have never required any work to be performed for NASA, and the above-mentioned precautionary section 305 patent rights clause is no longer used.

4. Joint Endeavors

The above review illustrates a number of instances where NASA has made an official interpretation and adopted administrative practices to support the position that not all contracts are subject to subsection 305(a). Joint endeavors represent yet another instance where NASA has made an interpretation that an agreement or arrangement which literally meets the definition of contract under subsection 305(j)(2) is not a contract in the context of subsection 305(a).

With the development of advance facilities, such as wind tunnels, sensing and communications satellites and a space transportation system, and the creation of high technology, such as supercritical wing and ADP systems, NASA found it to be in its interest, both national and international, to enter into arrangements whereunder NASA would contribute the use of its facilities or technology to other parties in return for the other parties agreeing to furnish their products or services to carry out a program or project of mutual interest. The parties then share the results and benefits of the project. Often these activities are carried out as a joint endeavor, as previously defined.

Joint endeavors may vary as to the number of parties involved, the type and amount of contributions made by the parties, as well as the technical nature of the endeavor undertaken. In general these activities and arrangements differ considerably from a formal NASA contract and somewhat from those activities previously discussed in that they are usually informal in nature, are sometimes bottomed on a best efforts basis, do not involve the reimbursement or exchange of funds between the parties, and are not deemed as requiring employment of one party's employees or contractors by the other party in making the contribution of facilities, equipment or services to the joint activity.

NASA's first interpretation as to whether section 305 applied to a joint endeavor occurred in April, 1959, in re-

sponse to an inquiry by a private company regarding an arrangement whereby NASA would contribute one of its facilities for the testing of privately developed equipment, and NASA and the owner of the equipment would share the resulting test data.²⁴ The position was taken that, while such an arrangement had the appearance of a contract with NASA, the fact that the company contributed equipment to the joint endeavor would not mean the company assumed any obligations to perform any work for NASA in the sense of subsection 305(a). Hence the interpretation was made that subsection 305(a) would not be applicable to any inventions made by the company or its employees during the testing of the company's equipment or any activities incident thereto. The interpretation was also made that should any of the company's employees participate in the testing, and should they as a result make an invention, the invention would not be covered by subsection 305(a) because it would not have resulted from the performance of any work for NASA.²⁵

Subsequent to this initial interpretation, NASA has had many occasions to determine whether an arrangement or agreement structured as a joint endeavor was to be considered a contract subject to subsection 305(a). The interpretation has been consistent that, under joint endeavors neither party is assuming any obligations to perform inventive type work for the other, and accordingly each party retains rights to any inventions that may be made in the course of carrying out its activities that are contributed to the effort.²⁶ This interpretation and the resulting practices are illustrated by the examples set forth below.

(a) Use of NASA Facilities

Where NASA's contribution is the use of a ground-based facility, and the other party furnishes equipment or services, NASA does not apply section 305, but acquires license rights to any inventions resulting from such use through negotiated provisions in the agreement.²⁷

NASA has a similar policy where the contribution is the use of its orbiter to carry the other party's payload for testing, demonstration, or performing other operations or analysis in space.²⁸

(b) Use of Satellite Data and High Technology

Other joint endeavors in which NASA has not applied section 305, involve activities wherein NASA's contribution is its satellite data²⁹ or its high technology such as supercritical wing technology in exchange for results of the analysis thereof. When the resulting activities are not of the inventive nature, no patent provisions are included;

when it is anticipated that inventions may be made, a patent provision may be included by negotiation.³⁰

(c) Contributions of Technical Interface and Technical Monitoring Assistance

NASA also entered into a joint endeavor with the McDonnell Douglas Corporation (and a similar one with the Boeing Company) whereunder McDonnell Douglas developed at its expense a spin stabilized payload assist module (SUSS/PAM) for launching payloads from the orbiter, and NASA provided technical interface and monitoring assistance and services.³¹ Subsection 305(a) was not deemed applicable to this joint endeavor, but under negotiated provisions NASA would acquire rights to inventions made by McDonnell Douglas in developing the SUSS/PAM in event of termination for default.³²

(d) Cooperative Launch Activities

In addition, NASA has entered into arrangements whereby NASA launches, at no cost to the other party, spacecraft and/or experiments provided at no cost to NASA by the other party, with the understanding that NASA and the other party are to share in the results, usually by exchange and/or publication of the information and data derived from the resulting activity. Again, section 305 has not been deemed applicable to these arrangements, but a provision may be included, by negotiation, to acquire license rights for governmental purposes if it is determined that the resulting activity is of an inventive nature. Other than such license rights, invention rights reside with the respective parties (or their employees or contractors) of the joint endeavor.³³

(e) Contribution of Major Hardware

Other NASA joint endeavors have involved activities where the various parties have made significant hardware contributions to a common program. As in the previously discussed joint endeavors, subsection 305(a) has not been deemed applicable, and any invention rights involved reside with the party (or its employees or contractors) who contributed the hardware. License rights, for governmental purposes, are acquired if it is determined that the resulting activity is of an inventive nature.³⁴

5. Summary and Conclusions

It is clear from the foregoing that during its nearly two decade history NASA has entered into numerous actual or proposed contracts, agreements, understandings or other arrangements, all within the literal definition of "contract" of subsection 305(j)(2), that were not deemed subject to subsection 305(a). In some instances they were for the procurement of goods and services (supply contracts using appropriate funds); in other instances they were for launch services or the use of NASA facilities on either a reimbursable or joint basis; and in still other instances they involved contributions of hardware on a joint basis. The issue does not turn on whether the arrangement between the parties falls within the literal definition of contract as defined in subsection 305(j)(2). Rather, the common basis for the decision not to consider these types of "contracts" under subsection 305(a) was a determination, consistent with the legislative history, purpose and intent, that they did not involve the performance of work of an inventive type for the Administration in the context of subsection 305(a).

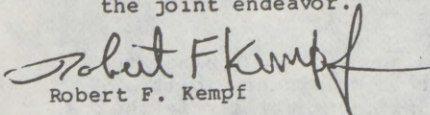
This determination is equally valid with respect to joint endeavors, wherein each party performs, or has performed, work on its own behalf in order to make contributions to the common project. To the extent that any inventive activity is performed by a party's employees or contractors, it is performed by or for that party for the purpose of enabling that party to make contributions to the joint endeavor. That is, one party is not performing, or not having performed, work for the other party, but rather, for itself. Neither party is empowered to direct, assign or require work of an inventive nature to be performed by the employees or the contractor employees of the other party. Thus, a joint endeavor is no different than the numerous other arrangements NASA has determined not to be subject to subsection 305(a) in that it does not require the performance of work of an inventive type for NASA.

In addition, there is nothing in the legislative history of section 305, nor of NASA's long-standing interpretation and administrative practices relating thereto, to suggest the determination should be any different because the technology involved may find commercial application, as may be the case for joint endeavors under the Materials Processing in Space Program. If it is determined that the activity does not involve the performance of work of an inventive type for NASA, subsection 305(a) is not applicable notwithstanding the nature of the technology involved or its commercial potential.

Because joint endeavors are not contracts under subsection 305(a), any rights to inventions made in the course of a joint endeavor undertaken in the Materials Processing in Space Program must be acquired by negotiation. It is recommended that at a minimum NASA continue the established practice of acquiring a royalty-free license to practice, for governmental purposes, all inventions made in the course of the resulting activities of a joint endeavor undertaken in the Materials Processing in Space Program. Consideration may be given to acquiring license rights of the same scope to practice any inventions specifically made in the course of any preparatory or background activities, to the extent necessary to practice inventions made in the course of the resulting activities. Beyond this, it will be necessary to consider each proposed joint endeavor case-by-case. However, it is recommended that, consistent with the policy set forth in NMI 8610.8 dealing with reimbursable launches,³⁵ NASA obtain assurances, by way of directed licensing rights, that the results of any joint endeavor activity which may have a significant impact on the public health, safety or welfare be made available to the public on terms and conditions reasonable under the circumstances.

It is therefore concluded that:

- (a) NASA does enter into many types of arrangements falling within the literal definition of contract under subsection 305(j)(2) that are not contracts in the context of subsection 305(a);
- (b) a joint endeavor is an example of one type of arrangement that is not a contract in the context of subsection 305(a);
- (c) a joint endeavor under the Materials Processing in Space Program is no different regarding the interpretation and application of subsection 305(a) than any other joint endeavor, and therefore is not a contract in the context of subsection 305(a); and
- (d) the allocation of property rights in inventions under any joint endeavor is a matter of agreement between the parties that must be specifically set forth in the joint endeavor.


Robert F. Kempf

Enclosure

FOOTNOTES

1. 72 Stat. 426; 42 U.S.C. §2451 et seq.; particularly 42 U.S.C. §2457.

PROPERTY RIGHTS IN INVENTIONS

Sec. 305(a) Whenever any invention is made in the performance of any work under any contract of the Administration, and the Administrator determines that-

(1) the person who made the invention was employed or assigned to perform research, development, or exploration work and the invention is related to the work he was employed or assigned to perform, or that it was within the scope of his employment duties, whether or not it was made during working hours, or with a contribution by the Government of the use of Government facilities, equipment, materials, allocated funds, information proprietary to the Government, or services of Government employees during working hours; or

(2) the person who made the invention was not employed or assigned to perform research, development, or exploration work, but the invention is nevertheless related to the contract, or to the work or duties he was employed or assigned to perform, and was made during working hours, or with a contribution from the Government of the sort referred to in clause (1),

such invention shall be the exclusive property of the United States, and if such invention is patentable a patent therefor shall be issued to the United States upon application made by the Administrator, unless the Administrator waives all or any part of the rights of the United States to such invention in conformity with the provisions of subsection (f) of this section.

(b) Each contract entered into by the Administrator with any party for the performance of any work shall contain effective provisions under which such party shall furnish promptly to the Administrator a written report containing full and complete technical information concerning any invention, discovery, improvement, or innovation which may be made in the performance of any such work.

(c) No patent may be issued to any applicant other than the Administrator for any invention which appears to the Commissioner of Patents to have significant utility in the

conduct of aeronautical and space activities unless the applicant files with the Commissioner, with the application or within thirty days after request therefor by the Commissioner, a written statement executed under oath setting forth the full facts concerning the circumstances under which such invention was made and stating the relationship (if any) of such invention to the performance of any work under any contract of the Administration. Copies of each such statement and the application to which it relates shall be transmitted forthwith by the Commissioner to the Administrator.

(d) Upon any application as to which any such statement has been transmitted to the Administrator, the Commissioner may, if the invention is patentable, issue a patent to the applicant unless the Administrator, within ninety days after receipt of such application and statement, requests that such patent be issued to him on behalf of the United States. If, within such time, the Administrator files such a request with the Commissioner, the Commissioner shall transmit notice thereof to the applicant, and shall issue such patent to the Administrator unless the applicant within thirty days after receipt of such notice requests a hearing before a Board of Patent Interferences on the question whether the Administrator is entitled under this section to receive such patent. The Board may hear and determine, in accordance with rules and procedures established for interference cases, the question so presented, and its determination shall be subject to appeal by the applicant or by the Administrator to the Court of Customs and Patent Appeals in accordance with procedures governing appeals from decisions of the Board of Patent Interferences in other proceedings.

(e) Whenever any patent has been issued to any applicant in conformity with subsection (d), and the Administrator thereafter has reason to believe that the statement filed by the applicant in connection therewith contained any false representation of any material fact, the Administrator within five years after the date of issuance of such patent may file with the Commissioner a request for the transfer to the Administrator of title to such patent on the records of the Commissioner. Notice of any such request shall be transmitted by the Commissioner to the owner of record of such patent, and title to such patent shall be so transferred to the Administrator unless within thirty days after receipt of such notice such owner of record requests a hearing before a Board of Patent Interferences on the question whether any such false representation was contained in such statement. Such question shall be heard and determined, and determination thereof shall be subject to

review, in the manner prescribed by subsection (d) for questions arising thereunder. No request made by the Administrator under this subsection for the transfer of title to any patent, and no prosecution for the violation of any criminal statute, shall be barred by any failure of the Administrator to make a request under subsection (d) for the issuance of such patent to him, or by any notice previously given by the Administrator stating that he had no objection to the issuance of such patent to the applicant therefor.

(f) Under such regulations in conformity with this subsection as the Administrator shall prescribe, he may waive all or any part of the rights of the United States under this section with respect to any invention or class of inventions made or which may be made by any person or class of persons in the performance of any work required by any contract of the Administration if the Administrator determines that the interests of the United States will be served thereby. Any such waiver may be made upon such terms and under such conditions as the Administrator shall determine to be required for the protection of the interests of the United States. Each such waiver made with respect to any invention shall be subject to the reservation by the Administrator of an irrevocable, nonexclusive, non-transferable, royalty-free license for the practice of such invention throughout the world by or on behalf of the United States or any foreign government pursuant to any treaty or agreement with the United States. Each proposal for any waiver under this subsection shall be referred to an Inventions and Contributions Board which shall be established by the Administrator within the Administration. Such Board shall accord to each interested party an opportunity for hearing, and shall transmit to the Administrator its findings of fact with respect to such proposal and its recommendations for action to be taken with respect thereto.

(g) The Administrator shall determine, and promulgate regulations specifying the terms and conditions upon which licenses will be granted by the Administration for the practice by any person (other than an agency of the United States) of any invention for which the Administrator holds a patent on behalf of the United States.

(h) The Administrator is authorized to take all suitable and necessary steps to protect any invention or discovery to which he has title, and to require that contractors or persons who retain title to inventions or discoveries under this section protect the inventions or discoveries to which the Administration has or may acquire a license of use.

(i) The Administration shall be considered a defense agency of the United States for the purpose of chapter 17 of title 35 of the United States Code.

(j) As used in this section--

(1) the term "person" means any individual, partnership, corporation, association, institution, or other entity.

(2) the term "contract" means any actual or proposed contract, agreement, understanding, or other arrangement, and includes any assignment, substitution of parties, or subcontract executed or entered into thereunder; and

(3) the term "made," when used in relation to any invention, means the conception or first actual reduction to practice of such invention.

2. The Declaration of Purpose and Policy in section 102 of the Space Act does not address the disposition of rights in inventions covered in section 305. 42 U.S.C. 2451.

3. See, for example, the testimony of John A. Johnson, General Counsel of NASA during Hearings Before a Subcommittee of the Select Committee on Small Business of the United States Senate on The Effect of Federal Patent Policies on Competition, Monopoly, Economic Growth and Small Business, 86th Cong., 1st. Sess., pages 255 and 267; and during Hearings Before the Subcommittee on Patents, Trademarks, and Copyrights, of the Committee of the Judiciary, pursuant to S. Res. 55 on S. 1089 and S. 1176, 87th Cong; 1st Sess., Part 1, page 161.

4. House Rept. No. 2166, 85th Cong., 2nd Sess. (July 15, 1958) at 22-24. An extensive discussion of the events that led up to this conference report can be found in Appendix A of An Evaluation of the Patent Policies of the National Aeronautics and Space Administration, Report of the Committee on Science and Astronautics, U. S. House of Representatives, 89th Cong., 2nd Sess.. Some key events discussed are:

(a) The introduction of the original House and Senate bills (H.R. 1181 and S. 3609, on April 14, 1958) containing no patent provisions.

(b) The subsequent hearings on S. 3609, during which the Deputy Secretary of Defense recommended that no special patent provisions be included in the legislation, based on the expectation that the policies and procedures of NACA (similar to those of DOD) would be applied by regulation.

(c) The reporting of H.R. 12575 (replacing H.R. 1181) out of House committee (May 24, 1958), with a section 407 entitled "Patent Rights," patterned after similar provisions of the Atomic Energy Act.

(d) The unanimous passing H.R. 12575 (June 2, 1958) with no debate or comment on section 407.

(e) The subsequent expressions of displeasure by industry and the private bar over section 407, primarily because of its similarity with what they considered the restrictive and arbitrary provisions of the Atomic Energy Act.

(f) The reporting out by the Senate Committee (June 11, 1958) of amended S. 3609 with a new Section 303, almost identical to section 407 of H.R. 12575.

(g) The successful floor amendment by Sen. Johnson during debate on amended S. 3609 to have section 303 deleted and the matter referred to conference.

(h) The subsequent appointment, by Rep. McCormack (Chairman of the Select Committee on Astronautics and Space Exploration) of a patent subcommittee (chaired by Rep. Natcher) to review the matter prior to any House-Senate conference. This subcommittee recommended an approach which provided, inter alia, that the Administrator would be entitled to ownership to inventions made under contract only when certain findings (based on the relationship of the invention to the duties of the employee of the contractor making the invention) were made; and as a separate matter would be authorized to waive ownership of inventions to which the Administration was entitled in the national interest. Thus the report of the Natcher subcommittee indicated an intent not to automatically vest ownership in the Administration under all contractual situations (no matter how broadly defined), as under the Atomic Energy Act. This report, unpublished, is entitled "Report of The Patent Subcommittee, House Committee on Astronautics and Space Exploration re Section 407, H.R. 12575."

(i) The adoption of the final version of section 305, coupled with favorable floor comment. While worded and structured differently than section 407 appearing in the re-

port of the Natcher subcommittee, it contained many of the salient features recommended in the report. Thus, when the conference report refers to the adoption of "entirely new patent provisions," it is in reference to the earlier draft of section 407 in H.R. 12575, and not in the rewrite of section 407 by the Natcher subcommittee. This is emphasized by the floor statements of Rep. Keating, which follow the report of the Natcher subcommittee rather closely in explaining the basis for new section 305.

5. 104 Congressional Record 13978 (1958)

6. House Rept. No. 2166, at 22.

7. On this point the report of the Natcher subcommittee (see note 4(h) above) states, by way of explanation of its redraft of section 407(a):

"The new version is not designed to be applicable to inventors or others directly employed by the Agency as Government employees. The rights of Government employees in such matters are already set forth by Executive Order (E.O. 10096, Jan. 23, 1950)."

The report then continues with an explanation of subsection 407(b) by stating "This spells out two conditions under which the Administrator is entitled to claim ownership in invention." The two conditions described are essentially the same as subparagraphs (1) and (2) of subsection 305(a), and are analogous to the basic policy set forth in paragraph 1. of E.O. 10096. Thus, there appears to be an intent to establish a relationship whereby, for the Administrator to be entitled to claim ownership to invention rights, the contractor employee is to be required to perform work for the Administration, indirectly through contract, in a manner analogous to the direct requirement for employees of the agency to perform such work.

8. 104 Congressional Record 13978 (1958) at 13986-13987. The provision dropped by floor amendment was section 303 (similar to section 407 in H.R. 12575) which was criticized as being too much like the restrictive and arbitrary provisions of the Atomic Energy Act. Also, the statement that "--the stringent requirements in the Atomic Energy Act -- are not fully applicable to the space field --" is one of the principal conclusions of the report of the Natcher subcommittee.

9. Supra, note 8, at 13987-13988. Rep. Keating's statements, like those of Rep. McCormack, are markedly con-

sistent with, and supportive of, the conclusions and recommendations of the report of the Natcher subcommittee.

10. The Natcher subcommittee, for example, noted in its report (see note 4(h)) that the original section 407, as it stood, tended to be "arbitrary and restrictive" and might "stifle interest and private endeavors in the space research and development field."

11. Testimony of John A. Johnson, General Counsel of NASA, during Hearings Before the Special Subcommittee on Patents and Scientific Inventions of the Committee on Science and Aeronautics, U.S. House of Representatives, on H.R. 1934 and H.R. 6030, 87th Cong; 1st Sess., at page 17.

12. There is no question as to the binding effect of a statutory definition of a term. However, as observed by authorities on statutory construction, such as the treatise of Sutherland Statutory Construction, Sec. 4707 [Sands, 4th ed 1973] [hereinafter Southerland]:

"Definitions are themselves... written in words whose meaning, whether viewed separately or in conjunction with the terms being defined and other language comprising their context, may be determinable only through further practice of the methods of interpretation."

"...words of an act may be restricted by its subject in order to avoid repugnance with other parts of the act (cite omitted)... [and] [t]he application of the words of a single provision may be... restricted to bring the meaning of the clause in question into conformity with the intention of the legislature..."

13. The official interpretation reflected in the regulations and long standing practices of an administrative agency charged with the duty of enforcing a statute has great weight in determining the operation of a statute. Although not binding on a court, it is unlikely that such interpretation would be overturned unless found to be clearly erroneous. Southerland, Sec. 4905 (and cases cited therein); C.D. Sands, 4th ed. 1973; also 82 C.J.S. Statutes, Secs. 358, 359 (and cases cited therein).

14. The courts are particularly reluctant to overrule a long-standing administrative interpretation of a statute where to do so would unsettle titles, or prejudice persons who have acquired contract or property rights in reliance on such construction. 82 C.J.S. Statutes, Sec. 359 (and the cases cited therein). Needless to say, a literal con-

struction of subsection 305(a) and 305(j)(2) at this time would have the effect of unsettling a myriad of rights in any inventions that may have been made in those instances where NASA has exercised reasonable judgment in making practical interpretations consistent with the legislative purpose (e.g., as has been done regarding the preparation of proposals, supply contracts, reimbursable launch service agreements, and numerous joint endeavors).

15. The Assistant General Counsel for Patents memorandum dated June 23, 1959 to the General Counsel on The Applicability of the "Property Rights in Inventions" Section of the National Aeronautics and Space Act of 1958 (Section 305) to inventions made in the performance of research and development work, the cost of which is not charged to NASA.

Two significant points made in the memorandum are:

(a) "It is inconceivable that the Congress would have intended that NASA could establish a relationship with a party whereby all the inventions made by that party or its employees under the circumstances defined in Provisions (1) and (2) of subsection 305(a) would become the exclusive property of the Government merely by NASA proposing to such party that it do work for the Administration"; and

(b) "In order not to work a completely incongruous result, it is recommended that NASA interpret the terms 'proposed contract,' as used in subsection 305(j)(2) in defining 'contracts,' as relating back to work done upon an understanding that a contract would be awarded."

16. That interpretation was made clear in the testimony of John A. Johnson, NASA General Counsel, during Hearings Before The Subcommittee on Patents and Scientific Inventions of the Committee on Science and Astronautics of the U.S. House of Representatives, on Public Law 85-568, 86th Cong. 1st Sess. In answer to a question by Rep. Fulton (pg 14) regarding the distinction between research and development contracts and supply contracts in the field of aeronautics and space, the General Counsel testified:

"We did make that distinction. We have made it administratively - and we were without any published legislative history on this to help use - because we simply could not believe, in the context of this section, that every time we entered into a contract for the supply of some office supplies or something of that kind it was intended that this kind of patent clause should into it. We have confined our patent clause to

- we have a rather elaborate formula in our regulations; but, to oversimplify it, it is basically a research and development type contract. We felt, after all, that this was the only reasonable intention we could read into this section of the law; but the language is so broad that some of the initial commentators on this section made it appear more horrible than it actually is in practice."

In his response to the General Counsel's answer Rep. Fulton made the point that the "law is too broad" and went on to --

"compliment the NASA, the Administrator, and the people who have been advising him on making the distinction as to the type of contract that the patent provisions apply to."

17. The NASA Procurement Regulations (Chapter 18 of Title 41 of the Code of Federal Regulations) requires the use of a section 305 patent rights clause only in contracts which entail technical, scientific or engineering work of a kind performed in a contract having as one of its purposes (1) the conduct of basic or applied research, (2) the design or development, or manufacture for the first time, of any machine, article of manufacture, or composition of matter to satisfy NASA's specifications or special requirements, (3) any process or technique for attaining a NASA objective not readily attainable through the practice of a previously developed process or technique, or (4) the testing or practice of a previously developed process or technique to determine whether the same is suitable or could be made suitable for a NASA objective. This official interpretation was initially taken in 1959 (14 CFR 1201.101-2(a)), and is still followed (see NASA PR 9.107-4, revised Dec. 1976).

18. Statement of Mr. James B. Webb, Administrator, National Aeronautics and Space Administration, Before the Committee on Science and Astronautics, House of Representatives, August 10, 1961. (NASA NEWS RELEASE NO. 61-173). This consideration is seen as reflected in the following language taken from Mr. Webb's statement:

"The significance of the patent provisions agreed to by NASA and AT&T is that whatever form of organization may be determined to be in the public interest and approved by the Federal Communications Commission for providing communication to the public through satellite relays, that organization will be able to use

inventions made by AT&T while in this cooperative relationship with NASA."

The patent provisions of the NASA/AT&T agreement were unique in many respects: (1) inventions "conceived or first actually reduced to practice in the performance of work under or in anticipation of the Agreement on or after May 18, 1961 were, by specific agreements of the parties, to "be regarded as being made in the performance of work under a contract...within the meaning of section 305" of the Space Act; (2) title to such inventions was waived in advance to AT&T but in addition to the usual rights under section 305, NASA also retained the right to sublicense United States business throughout the world in the field of communications satellites; and (3) with respect to inventions made by AT&T during the period of the contract but unrelated to the contract save for being contemporaneously made and of similar use, the Government was to receive a broad royalty-free license together with the right to require sublicenses. For a thorough analysis of the AT&T arrangement, which has not been followed in any other instance, see Allnutt, Patent Policy for Communications Satellites: A Unique Variation, 46 MARQUETTE L. REV. 63 (1962).

19. Assistant General Counsel for Patent Matters memorandum of February 3, 1964 to the General Counsel on Recommended Patent Clause for the Cooperative Agreement Between NASA and the Communications Satellite Corporation.

The memorandum notes that the position recommended therein for the Comsat agreement is quite different from that previously taken in the AT&T agreement. It points out, however, that the rather marked departure (taken in the NASA/AT&T agreement) from standard NASA patent practices was essentially prompted by two reasons neither of which is "effective today."

As to the first reason, it was pointed out that the need to insure freedom of action in the communication satellite field pending a Congressional decision on a communications satellite system no longer existed in view of the establishment of the Communications Satellite Corporation under the Communication Satellite Act of 1962. 76 Stat. 421, 47 U.S.C. 721(b)(1062).

The second reason dealt with the practical difficulty of determining whether AT&T inventions relating to Telstar were made under the NASA/AT&T agreement or as a result of AT&T's independent research programs. To avoid this difficulty, the Government under the NASA/AT&T agreement acquired rights to all such inventions.

The memornadum took the position that NASA was not entitled to any rights to inventions made by Comsat or its contractors since "if Congress intended for NASA to attempt to

acquire patent rights in inventions developed in the corporation funded research, either to insure royalty-free use of such inventions by the Government, or as a means of assuring effective competition among the corporation's suppliers, there is no doubt that such a prescription would have been included in the Act.....The view that NASA is not entitled to demand such an interest in the cooperative agreement is reinforced by the fact that the FCC and not NASA is charged under the Act with the responsibility of insuring effective competition among the corporation's contractors."

20. Ibid.

21. Agreement Between the National Aeronautics and Space Administration and Communications Satellite Corporation For Satellite Launching and Associated Services to Be Furnished By NASA In Connection With The Launching of Intelsat II and Certain Intelsat I Satellites, dated July 22, 1966, Article X - Property Rights in Inventions.

22. As a further clarification of this interpretation of section 305, ART II - Par. 1.C. of the NASA/Comsat Agreement (note 21) contained the following language:

"c. The Corporation represents that it proposes to do the following, which will not, however, constitute work performed under this Agreement.

- (1) Provide for the design, development, and testing of all spacecraft.
- (2) Perform all spacecraft pre-launch tests at ETR.
- (3) -----"

23. The most recent interpretation is found in paragraph 6(a) of NASA Management Instruction (NMI) 8610.8 of January 21, 1977 (14 CFR 1214.104(a)) entitled Reimbursement for Shuttle Services Provided to Non-U.S. Government Users:

"6. PATENT AND DATA RIGHTS

a. NASA will not acquire rights to inventions, patents or proprietary data privately funded by a user, or arising out of activities for which a user has reimbursed NASA under the policies set forth herein. However, in certain instances in which the NASA Administrator has determined that

activities may have a significant impact on the public health, safety or welfare, NASA may obtain assurances from the user that the results will be made available to the public on terms and conditions reasonable under the circumstances."

24. Letter of April 6, 1959 from NASA General Counsel to Patent Counsel, General Electric Company, Cincinnati, Ohio.

25. Ibid.

26. This is not to say that NASA does not obtain rights to inventions which may result from joint activities under an endeavor. However, such rights are obtained by negotiation and agreement, and not by the imposition of subsection 305(a). Typically, when the resulting activities are of an inventive type, NASA acquires at least a royalty-free license to practice, for governmental purposes, any inventions arising from such results. On a case-by-case basis greater rights may be acquired to assure that the results of a joint endeavor are made available to the public upon reasonable circumstances.

27. For example, NASA's policy for the use of its installation research facilities by individual researchers is set forth in the NASA Supplement for the Federal Personnel Manual, Chapter B11, issued September 29, 1977, which provides:

"Rights to any inventions conceived or first reduced to practice during, and resulting from use of Government facilities should be stated in the agreement. Normally NASA should obtain a royalty free license for the U.S. Government to practice the invention for governmental purposes.

28. This policy is reflected, for example, in the Announcement of Opportunity for Materials Processing Investigations on Space Shuttle Missions (A.O. No. OA-77-3, Feb. 8, 1977) seeking investigations comprising applied and basic research projects in branches of materials science where the weightlessness and ultra high vacuum obtainable in orbital flight can be exploited to unique advantage. It is stated, in paragraph V.2.:

"For a Cooperative Project, NASA will obtain a royalty free license to practice for U.S. governmental purposes any inventions and patents resulting from the experiment and the right to use and disclose the resulting data for U.S. governmental purposes.

29. Typical arrangements where a significant NASA contribution is its satellite data are:

(a) "Agreement Between National Aeronautics and Space Administration and the GEOSAT Committee, Inc." for the purpose of demonstrating improved remote sensing techniques for mineral and petroleum exploration;

(b) "Cooperative Agreement Between the California Department of Water Resources and the National Aeronautics and Space Administration for an Application Systems Verification and Transfer (ASVT) Project involving Irrigated Land Assessment For Water Management," to evaluate the utility of LANDSAT as a source of data for use as input to water management models and decisions;

(c) "Cooperative Agreement Between The Appalachian Regional Commission and The National Aeronautics and Space Administration For Appalachian Lineament Analysis" to conduct a joint project involving LANDSAT-derived information for certain land use purposes; and

(d) "Memorandum of Understanding Between NASA and the Agency [ESA] for LANDSAT ground stations" wherein NASA provided LANDSAT data and ESA established a system for the reception, pre-processing, archiving and dissemination of such data.

30. Thus for example, in a model "Cooperative Endeavor Agreement" under which NASA made certain of its scientific and technical data available under specified conditions and the recipient provided NASA with reports of the result of applying such data to commercial aircraft, the following patent provision was included:

"5. PATENTS

(a) NASA, acting on behalf of the U.S. Government, has filed application for Letters Patent in the United States and certain foreign countries on an invention made by Richard T. Whitcomb and entitled, Airfoil Shape for Flight at Subsonic Speeds. The supercritical aerodynamic technology furnished by NASA to Lear Avia under this Agreement is based, in large part, upon the novel concepts, theories, formulae, and technology encompassed by this invention. In recognition of these contributions offered by the Government, Lear Avia agrees that should its application of such technology to commercial aircraft, as contemplated under this

Agreement, result in patentable modifications or improvements to the supercritical aerodynamic technology, Lear Avia will provide NASA with the disclosure of such inventions and grant to the U.S. Government a nonexclusive, irrevocable, royalty-free license to practice such inventions throughout the world for government purposes.

Such agreements have been entered into with Lear Avia, Cessna, Beech, and Gates Lear Jet.

31. Agreement of November 24, 1976, between McDonnell Douglas Corporation and NASA concerning the design, manufacture, test and delivery of a spin stabilized payload assist module for launching spacecraft.

32. Supra, note 31. ARTICLE IX - Termination for Default

33. Examples of arrangements of this type are:

(a) "Memorandum of Understanding Between The Federal Minister for Scientific Research of The Federal Republic of Germany and The United States National Aeronautics and Space Administration" for Project HELIOS, having the general objective to provide new understanding of fundamental solar processes and solar terrestrial relationships by the study of phenomena such as solar wind, magnetic and electric fields, cosmic rays, and cosmic dust.

(b) "Memorandum of Understanding Between The United States National Aeronautics and Space Administration and The Netherlands Agency for Aerospace Programs" for the Infrared Astronomical Satellite to perform an all-sky survey of extraplanetary, galactic and extragalactic infrared sources.

(c) "Memorandum of Understanding Between The United States National Aeronautics and Space Administration and The European Space Agency for The International Solar Polar/Out-Of-Ecliptic Mission" to conduct coordinated observations of the interplanetary medium and the Sun simultaneously in the northern and southern hemispheres of the solar system.

(d) Letter agreement between NASA and The Centre National d'Etudes Spatiales, France, selecting a proposal entitled "Multipurpose French Cooperative Environment Tests to be Conducted on NASA LDEF," for participation in the NASA Long Duration Exposure Facility (LDEF) Mission. The proposal was submitted in response to the NASA Announcement of Opportunity AO-OAST-76-1, and has as a scientific ob-

jective the investigation of the effect of long term space exposure on thin metal film and evaporated cathodes, optical coatings, holographic gratings, thermal coatings, structural materials, and fiber optics.

(e) Letter agreement between NASA and the University of Sydney, Australia, selecting a proposal entitled "Aggregation of Human Red Blood Cells," in response to NASA Announcement of Opportunity AO-OA-77-3 (see note 28). The scientific objective of the proposed experiment is to observe the aggregation of human red blood cells under conditions approaching zero gravity.

No patent provisions were included in examples (a) - (c), but examples (d) and (e) included the following:

"It is further understood that should any inventions and patents result from this project, NASA is granted a royalty-free license to practice such inventions and patents for U.S. Government purposes."

34. Representative examples of joint endeavors involving contributions of major hardware are:

(a) "Memorandum of Understanding Between The National Aeronautics and Space Administration and The European Space Research Organization for a Cooperative Programme Concerning Development, Procurement and Use of a Space Laboratory In Conjunction With the Space Shuttle," wherein ESA and its members developed the Spacelab (some of the subcontract research and development work performed by US companies) to be utilized with the NASA developed orbiter;

(b) "Memorandum of Understanding Between The National Aeronautics and Space Administration and The National Research Council of Canada For a Cooperative Program Concerning the Development and Procurement of a Space Shuttle Attached Remote Manipulator System (RMS)," wherein Canada developed the RMS to be employed on the NASA developed orbiter;

(c) "Memorandum of Understanding Between The European Space Agency and The United States National Aeronautics and Space Administration," under which ESA is to develop major hardware to be incorporated into the NASA developed telescope; and

(d) "Memorandum of Understanding Between The Department of Communications of Canada and The Centre National D'Etudes Spatiales of France and The National Aeronautics and Space Administration of The United States of America," wherein Canada is to develop significant hardware (some to be produced in the U.S. under subcontract) to be used in and with a U.S. developed satellite.

No patent provisions were included in examples (a) - (d), above.

35. Supra, note 23.

Mr. BROWN. Thank you.

Mr. FUQUA. Thank you, Dr. Frosch. We appreciate your being with us here this morning. We would like to take the next three witnesses together, in the interest of time and also the fact that the House is in session and we may be called away for votes intermittently. We will take them in order and ask questions at the end of their testimony. The first will be Dr. Sherwood Fawcett, president, Battelle Memorial Institute; then Dr. William P. Slichter, chairman, Committee on Scientific and Technological Aspects of Materials Processing in Space; and then Mr. E. F. Branahl, vice president and general manager, McDonnell Douglas Astronautics Co.

Dr. Fawcett, you may proceed.

STATEMENT OF DR. SHERWOOD FAWCETT, PRESIDENT, BATTELLE MEMORIAL INSTITUTE

Dr. FAWCETT. Mr. Chairman, it is an honor to be invited to appear before this committee to present my views on H.R. 2337, which, if enacted, would establish a Space Industrialization Corporation.

First off, I strongly endorse this legislation. This bill, I believe, would provide the stimulus to foster private innovation in space through Government sharing of the high risks associated with the early phases of the innovation process. The innovation process, as you know, is never a simple one. It is expensive and takes a long time. In the case of developing new products or processes using the properties of space, the time, money, and risks will be much greater. By the same token, the rewards from innovation in space may be much greater.

I particularly want to endorse the concept of the Space Industrialization Corporation requiring repayment for its financial assistance, including a profit on profitable ventures and full documentation on unprofitable ventures. This concept is significant, I believe, because it assures that the Government will get paid back for its risktaking, and it underscores the point that this is not a Government handout.

The kind of innovation that will be encouraged by H.R. 2337 may do much to advance civilization and improve the quality of life. And it may be important in maintaining this Nation's position as a leader among the advanced industrial countries in the coming century.

Now, before developing these thoughts further, I would like to take a few minutes to tell you a little bit about Battelle Memorial Institute—what it is and what it does. I wish to do this to, in effect, establish our credentials and to help relate our experience to some of the purposes of H.R. 2337.

Mr. Chairman, Battelle Memorial Institute, which is now in its 50th year of operations, is the largest privately operated nonprofit research institute in the world. Its major effort is devoted to sponsored research; that is, research carried out by Battelle under contract for companies, Government agencies, and trade associations. In 1978, for example, worldwide Battelle conducted about 2,840 studies for more than 1,700 sponsors based in 41 countries.

Our activities cover the physical, life, and social-behavioral sciences. This research ranges from the improvement of manufacturing processes to the creation of biomedical materials. Nearly every academic

discipline is applied as we develop solutions to the myriad problems with which industry and government are faced. We are committed to providing technological support to the innovation process.

We have a very special interest in any present and future developments that may potentially increase our ability to carry out our mission. In our view, the activities and developments associated with industrialization of space represent a means to reach beyond some of the limitations of ground-based research. Thus, they represent a new frontier. We view H.R. 2337 as a mechanism designed specifically to help exploit this new capability for the public benefit through private industry.

Battelle conducts its contract research at four major research centers—in Columbus, Ohio, in Richland, Wash., in Frankfurt, Germany, and in Geneva, Switzerland. The institute has two subsidiaries—the Battelle Development Corp. and Scientific Advances, Inc.

The Battelle Development Corp. (BDC) was established in 1935 specifically to identify inventions and develop them to a point where their usefulness is demonstrated. Scientists and engineers at the various Battelle research laboratories are one source of inventions acquired by BDC, but some of the inventions it receives come from universities, industrial organizations and individuals.

BDC has as a primary objective the optimum development of these inventions for the benefit of the public, the inventor, and the sponsoring industries. In our view, H.R. 2337 has this same objective relative to U.S.-owned space-oriented intellectual property.

Scientific Advances, Inc. (SAI, as we call it), has the specific objective of assisting in the development of new high-technology-based enterprises. Because of its relationship to Battelle, SAI is unique in being able to provide technical as well as marketing, financial, and general management support to these new enterprises. SAI's involvement has included a broad spectrum of technologies ranging from holography to ultrasonic medical instruments and from electronics to solar energy. SAI is a member of the National Venture Capital Association.

I will now say something more about the characteristics of contract research, since it is our belief that H.R. 2337 must be responsive to the same requirements that we must meet in our work for our sponsors.

These characteristics of contract research are most clearly seen in research sponsored by the industrial sector. Battelle's industrial sponsors are usually corporations that for one reason or another request scientific or engineering assistance. When Battelle agrees to conduct research for such a sponsor, it also agrees to maintain confidentiality. Maintaining confidentiality not only means not discussing what we are doing for a sponsor, but also not identifying the sponsor publicly.

Further, we must maintain a very strict code of ethics. For example, if we are doing a particular research project for company X, and company Y asks us to do similar research, we must diplomatically and carefully decline. We carry this approach further in that within Battelle we operate on the "need-to-know" principle relative to the knowledge our technical personnel can obtain about our industrial contract research projects. Our 50 years of experience have proved to us that unless we maintain strict confidentiality regarding our

sponsors' interests, we will not be able to keep our existing sponsors or gain new ones. Clearly, we could also be subject to legal action were we to reveal any information to which anyone has proprietary rights. Each company's future depends on the protection of its ideas for new products or processes.

I have elaborated on our concern for confidentiality because we heartily endorse the clause for exclusion from the Freedom of Information Act contained in H.R. 2337. If this exclusion is removed, it is our view that private industry will not initiate commercially significant space research and applications activities. And the involvement of private industry in space research is essential if the potential benefits are to be developed and made available to the general public through the private enterprise system.

The development of practical uses of space technology will require the best of everything: the best brains, the best equipment, and the best possible business environment. Therefore, any company which is considering investing its own best efforts will need assurance that it will get all the rights to results deriving from those efforts.

Even though H.R. 2337 is designed to put up some of the front-end high-risk funding for space industrialization, the ideas themselves can only come from industry's heavy investment of its own creative talents and the development of the ideas to a point where they can be justified for funding. This investment will not be small. Therefore, maintaining confidentiality and providing for protection of proprietary and other rights are key elements of the bill. If these elements are not retained, the result could be a relatively useless bill.

Now let us turn to the innovation process. The following statements illustrate some of the things we have learned about that process over the past 50 years:

Most successful new concepts originate when a need is identified. Moving from concept to first successful commercialization usually takes many years and in some cases a decade or more.

Successful development of an idea eventually requires many kinds of people—conceptualizers, inventors, scientists, engineers, production specialists, salesmen, and businessmen.

Every successful innovation has one or more champions—technical and financial entrepreneurs fully committed to the success of the idea.

For an organization involved in innovation to succeed, it must be capable of identifying and evaluating real market needs and of focusing its efforts on meeting those needs.

The failure rate for new technical product ideas is extremely high. New product ideas are more likely to fail in the marketplace than they are to fail technically.

To demonstrate the validity of these observations, let's look at one example of innovation—xerography. As you may know, Battelle was deeply involved in the development of xerography. We did not invent the process, but we helped shepherd the invention through the innovation process to commercialization.

Xerography, the foundation for the present-day Xerox Corp., was invented by a patent attorney to meet a need he recognized for a better method for copying material quickly. That was in 1937.

The first commercially successful Xerox copier was placed on the market in 1960—some 23 years later.

Battelle remained dedicated to the development of xerography even though other organizations felt it had little if any future.

Battelle championed xerography by providing development talent, providing some early funding, and helping to find a route for commercialization.

External to Battelle, market analyses indicated only a limited future for xerography.

Several major companies turned down the opportunity to produce and market what became the Xerox process.

The Haloid Corp., now the Xerox Corp., needed a new product line and made a major financial and total management commitment to the research, development, and commercialization of xerography.

Further, Xerox made a major innovation in the method of marketing it used to get its equipment into use.

Xerox and the copier industry it helped to create now has a major worldwide impact and employs hundreds of thousands of people. But if the key factors in innovation had not come into play, secretaries might still today be correcting the original and 15 carbon copies.

It is important to remember that several major companies turned down this idea. If there had been something comparable to H.R. 2337 in 1937, things might have been easier and moved faster.

Now, I would like to talk more specifically about the tremendous investments that will be required for space industrialization. Fortunately, a significant portion of the initial space investment has already been made by the Government as a result of past national policy decisions; for example, NASA ground-based facilities, flight systems, and some research. But to exploit these, the necessary research and development activities leading toward eventual industrial applications will still require very large high-risk investments.

Let me demonstrate this last point with an example. Battelle has purchased two of NASA's \$10,000 Getaway Specials. Our scientists have come forward with some sound research experiments that appear to have good application potential. The cost to develop the initial flight experiments will range from 25 to 50 times what we have to pay NASA for the flights, and these flights can do no more than provide initial indications relative to feasibility. The cost to commercialize these ideas could involve the investment of many millions of dollars—costs many orders of magnitude beyond the costs for a flight. Thus far we have gone forward with our Gataway Specials on our own; however, without significant financial support and industrial involvement, there is no possibility for early commercialization.

Some organizations may be capable of funding their own space research, but the number will be very few. I believe there will be a consensus that industry across the broad spectrum will need Government support in some form if it is to enter the era of space industrialization in the near future on a significant scale.

I want to make one additional point at this juncture. That is, over the history of our country's technological development, it has been shown that many of our most important technical advances have been initiated by small enterprises or individuals. The Wright brothers, for example, developed their aircraft in their small bicycle shop, and we all know the stories of Henry Ford, Thomas Edison, and many

others. I think the biggest value of H.R. 2337 is in providing an opportunity to the many creative minds of our Nation to participate in space industrialization. If passed, it will open the door to space industrialization for those now unknown inventors who just may create the next major technology advance for our country.

Early in my testimony, I noted that Battelle has a subsidiary called Scientific Advances, Inc. SAI is Battelle's venture capital for-profit component. Too often venture capital organizations are high-risk investors. In a sense that is their business, but I want to assure you that they are also hardnosed business people who want to know where they are going. Let me enumerate some of the characteristics SAI looks for in a product or service when considering an investment. It must be:

A technically feasible product beyond the research stage.

An underlying technology for which follow-on products or services can be envisioned.

Unique technical know-how, with or without patents, that will provide essential leadtime in the marketplace.

The broadest possible spectrum of potential customers.

Considering that set of characteristics, one might ask whether SAI would invest in a space industrialization project. In view of the first of these guidelines, a technically feasible product, it is extremely doubtful that an organization like SAI with its limited resources would undertake such a high-risk venture.

At this point, the purpose of the initial space development activities will be to find out whether it is technically feasible to produce a product in space or improve a ground-based process. Once we clear this hurdle, it may be easier to clear the others.

SAI also has another set of criteria, or guidelines, which it calls the market competition factors. The major ones are:

The overall market should be fast growing.

It should be possible to build a stand-alone company to at least \$5 to \$10 million in sales within 5 years—and the 5-year period seems to be very important for venture capital.

The opportunity should not depend upon one or a few customers, including the Government.

At this point in space industrialization, these criteria may not seem important. However, eventually all these and other criteria must be considered in attempting to entice people and organizations to provide venture capital.

Venture capital investors must consider these plus a myriad of other nontechnical questions. I can assure you that in the end venture capital investors tend to be not all that venturesome. To be sure, they take risks that go beyond common business practice, but they are also in the business to make a profit as quickly as possible. Their profit must be high when they win in order to more than offset the losses when they lose. I believe H.R. 2337, if properly administered can open the door wider for developing and applying space technology than would now be possible in the private venture capital business.

I would now like to turn to the international scene. High technology is the backbone of this country's strength. Along with our

agriculture, which has been largely built on advances derived from Government-supported research, it provides us with one of the few means to build a positive balance of payments. Our foreign competitors have recognized this strength and are doing everything within their power to gain on U.S. industry.

For example, Canada, whose industry we normally consider inter-related with our own, passed the Industrial Research and Incentives Act several years ago, and up to 1977 had made grants to industry totaling \$110 million for the purpose of improving their industry's competitive posture. In recent years their focus has been on space, electronics, and aeronautics—the very areas in which our Government and industry have been accustomed to leading the world.

As I mentioned earlier, Battelle has laboratories in Europe, and we provide contract research services worldwide. Like other organizations operating internationally, we must understand our sponsors located outside the United States. I spend considerable time overseas, and I can assure this committee that it is not always easy to determine who our sponsors are; that is, whether we are dealing with industry through the Government or with the Government through some industrial entity. Apart from the United States, in most advanced technical countries industry and government are so closely related that it is sometimes difficult to distinguish between them.

I am not advocating that our industry-Government relationship be changed. In fact, I would be totally against ties between Government and industry in the United States which became too close. However, I am stressing that the worldwide market is becoming more and more competitive for U.S. industry in the high-technology fields. I cited earlier the Industrial Research and Incentives Act of Canada which provides funds to Canadian industry for the purpose of improving their foreign competitive posture. This is only one of many examples of foreign government-industry cooperation. We see it in Japan, and it is prevalent in Europe, particularly in West Germany. It may be of particular future import that there is a very strong interest in space processing in West Germany. I believe Germany sees the potential of this area just as do some—but, unfortunately, too few—people in the United States. The final outcome of this friendly competition may well be decided on the basis of who is willing to take the most risks at the earliest date.

To me, the most significant portion of H.R. 2337—and I have alluded to this before—is the provision of a method for the Government to be repaid for its risk taking. To quote from that part of the bill:

The corporation shall provide assistance in accordance with this section. Such assistance shall primarily take the form of the provision of funds to industrial ventures under negotiated management plans, with repayment including a profit being required of profitable ventures, with full documentation being required of unprofitable ventures so that future applicants might benefit from the knowledge gained, and with specifically agreed-to provisions for patents, proprietary rights, licensing and use-relating products and processes associated with and ensuing from such ventures.

In brief, the winners will pay for their success, and even the losers will provide information useful to future applicants.

In summary, Mr. Chairman, I think H.R. 2337 is especially timely and can provide the impetus needed to get space industrialization off

the ground. It is time that we support our creative people so that they and the United States can capitalize on our research. As I have said, I believe this bill will help to move space industrialization to the point where private venture capital will enter into the funding for full commercialization. It can also help provide our industry with the competitive edge it can develop when the Space Shuttle becomes operational. Let's not end up in the 21st century with other countries reaping the profit from our hard-earned achievements and major investments in space during these last decades of the 20th century.

I would like to end on a personal note. When you sit in Columbus there isn't very much good news coming from Washington these days. Gentlemen, to me this bill is good news and I want to commend the authors for their wisdom and their courage for putting it forward.

Thank you very much.

Mr. FUQUA. Thank you very much, Dr. Fawcett, particularly for the good news part of it.

Dr. Slichter.

Mr. SLICHTER. Thank you for the opportunity to talk to you. I will abbreviate the remarks that have been given to you.

Mr. FUQUA. We will make the total text a part of the record.

[The prepared statement of Dr. Slichter follows:]

PREPARED STATEMENT OF WILLIAM P. SLICHTER

SUMMARY

The provisions of H.R. 2337 to establish a Space Industrialization Corporation are well intentioned toward the national benefit, but are premature in light of the limited, inconclusive achievements in materials processing in space. Establishment of the corporation now might also have a disruptive effect upon the orderly development of the NASA-managed program on materials processing.

Although possibilities exist for materials processing enterprises in the low-gravity environment of space, they are limited in scope and specific in nature. The effects of gravity have long been known with great accuracy. Recourse to the space environment is likely to produce no more than incremental improvement over processing capabilities on earth, but many offer some basic knowledge in furtherance of terrestrial research and technology.

Experience from previous flights on the utility of space for the processing of materials is limited, and important information for future flights must await the launching of the Space Shuttle and Spacelab. This information should come from carefully planned research under the management of NASA, not from the stimulus of an organization intended to encourage commercialization.

Mr. Chairman: My name is William P. Slichter. I am a member of the technical staff of Bell Telephone Laboratories. My present position is Executive Director, Research, Materials Science and Engineering Division. My office is at Murray Hill, New Jersey.

I received my Ph.D. degree in chemical physics from Harvard University in 1950 and joined the Bell Laboratories the same year. In the intervening time I have been involved in chemical research on properties of plastics, rubbers, and semiconductors and on the growth of crystals. Since 1958 I have held a series of administrative posts at Bell Laboratories involving research and engineering on materials. I assumed my current position in 1973.

Thank you for the opportunity to offer my views on aspects of the Space Industrialization Act of 1979 (H.R. 2337). My invitation to come before this Committee arises from my service in 1977-78 as chairman of a committee of the Space Applications Board, National Research Council, that carried out a study of the Scientific and Technological Aspects of Materials Processing in Space (STAMPS). This study was conducted at the request of the National Aeronautics and Space Administration (NASA) to the President of the National Academy of Engineering, National Research Council. The STAMPS Committee was comprised of a dozen scientists, medical people, and engineers selected from

universities, industries, and government laboratories. In the course of about eight months of investigation and review the Committee had the benefit of advice from about eighty professionals drawn from the broad community of experts on materials. At the conclusion of the study a report on "Materials Processing in Space" was issued under the auspices of the National Research Council (1978).

Mr. Chairman, I share with many people a keen interest in the progress of the national space program in directions that serve the public well. Already there is clear demonstration of the unique capability of space flight in a diversity of applications for the good of the nation, through surveys of the earth's resources, and so on. The scope of the Space Industrialization Act appears to be primarily in the area of materials processing and manufacturing. My comments are addressed to this sector and are based upon my service on the STAMPS Committee. To summarize my views, I feel that the Space Industrialization Act, as proposed, is premature and that its introduction now might have a disruptive effect upon the orderly development of the NASA-managed program on materials processing.

The STAMPS Committee differs from the finding in the Act that "the existence of effective opportunities in space has been demonstrated." Instead, the Committee judged that while possibilities do exist for materials processing enterprises in space, these are quite limited in scope and specific in nature. Some people have forecast great advantages for materials processing in space, and indeed have suggested the prospect of extraordinary discovery for materials in the space environment. The STAMPS Committee believes that such prospects are greatly exaggerated and that the useful exploitation of space for commercial purposes with materials will occur mainly in the realm of singular, exemplary substances. Thus, space technology may well serve as the source of basic information on materials science or of reference materials to serve as industrial and scientific standards, but it is not likely soon to produce substantial quantities of materials in commerce.

I want to make a fundamental point. It should be remembered that the effects of gravity on objects of all sizes have long been known with great accuracy. Gravity is a small force compared with many other familiar forces in nature. Only limited prospects exist that the elimination of gravity would lead to the discovery of some extraordinary new behavior of matter. Perhaps in some special cases in which subtle forces even weaker than gravity are operative, the removal of gravity will reveal unanticipated results. For the most part, however, we know what to expect in the absence of gravity. When gravity has an adverse effect on a process, strategies for dealing with gravity can usually be found on earth that are much easier and less expensive than recourse to space flight. The resort to processes in low gravitational fields can be expected in the main to provide only incremental improvement upon capabilities on earth.

In our opinion the results from experiments on materials processing from the Apollo, Skylab, and Apollo-Soyuz flights were neither extensive nor conclusive enough to tell much about the outlook for processing materials in space. The Space Shuttle and Spacelab have not yet flown, so their capabilities and limitations for materials processing have not been tested. Looking backward, I believe that the potential benefits of materials processing in space have been seriously overstated in a number of cases. The space environment poses severe demands upon people and equipment that can only be assessed from the results of extensive experiments. This information should come from carefully planned research under the management of NASA. Only when this experience is well in hand can reliable answers be supplied to questions of manufacturing feasibility and commercial cost.

The purpose of the STAMPS Committee was to study the science and technology associated with the processing of materials, and not to assess the elements that belong to commerce and business. Inevitably, however, the two arenas are mingled involving the technical prospects of new discovery and the technical merits of ventures already contemplated. The technological conclusions of the STAMPS Committee took note that Federal agencies such as the National Science Foundation, and others, take responsibility for funding some aspects of research in materials science and technology germane to their missions. Industry is also a large supporter of such work. The STAMPS Committee believes that NASA's programs on materials processing in space should operate within this range of science and technology, seeking a sound base of information without emphasis on entrepreneurship or commerce. Indeed, this interval would be the

first of two phases in the activity of the space facilities, and would concentrate on development and demonstration. Intrinsic to this first phase would be substantial support by NASA of earth-based activities designed to supplement and provide comparative data for space experiments. Close interactions between NASA and the materials communities of universities and industries will be essential here to assure that the work delineates well the potentials and limitations of materials processing in space. The introduction at this point of another organization with a stated role in the development of space might well interfere with NASA's charter in planning, and also lead to confusion in the processes of selection of candidate projects for flight.

The Committee visualized a second phase for materials processing, one in which the Space Shuttle and Spacelab would become available as a national resource to universities and industries on the same bases as other national experimental facilities. Individual investigators and groups wishing to use the Shuttle would be required to pay for time on the facility, according to some fee schedule which, like rates with other national facilities, would not be designed to cover the total real cost of operating the facility. Still, the assessment of meaningful fees for use of the Shuttle would require convincing the funding agencies including industries of the value of the proposed activities. NASA must itself maintain control over the use of the space facility to insure that the proposed activities are of sufficient scientific merit or technological value to warrant being included in space flight.

In summary, Mr. Chairman, I believe that the proposed Space Industrialization Act, though commendable in its general purposes, is altogether premature. In good time there may emerge some new technologies that would be well fostered by legislation contained in H.R. 2337. For the present and probably the next several years, however, a carefully constructed program of experimentation in space, followed by a deliberate assessment of specific achievements, is more likely than the creation of a new governmental organization to stimulate eventually the elements for the commercialization of space which H.R. 2337 seeks to support.

STATEMENT OF DR. WILLIAM P. SLICHTER

Dr. SLICHTER. Thank you. My invitation to come here arises from my service a couple of years ago as the chairman of a committee of the Space Applications Board, National Research Council, that carried out a study of the Scientific and Technological Aspects of Materials Processing in Space (STAMPS). This study was conducted at the request of the National Aeronautics and Space Administration to the President of the National Academy of Engineering, National Research Council.

The STAMPS Committee was comprised of a dozen scientists, medical people and engineers selected from universities, industries and Government laboratories. In the course of about 8 months of investigation and review of the committee had the benefit of advice from about 80 professionals drawn from the broad community of experts on materials. At the conclusion of the study a report on materials processing in space was issued under the auspices of the National Research Council (1978).

Mr. Chairman, I share with many people a keen interest in the progress of the national space program in directions that serve the public well. Already there is clear demonstration of the unique capability of space flight in a diversity of applications for the good of the Nation, through surveys of the Earth's resources and so on.

The scope of the Space Industrialization Act appears to be primarily in the area of materials processing and manufacturing. My comments are addressed to this sector and are based upon my service on the STAMPS Committee. To summarize my views, I feel that the Space

Industrialization Act as proposed is premature, and that its introduction now might have a disruptive effect upon the orderly development of the NASA-managed program on materials processing.

The STAMPS Committee differs from the finding in the act that "the existence of effective opportunities in space has been demonstrated." Instead the committee judged that while possibilities do exist for materials processing enterprises in space, these are quite limited in scope and specific in nature. Some people have forecast great advantages for materials processing in space, and indeed have suggested the prospect of extraordinary discovery for materials in the space environment. The STAMPS Committee believes that such prospects are greatly exaggerated and that the useful exploitation of space for commercial purposes with materials will occur mainly in the realm of singular, exemplary substances. Thus space technology may well serve as the source of basic information on materials science or of reference materials to serve as industrial and scientific standards, but it is not likely soon to produce substantial quantities of materials in commerce.

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That is the conclusion of my remarks. Thank you very much, Mr. Chairman.

Mr. FUQUA. Thank you very much.

We have a vote on the floor. I think this would be an appropriate place to take a short recess, and we will run and vote and be right back.

[Recess.]

Mr. FUQUA. The subcommittee will be in order.

Now we will hear from Erwin F. Branahl, vice president and general manager of McDonnell Douglas Astronautics Co.

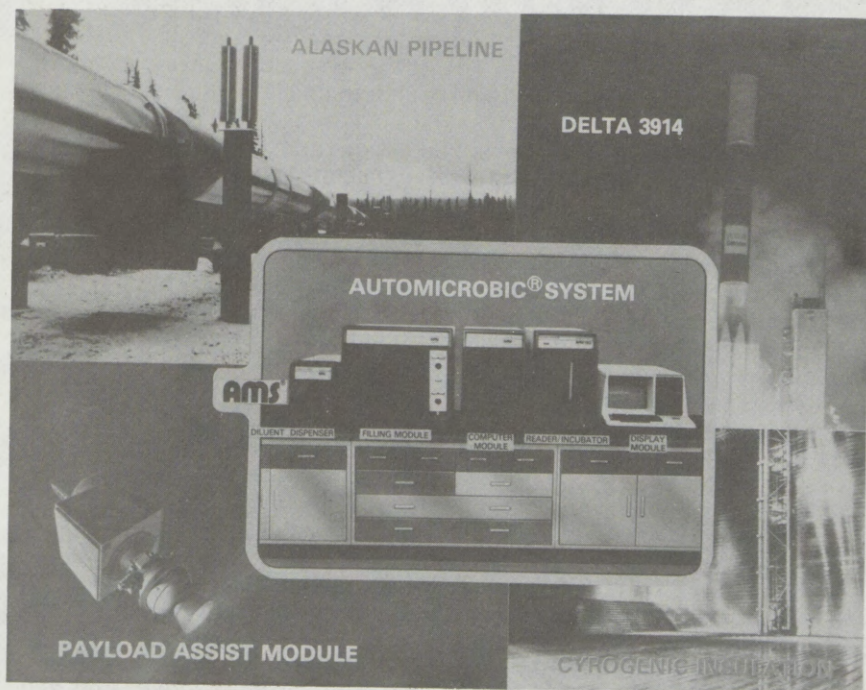
**STATEMENT OF ERWIN F. BRANAHL, VICE PRESIDENT AND
GENERAL MANAGER, McDONNELL DOUGLAS ASTRONAUTICS
CO.**

Mr. BRANAHL. Mr. Chairman and distinguished members of this subcommittee, we welcome the opportunity to appear before you because we are deeply involved in investigations of the commercial potential of materials processing in space. Mr. James Rose, who manages our space processing work, is with me to help answer detailed questions you may have regarding that work.

As you know, to many in the scientific community, space has come to represent a world of great opportunity. The opportunities offered by the unique environment of space promise to open vast new markets for products unthinkable 10 or 20 years ago.

Many such promises have already been fulfilled. Man's work in space has already greatly affected all our lives. And innovative companies like McDonnell Douglas have been in the forefront of the move to adapt the technology of the space programs to commercial uses.

We have invested heavily in new products derived from our diverse space technology background. The AutoMicrobic System [Slide 1], which automatically identifies and counts disease-producing microorganisms and then determines antibiotic sensitivity, represents our entry into the field of microbiology. Other products include:



SLIDE 1

Heat pipes used on the Alaskan Pipeline;

Cryogenic insulation, which is an efficient way to increase the amount of liquid natural gas a ship can carry;

Model 3914 of the Delta series of launch vehicles; and

The spinning upper stages to be used as part of the space transportation system.

McDonnell Douglas has currently invested more than \$100 million in these five products alone.

To date, our effort has been apply technology derived from past space programs to make new products on Earth. But as the character of the space program changes—as man gains routine, economical access to space through upcoming shuttle and Spacelab flights—new opportunities for commercial ventures present themselves. In this new era, however, the opportunities will arise from use of the environment of space.

By using the long-duration, weightless environment of an orbiting spacecraft, we can explore new manufacturing processes which take advantage of the absence of such earthbound phenomena as natural convection and sedimentation. Using these processes, we can not only manufacture products vastly superior to those produced on the ground, entirely new classes of products become possible. Having escaped the problems posed by gravity-induced convection, space manufacturers will be able to grow crystals of exceptional purity with highly controllable characteristics; they will find it much easier to mix and homogenize liquids, to cast mixtures of metals, and to separate and purify the elements of mixtures.

The advantages of processing in space are well known to the members of this committee and to many in private industry. The obvious question to ask is: Since space processing holds such enormous promise, why isn't private industry actively seeking ways to take advantage of the opportunities? Primarily because industries realize that merely to identify phenomena—how various materials and processes behave in space, which has been the thrust of space experiments to date—is not enough. Before private industry will invest the huge sums of money required to begin such untried processes, it must be reasonably confident that:

The product will have a very high value per pound;

The benefits of processing in space will be substantially greater than processing on the ground, that is, capable of producing less expensive, more useful products, or producing products that simply can't be done on Earth.

The investor must also be reasonably confident that:

The space process can be developed in a given time at an affordable cost;

A market exists and that this market will be able to support a price that assures a reasonable return on investment;

This market will not vanish because a new product appears and captures the market or because there is a breakthrough in the technology that permits efficient ground production.

Because these risks are so difficult to assess and so imposing, and because the required initial investment is so large, most industries adopt a "wait and see" attitude.

Until more data is available, industries find it extremely difficult to assess the potential of new processes and products. To help establish the capabilities and potential of manufacturing commercial products in space, we have begun to significantly expand our in-house investigation of materials processing opportunities.

One of the most promising areas, we believe, is that of pharmaceuticals. Many pharmaceuticals we've targeted for investigation appear to meet the previously mentioned criteria and promise to alleviate or cure diseases that have plagued man for centuries. Although we can identify the benefits of many of these products, they cannot be processed in sufficient quantity and purity in the presence of gravity—that is, on Earth. The problem is that ground-based commercial processes cannot adequately separate the small quantity of high-value product from the large quantity of starting material. Our work with continuous free-flow electrophoresis (slide 2) a separation process based on the relative motion of charged particles in an electrical field—leads us to believe that using this process in the microgravity environment of space will enable us to obtain pharmaceuticals in much larger quantities and with much higher purities.

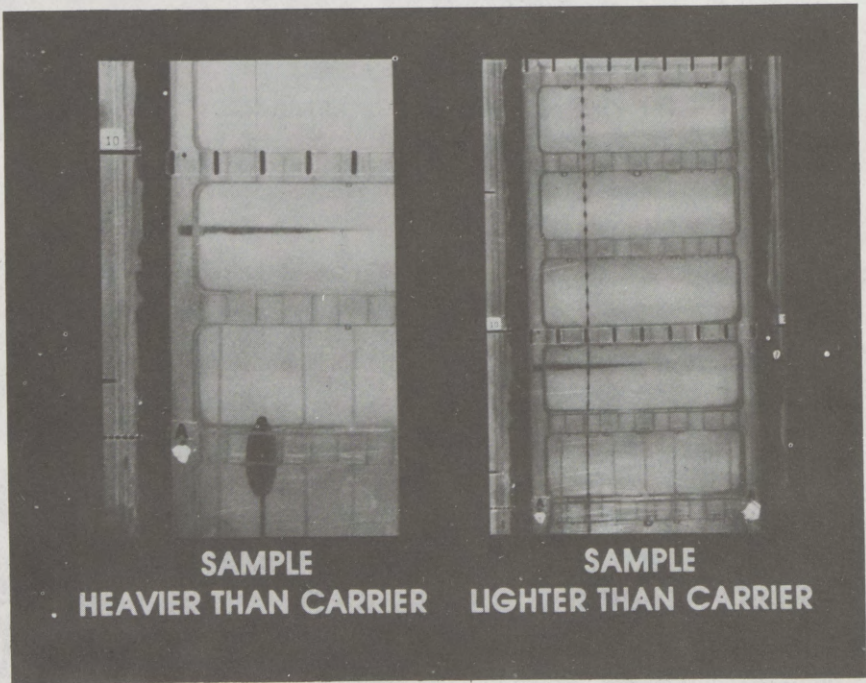


In theory, this process, which we are developing, is fairly simple. A flow of carrier fluid is injected at the bottom of a long rectangular chamber. The fluid exits through a number of outlets arranged across

the top of the chamber. The sample material to be separated is injected into this flow, and voltage is applied across the chamber, causing a force on each particle of the sample stream. These forces cause the various particles in the sample to migrate as individual streams toward the chamber's walls at differing speeds, thus separating them so that they may be drawn off at the top through the appropriate outlets.

This process, which holds so much promise for use in space, is seriously limited on Earth. Gravity adversely affects its usefulness because it limits both potential output and purity.

One of the most significant effects gravity has on the process is that it indirectly limits the concentrations of sample, and thus the output of the device. In order for the separation to work properly, the carrier fluid and the sample must flow smoothly through the chamber. In order to achieve such a flow, our work has shown, the sample must be highly diluted, making the density of the sample and the carrier fluid essentially the same.



SLIDE 3

(Slide 3.) A sample stream heavier than the carrier fluid will collapse on itself and not flow at all. One that is lighter than the carrier fluid will ball up, disrupting the smooth flow. To avoid these phenomena, caused by gravity, our tests showed that sample concentrations must be limited to approximately one-tenth of 1 percent protein by weight.

MICROGRAVITY IMPROVES ELECTROPHORESIS

YIELD IS INCREASED

CONCENTRATION CAN BE INCREASED TO 10%—40%

YIELD IS INCREASED BY A FACTOR OF 100 - 400

PURITY IS INCREASED

STREAM OVERLAPPING IS ELIMINATED

PURITY IS INCREASED BY A FACTOR OF 5

SLIDE 4

In space, on the other hand, these concentrations can be increased to at least 10 percent and as high as 40 percent and still remain suspended in the carrier fluid (slide 4). This increased concentration means that an electrophoretic chamber in space would turn out 100 to 400 times as much product as a chamber on the ground.

Processing in space offers the additional benefit of improved purity. On Earth, as the particle streams separate, gravity acts on the density differences between each of the streams and the carrier fluid. This phenomenon causes the streams to widen and overlap, which, in turn, limits the purity. Because this overlapping phenomenon does not occur in the microgravity of space, our analyses indicate that purity would be increased by a factor of five.

Our extensive analytical and experimental work on this process has been accomplished by a highly skilled team of engineers and scientists representing such disciplines as fluid dynamics, thermodynamics, microbiology, and biochemistry. Our aim is to make the best design possible for use on Earth so that by understanding its capabilities we can understand its limitations. We have developed sophisticated mathematical models of the process, which can be used to predict the operation of the process on the ground. We are now performing laboratory tests to verify the ability of these math models to accurately predict the performance of the electrophoretic chamber on Earth. Once this has been accomplished, we will remove the gravity effects from the math model and predict the chamber's performance in space. If our current predictions of significant space improvements are substantiated, we will then test the unit in space.

CANDIDATE SPACE PRODUCTS

PRODUCT	FUNCTION	CURRENT STATUS
ANTIHEMOPHILIC FACTOR (23,000)* VIII	ELIMINATES IMMUNOLOGICAL REACTIONS FOR HEMOPHILIACS	LOW PURITY & LOSS OF BY-PRODUCTS
ERYTHROPOIETIN (1,150,000)*	STIMULATES RED BLOOD CELL PRODUCTION IN ANEMICS	LOW PURITY & ONLY RESEARCH QUANTITIES ARE AVAILABLE
BETA CELLS (3,200,000)*	SINGLE INJECTION CURE FOR DIABETES	CANNOT BE EFFECTIVELY SEPARATED

*ANNUAL PATIENT LOAD

SLIDE 5

As part of our investigation, we examined the potential of a number of products for electrophoretic processing in space and then selected three for more detailed study (slide 5) :

1. Antihemophilic factor VIII, which is used to treat hemophilia.
2. Erythropoietin, which could be used to treat patients with anemia.
3. Beta cells, which can potentially be used to treat diabetics who must now rely on insulin.

We selected these particular products for study because the present ground-based production methods yield materials that are very low in purity, as is the case with antihemophilic factor VIII, or an inadequate supply, as is the case with erythropoietin, or because the product cannot be effectively separated on Earth, as is the case with beta cells.

The 23,000 patients in the United States alone must take antihemophilic factor VIII at least twice a week. Today's material, which is processed from blood by precipitation techniques, is less than 5 percent pure. The impurities, mostly unwanted proteins from the blood plasma being processed, can cause immunological reactions in the patient. Using electrophoresis in space to separate the antihemophilic factor VIII would not only remove most of these impurities, specific useful proteins present in the plasma could also be separated at the same time. The most familiar of these are probably gamma globulins, which are used to treat measles, polio hepatitis and other infectious diseases. These highly valuable byproducts are usually lost by the ground-based processing methods now in use. In addition, by recovering all possible products from the blood, we could reduce the number of blood donations required every year.

Erythropoietin, a product produced by healthy kidneys, cannot be purified in quantities sufficient for commercial use. Today only research quantities of relatively impure erythropoietin can be obtained from sheep's blood and from humans suffering from certain types of anemia.

More than a million Americans could use erythropoietin, and only a little more than 1 pound would supply them with their annual needs. Included among this group are those who must receive artificial kidney treatment. For people on kidney dialysis, frequent blood transfusions are required to replace the red blood cell production normally stimulated by the erythropoietin produced in healthy kidneys. Unfortunately, these transfusions often set up immunological reactions in the patient, seriously reducing the probability of success of a kidney transplant. Erythropoietin could minimize both the need for frequent red cell transfusions and the immunological reactions that often accompany them. Erythropoietin could also benefit the some 200,000 people who suffer from chronic anemia.

The third product we studied in depth, which has the potential for an even greater impact, is pancreatic beta cells. This product could help the some 3 million insulin-dependent people. Currently these people must receive daily injections of animal insulin, a treatment which controls the patient's blood sugar level and metabolism, but does not prevent the other insidious aspects of the disease—blindness, accelerated arteriosclerosis, and kidney disease, for example.

Medical researchers at one clinic treated seven patients with end-stage diabetic kidney disease by injecting human pancreatic islets containing beta cells into a blood vessel entering the liver. After injection, these islets formed a surrogate pancreas—producing insulin. Because this surrogate pancreas was supplying the patient with natural insulin, within 2 weeks to 2 months 6 of the patients reduced their dependence to between zero and 25 percent of their previous levels. The problem with this technique was that impurities in the pancreatic tissue fragments caused the liver to begin to degenerate and the implanted islets to be rejected. Space processing by electro phoresis shows great promise of removing the impurities which cause both liver deterioration and islet rejection. If this is true, a single injection of beta cells could allow a diabetic's own liver to begin to produce insulin, making a single-injection cure possible.

We are convinced that the benefits of space production could be substantial. The three products I've discussed—antihemophilic factor VIII, erythropoietin, and beta cells—promise to meet many of the requirements any industry will demand before initiating such ventures.

For each, very small quantities would satisfy a reasonable 25-percent share of the available market. It would take a mere three one-hundredths of a pound of antihemophilic factor VIII, only three-tenths of a pound of erythropoietin, and 5 pounds of beta cells. The benefits of the space environment over Earth are clear—both better purities and higher yields seem certain. Purity increases by a factor of 5. And to produce the quantity of antihemophilic factor VIII I mentioned would take 5,000 ground chambers, but only 20 in space. For erythropoietin, 75 space chambers could equal the yield of 30,000 ground chambers. The 5 pounds of beta cells, which cannot be separated effectively on Earth, could be done by only two space chambers.

An added benefit is that these higher efficiencies would also help reduce costs to consumers. For example, the only available erythropoietin today is a crude extract costing 83 cents per unit. At a normal dose of 1,600 units per week, it would cost the average patient on dialy-

SPACE PRODUCTION OF PHARMACEUTICALS IS COMMERCIALY VIABLE USING ELECTROPHORESIS

PRODUCT	ANNUAL REQUIREMENTS		
	PRODUCT NEEDED	GROUND CHAMBERS	SPACE CHAMBERS
ANTIHEMOPHILIC FACTOR VIII (25% U.S. MARKET)	0.03 LB	5,000	20
ERYTHROPOIETIN (25% U.S. MARKET)	0.3 LB	30,000	75
BETA CELLS (25% U.S. MARKET)	5 LB	*	2

***INADEQUATE RESOLUTION PREDICTED**

SLIDE 6

sis approximately \$69,000 a year for the medicine. But even if the patient could afford the high cost, he couldn't purchase such an amount because sufficient quantities cannot be made on Earth with present techniques, nor does it seem likely that it can be made as a commercially viable product in the foreseeable future. Using electrophoresis in space, we believe, will yield not only a product of much higher purity and sufficient quantities to satisfy a large market, costs may also be significantly reduced.

Using this data, generated as part of our ongoing investigation of space processing, we were able to obtain a formal and active working agreement with a major U.S. pharmaceutical company. They have joined us in our continuing program to study and evaluate all aspects of a commercialization program.

But even though we have identified products of tremendous promise, have developed a potentially viable process, and have enlisted the participation of a major pharmaceutical company—even though we have come so far—the obstacles to ultimate commercialization are formidable:

- The process must be verified in space;
- FDA approval is uncertain;
- NASA's funding, its schedule and the availability of space facilities are beyond our control;
- New legal and regulatory precedents must be established; and
- The time from concept development to commercialization is extremely long.

Even though we have expended more than 2 years of company-funded effort, we anticipate that approximately 8 more years will be necessary before commercial operations can begin—3 years of additional ground-based research and development of the process and products, 4 years for technology verification and pilot demonstrations using the Spacelab, and an additional year to obtain final regulatory approvals. These and other factors make the risks extremely high and the initial investment, the front-end cost, enormous.

As Stover L. Babcock, Jr., of Merrill, Lynch testified recently before the Senate Subcommittee on Science, Technology, and Space, investors are concerned not just with rates of return on investment but with the risks inherent in that investment, that is, with risk-adjusted rates of return. Private capital will, of course, seek the best risk-adjusted rate of return available both on Earth and in space. Before space commercialization opportunities will attract private capital, the risk-adjusted rates of return must be competitive with other investment opportunities.

Although our study of a model space product showed a potentially profitable rate of return, when the risks were added to the calculation, the rate of return was well below the industry average. Though based on a specific product, this result is typical, we believe, of other high-technology space process developments.

This combination of high risk and large investment makes such ventures prohibitive to private industry alone. For the foreseeable future, we believe the Government must support the "proof of concept" research and development efforts of innovative companies willing to take the initial steps to develop the commercial potential of space. This type of Government support, we must emphasize, does not remove the burden of risk from the shoulders of industry, it simply improves the competitiveness of space as an area for private investment. With such support, once the capabilities and potential of manufacturing or processing commercial products in space have been established, we are convinced that private industry will expand its involvement.

Having recognized the need for Government support in the initial, high-risk stages, we began a dialog with NASA in 1977 to discuss ways to stimulate industry's participation in commercializing space while protecting the interests of both industry and the Government. NASA's encouragement and responsiveness led us to propose in November 1978 that we establish a formal cooperative agreement to demonstrate the viability of our electrophoretic technique for processing biological products in space. Under the terms of this proposed agreement, we will provide the processing equipment unique to our concept, and NASA will provide the Shuttle/Spacelab flights and support necessary to verify its operation in space.

This cooperative approach with NASA, we believe, is one way to lessen the risk by reducing the amount and duration of the long-term investment. The initial company-funded, ground-based development phase would be followed by a jointly sponsored phase for space verification and pilot demonstration. If mutually agreeable provisions can be reached, we will move forward with this ambitious program.

While we cannot say that such an agreement will meet the needs of other innovative companies that want to work in space, we are convinced that they will require some form of Government assistance. In some cases, I might add, this assistance may include time-phased protection against predatory competition. We urge careful consideration of ways to encourage NASA's policies of support for commercial companies and ways to supplement them, if necessary, to stimulate broad participation.

Encouraged as we are by the promise space holds for commercial processing, we are equally encouraged by this committee's sensitivity to the problems that confront us all in our efforts to take advantage of the opportunities of space.

Just as the combined efforts of Government and private industry helped make the first phase of the national space program a reality, such a partnership can help open the environment of space to a new world of opportunity that will benefit us all.

I would like to make just one comment about the bill. I believe some form of Government assistance is required to make the risks inherent in space processing acceptable to industry. H.R. 2337 is certainly one approach to achieving this desirable end.

I have one serious concern about the bill. As I see it, it sets up a corporation that can function as an umpire and as a competing team. As an umpire the Corporation can decide which proposed programs are worthy of their support including those proposed by the corporation itself. This perceived conflict of interest may deter some commercial firms from participating with the Space Industrialization Corporation.

Thank you.

Mr. FURQUA. Thank you, sir. I might point out the closing comment you made was discussed yesterday and that possibly the Corporation could not have its own experiments. This may be one way to get around the potential conflict that you mentioned. Dr. Fawcett, in NASA's applications program, what do you see as the relative roles of Government and industry in stimulating the commercialization of new and innovative technology?

Dr. FAWCETT. This is a question which greatly interests us at Battelle, as we have some degree of involvement with many aspects of the applications program. Many types of activities are involved, and many objectives are being pursued, so no single comment can cover the entire program. Let me begin with some general observations, and proceed to comment on two particular programs.

In general, NASA has been concerned with the early phases of developing a new applications possibility; that is, they have been demonstrating concepts, carrying out required advances in the state of the art, and reducing technical uncertainties. If, however, the application is really to come to fruition, someone must fund and implement an operational system, or produce a product or provide a service on an ongoing and efficient basis to meet a need somewhere in the private or public sector. This, by its charter, NASA does not do. Every application, then, must be "handed off" at some point to some other organization, public or private. Experience shows that these handoff points can be sources of difficulties. In the past, many

innovations have died at such points. NASA appears to have had particular difficulty when the handoff is to the private sector. It is my belief that this is, at least partly, due to the fact that NASA does not place as much emphasis on things like market viability as it does on technical feasibility. In view of NASA's traditions, this is understandable, but nontechnical aspects must be addressed by someone if the broad spectrum of applications ideas are to be put to work.

For example, consider space-based remote sensing of the Earth's land surface. Seven years of experience with the Landsat program has put us in a position to go after several kinds of benefits. We could attempt to develop self-supporting general purpose remote sensing systems similar to Landsat itself. There are possible special purpose satellites which could be fully or partly self-supporting (soil moisture, Stereosat, advanced geology satellites). In some cases, the technology is not particularly new, but market and institutional innovation may be required. Where the private sector develops an approach, as in the case of communications satellites, the benefits of space can be realized relatively easily. In other cases, they may not be. A new type of combined Government/private entrepreneurial arrangement is needed if the broad spectrum of space technology developments is to be moved into the private sector.

A case in which private involvement is even more central is that of materials processing in space. This is a much newer technology than that of remote sensing, but one of very high promise. Much remains to be learned about the fundamental phenomena of materials in a weightless environment, but it is not too early to begin consideration of how the private sector can be motivated to participate and how worthwhile and profitable processes can be developed. NASA is currently working on a policy in this area, and it may be premature to comment on that policy at this time, but I would urge that inputs from the private sector be solicited and considered in formulating this policy and in determining the level and direction of research and development activity in this area.

To summarize then, Mr. Chairman, I would suggest that industry and Government do not, at this time, appear to be having fertile communications at this technology handoff point. What we need is some better way to make industry's needs and attitudes known to those on the technology side, and better ways to make new technological capabilities attractive to industry. The Space Industrialization Corporation is one mechanism for doing this, and others may be needed. In any case, a much closer working relationship between the Government and private industry relating to space technology would benefit all of us.

Mr. FUQUA. Dr. Slichter, in the STAMPS Committee evaluation, in the findings and recommendations, do those apply to biological processes as well as materials processes?

Mr. SLICHTER. Materials would certainly include biological processes. The study embraced a number of these. Among the many people we talked with are people interested in biological culturing and medical applications.

Mr. FUQUA. Including electrophoresis?

Mr. SLICHTER. Yes. We talked about electrophoresis at rather considerable length.

Mr. FUQUA. And you feel that still—it appears to me in my limited knowledge of it, probably the biological field there would be a greater advantage of the space environment probably than there would be in the materials, even though I think, my own personal view is, materials would also have a place in the biological field.

Mr. SLICHTER. I think that is right. I associate myself with Mr. Branahl's remarks to the effect that whatever you would produce in a commercial sense from space would have high value in contrast to its unit size, weight, or volume, whatever. One would not conduct massive commercial operations in the normal sense. Biological things might be part of this.

Now, this hearing is the wrong arena in which to discuss details, I suspect, as to whether this biological process has merit.

Mr. FUQUA. Yes.

Mr. SLICHTER. I think I heard Mr. Branahl say some things that the committee—the STAMPS Committee—also felt you would want to do a lot of things that you think are important on the ground and establish a very clear understanding of what the process is that you are doing on the ground. You would then test the aspects that can't be resolved on the ground in space or use supplementary results from space to enrich the information derived in terrestrial experiments. Some of the most important contributions of space technology in the materials area would be, through sorting out the answers to questions posed, to enhance the capability of ground commercialization.

Mr. FUQUA. The European countries have expressed a more positive opinion of the potential of commercializing biological material in space than the National Academy Committee reported. Is that a basic difference of opinion? Or are they using a different criteria?

Mr. SLICHTER. I don't know enough, Mr. Chairman, about the European lab. I have the impression that they are interested in some demonstration results. I think the world is, too. The committee's attitude is that would be very interesting to see what emerges from it, but the committee was very much of the opinion that you don't conduct experiments of this sort by flying it and seeing what happens.

It is an attractive and appealing thing to believe that something will emerge fortuitously and perhaps gratuitously from an adventure in space. You really know an awful lot about the behavior of matter right now. And you should focus efforts on testing what you don't know or verifying what you think you know is in fact true. I don't think this is at odds with the European laboratory venture because they are going to do some interesting experiments and people will be doing parallel experiments on the ground. That is an important additional feature which has not always been put in space ventures that have been tried up to now.

Mr. FUQUA. Mr. Branahl, what impediment do you see at this time between government and industry that will affect programs that you are involved in, that you alluded to in your testimony, in support of a joint endeavor?

Mr. BRANAHL. Well, I am encouraged to believe that if the joint endeavor agreement is finally agreed to by NASA that we have gotten over most of the hurdles we would be concerned with, rights and data and that sort of thing, and an agreement that NASA won't go out and get somebody else to do a similar thing in a similar time period.

So it remains to be seen when we can get that endeavor signed, but we hope in the near future.

Mr. FUQUA. Dr. Fawcett, the Space Industrialization Corporation concept—risk requirements and returns on investment—how different should it be than the Battelle subsidiary you mentioned particularly with respect to venture capital, how is that different?

Dr. FAWCETT. As I see it, the Space Industrialization Corporation would be taking some of the very high-risk part of an operation going from an idea or concept to a commercialization phase. Let me try to address this question by using an example project on which we are working right now, not in connection with SAI but in connection with what is referred to as the Gateway Specials.

It is not possible to discuss this here in great detail; however, in the field of biological materials, we have an exceptionally good idea for materials processing in space. We had to invest about \$50,000 to determine whether an experiment was justified, and then we figured it would take some \$300,000 to conduct the first exploratory test in space. These amounts are insignificant to you, but they are very large in some segments of industry, including Battelle.

We are now talking with companies about sponsoring this exploratory research. The \$300,000 may seem insignificant in terms of NASA budgets, but when you talk to industry it is not. We have several companies that are very interested but one of them, as an example, has a sales volume of \$5 million a year; \$300,000 is a pretty good chunk of the money they have available for research.

Furthermore, they have to invest their research funds to pay off within about 5 years. Unfortunately, we and they both know that this proposed experiment will only tell us whether we should go forward and, hopefully, a little bit more about how to do it. So, eventually, there are going to be millions of dollars tied up in this work as it goes on, but the preliminary market studies look favorable, if things work right. Normally, in the venture process, you wouldn't even spend the \$300,000 involved in the initial research because the risk is far too high.

As I see it, this phase, where you are establishing the technology and the feasibility of a potential product, would be a very logical risk for the Space Industrialization Corporation to take, but difficult to sell to industry. Once you get through the initial phase and know you have something, then the business of paying back, the business of paying royalties back to the Space Industrialization Corporation—or some other means of payback—would be straightforward, and most companies could factor that into their pricing schedule.

In my views this points to the big risk involved in applying such new technology. To try something this risk, it has to be funded by something like the Space Industrialization Corporation.

Mr. FUQUA. Mr. Winn.

Mr. WINN. Thank you, Mr. Chairman.

Gentlemen, I appreciate your testimony, the differing ideas and approach to the subject. I particularly noticed your remarks, Dr. Fawcett, about the code of ethics and in a little different vein, if you will recall, Dr. Frosch raised what I consider an interesting point when he mentioned the reluctance of industry to allow Government audits, to determine if a venture were profitable. It might be profitable. Do

you think that would be a problem? Do you think industry would allow such an audit? Do you think such an audit would be necessary?

Dr. FAWCETT. I can only speak in terms of the experience of our subsidiary that does a lot of licensing of patents to industry. Most of these licenses are based on royalties based on percentage of sales by the licensee. We have to depend upon their sales data and other factors that have to do with what they are selling and how they are going it. It is my impression that this is common practice in industry. I know in our case we find no problems in dealing with industry where they report to us. There must be a good deal of trust, but we just have not had a problem with that. I can't see it arising here.

Mr. WINN. You think there is enough trust among the corporations, and the credibility of those corporations that would stand behind that, that it really would become a problem?

Dr. FAWCETT. Maybe we are naive, but that has been our experience.

Mr. WINN. It would just have to be understood by everyone involved what the rules of the game might be, which is not unusual as I understand your testimony.

Dr. FAWCETT. Yes, sir.

Mr. WINN. Well, I don't think there is any doubt about it from everybody's testimony that the financial burden for space industrialization projects will remain quite high, even if it becomes routine, and I am just wondering if there is ever going to be a time when the Federal Government no longer will have to have an active role in such a program. Do you think that is foreseeable?

Dr. FAWCETT. One example you might look at is the aircraft business. There still seems to be a role for NASA in the aviation business, one way and another. I am not familiar with all that goes on in the aircraft industry, but apparently that is a very mature industry and yet there is still a role for a Government agency to be providing basic data and information.

I would think that probably is always going to be present to some degree. Whether that part of it is done by NASA, rather than the Space Industrialization Corporation would be another matter.

Mr. WINN. Mr. Slichter touched on it, and I wonder if you could elaborate on how you feel about how the corporation would affect the NASA research program.

Mr. SLICHTER. It would depend upon the manner in which the corporation might be set up. I can visualize the corporation being a useful contribution, if it came into being and operated in a manner that allowed the merit of propositions to survive with strong attention paid to the technological, as well as the entrepreneurial aspects. But I hasten to add, this is not an area in which the committee I served on felt it was competent to speak, and therefore the remarks I have just made represented my own remarks and not remarks associated with the committee.

On the other hand, I think the Stamps Committee does feel that NASA has need, in its own enterprises, of great reliance on what is commonly called a peer review system, in which the merits of things to be done with this national facility are sorted out in terms of what we can judge about their likelihood of success in real technological scientific terms and not merely the aspirations. There has been rather a lot of aspiration. It is only natural. I think that the

committee has felt that that review system is a great strength that needs to be relied upon.

Now, again, interjecting only my own comments, not those of the committee, I feel that a corporation would need to have an input of a character to decide the prospects of technological success in order to decide whether it is a good way to spend money.

Mr. WINN. Yesterday—well, today you say you think this could be delayed or they should wait a little while. It may be too ambitious an undertaking. Yesterday we had the opposite testimony. They said if we don't get rolling now, the Russians, West Germans, or Japanese might do the same thing and we would lose our No. 1 standing like we seem to be doing in the airframe industry.

It was pointed out the Russians are doing something in space right now. We don't know exactly what.

Mr. SLICHTER. I am not any better informed than the average newspaper reader about that. As I said earlier, we don't know enough about the capabilities of the space environment. Despite some successes, successes have been limited. The capabilities of new vehicles, the Shuttle and Spacelab, have only been imagined and have not really been tested.

Some fundamental and basic quantities that you need to know have not been correctly measured. A prudent planner of a technology, and by extension a prudent investor, would need to know a lot more than we now know. Space environment is a complicated environment. And to do a real job of commercialization, it seems to me, you need a great deal more clarification. The opportunity to get ahead is considerable. The opportunity to make some substantial mistakes based upon ignorance is also considerable.

Mr. WINN. Mr. Branahl, from your standpoint, on my earlier question to Dr. Fawcett, how would McDonnell Douglas feel about the Government auditing the project to determine profitability?

Mr. BRANAHL. Well, we are used to that sort of thing. I believe the comments are made by people who haven't worked for military and NASA in the past. So it is not an unusual thing for us.

Mr. WINN. So you think your experience has not been too bad, that we shouldn't be reticent about that problem, if it is really a problem?

Mr. BRANAHL. You can get used to anything over a period of time. I think we are used to the auditing.

Mr. WINN. Thank you very much. Mr. Brown.

Mr. BROWN. Thank you. Gentlemen, we are talking about a proposal here which has some very widespread aspects. Basically, I am thinking here in terms of the national problem that confronts us of maintaining leadership in technological innovations and industrial productivity in this country.

As a general thesis, I think it is true that only insofar as we maintain leadership in our capacity to innovate technologically is our economy going to be able to remain sound. The basic reason for that is that countries at lesser stages of development who can take our technology and focus on it have economic advantages over us in many cases, including, say, lower labor costs or better access to materials or any number of advantages which generate when the technology has matured.

The Japanese are a prime example. They have invaded and taken over a number of our major markets. To remain ahead of them we will never be able to recapture the gains they have made in a particular area, we could never beat the Koreans in textiles, for example, or the Chinese if they enter into the textile market, because they have huge supplies of low-cost labor and if they take the same machines we are using and have equal imagination and style they will capture our market, so we have to be ahead.

Hence, the importance of innovation. And hence the importance of a proposal such as this, as maybe a mode, a method of maintaining superiority in certain technological fields where we have done the basic work, but that technology is now becoming available to the European community, to the Japanese community, so how do we keep ahead of them in these things?

This is what goes through my mind as I listen to your testimony. Dr. Slichter, you have heard the gentlemen on each side of you indicate that there are promising possibilities here. According to Mr. Branahl it is not a matter of any breakthroughs in the knowledge of materials. Apparently in the three cases that he cited in his testimony, they understand the effects of gravitation. They think that process in a space environment would enable them to solve their problems and produce a product at a profitable cost or profitable price.

They don't know, if course, because experiments would be needed to confirm that and in the nature of things the experiments, if they are done on the shuttle, given the launch schedule and the opportunities, are going to take the next 5 years. But is there anything in what they have said that changes your mind about the desirability of proceeding, say, within a 5-year time span with a procedure such as is embodied in this bill or encouraging that sort of thing?

Mr. SLICHTER. Mr. Brown, I find myself in considerable sympathy, speaking on behalf of the STAMPS Committee, with that kind of program. We indeed visualize, and my full remarks make some allusion thereto, and so does the committee report, that an information and experience-seeking time of perhaps 5 years is an important first phase to arrive at the kind of judgments that we have heard described earlier as being necessary to evaluate whether a commercial project has merit.

The point that the Committee on Materials tried to stress was that the experiments done thus far are neither extensive nor conclusive enough to say that the time for commercial go-ahead is at hand, and I didn't hear Mr. Branahl saying that either, I think. He delineated some expectations—

Mr. BROWN. "Ten years would be required," he said.

Mr. SLICHTER. Yes. Some expectations are more optimistic in some persons view than others, and that is not the point of my testimony. The point of my testimony is to emphasize that we really know a great deal about the environment of low gravity, even though the experiments so far have been quite minimal and some of them indeed have been questionable.

But mankind has known about gravity for, well, forever, and has known about it in an accurate sense for hundreds of years, most especially the past decade, so there is little mystery to be uncovered, the

committee believes, in an entrepreneurship in space. The burden of my remarks is that what you will get will at best be an improvement upon what you can do on the ground, and that another breakthrough is unlikely. I don't believe either of the other gentlemen were predicting breakthroughs. They are predicting optimism, and that is fine. But the extent to which that optimism is allowed to color and sway the judgment of a management such as NASA which has public sensitivities, to the extent to which that optimism enters here is indeed an additional matter of concern.

I think the time interval you are talking about is one that the committee thought was one in which we, the community of technology-oriented people, learn a lot more. The basis on which having learned that, further commercial enterprises should be followed, is something I don't feel qualified to testify to.

Mr. BROWN. I am trying to soften the stark contrasts that are being presented here a little bit because I can assure you that if this subcommittee this week reported this bill out, it would be 10 years before we had deployed the program contemplated by it. What I am saying is, if we are going to have a focused national effort aimed at industrial productivity and preserving the health of the U.S. free enterprise system, we might need to look at staging this thing a little more carefully and doing a better coordinated job of planning, so that 10 years from now when we are convinced that there are profitable operations to be done in space, we don't take another 10 years getting it started.

Mr. SLICHTER. Or perhaps 10 years from now, Mr. Brown, when we are convinced that there isn't a profitable operation. That might also be the answer. The answer may be "yes" in this field; it will be the answer "no" in some other field.

Mr. BROWN. The process of determining whether or not this has ultimate potential can take place in the normal course of doing it. I think Mr. Branahl ought to be able to fly an experiment on one of these Shuttles. It would demonstrate, first, practicability of doing some of this processing he has indicated in space, and from that you progress to determine if it is technically feasible, what are the economic benefits, and so on.

This will be a long, drawn-out process before it is out. I am afraid that the advantage which other countries have over us may be their ability to do this type of coordinated planning for potential development that we cannot. This is the thing that bothers me more than anything else. It may be a harebrained idea but we are not coming up with any better ideas, it seems to me, to maintain our rate of innovation.

To take a simple example which bothers me a little bit, I think we have the capability today for direct television broadcasting from space. Every television set in the country with a little minor development would work probably, and yet I see a failure because of the large number of stakeholders involved in developing any national program for doing so and the possibility that Japan or Europe or China even may do it before we do.

A huge space television electronic industry we have practically created is going by default to some other country's industry. Has that point occurred to you in your business?

Mr. SLICHTER. You refer to my employment in communication—

Mr. BROWN. Yes. The best laboratories in the country.

Mr. SLICHTER. Yes, sir. Indeed it has. We worry about that very much.

Mr. BROWN. What conclusions do you come to after worrying about it?

Mr. SLICHTER. Well, I think we would want to have the best opportunity that we can to capitalize upon our inventiveness and our capacity to put television into being, and to make the judgments that would lead to that but to make those judgments without pressures that might contravene some of our planning. I worry about that, again, in the context of any public corporation seeking to provide the same kind of analysis and wisdom that NASA would bring to a topic or that some other national facility might bring.

One thinks in terms of those who are the investigating sources of industry. It is hard being a technological manager with the problems that a recalcitrant nature imposes upon you without also being obliged to respond too intimately to the urgings of the well-intentioned but more distant arenas of public thought.

Mr. BROWN. I think I understand what you are saying. I hope you understand what I am saying also. It is a possibility that the Bell System—and I know you have no responsibility for this—which has done a tremendous job in creating the best communications systems in the world for this country, now has tens of billions of dollars invested in fixed assets on the Earth, and a laudable desire to amortize those fixed assets may, because of that, have strategies for not utilizing new technology which would lose our technological leadership to other parts of the world.

I just threw that out as a possibility, that this great well-intentioned corporation in the long run could be making mistakes that would be harmful to it and to the country.

Mr. SLICHTER. I hope, Mr. Brown, that my small contribution to the enterprise was not excessively colored by my employment, but I would perhaps answer that one of the reasons for the success of the Bell Laboratories that you so kindly alluded to has been that over the years it has been at the central core of our belief and action that far from wanting to sequester ourselves in a field of technology to the exclusion of others, we have tried to capture the best of science and technology that we were able to comprehend.

I think that that should be the theme of our national plan and motive in dealing with these other foreign countries—opportunities that you alluded to earlier. That by seeking success through excellence we will have had to exercise the best judgments.

Mr. BROWN. Well, I only raise this question not to be argumentative but because the Congress and the administration is deeply concerned about this problem of lags in the American economy as a whole, and we are searching for understanding of it and we are searching for reasonable answers as to what we could do if anything to alleviate this condition, and hence it looks likely to crop up into almost any kind of a hearing, including one on space industrialization. It may not seem reasonable, but it will crop up in a number of forums before many different committees because I think we are seeking a situation where we have a profound frustration at our inability to deal with these large economic problems, and we are wondering why.

It comes up in the subcommittee that I chair, dealing with the National Science Foundation, which supports basic research. We know that basic research is a key to innovation. We are not sure how it works; however, what the full transmission chain is from sound basic science, lots of Nobel prizes and great men working in laboratories, to a healthy economy. And we are trying to explore that. Just as I am sure you and your laboratory think about it.

Well, rather than belabor this point excessively I want to thank you gentlemen for being here this morning and making a very important contribution to these hearings. And I hope that you don't feel that you have been mistreated too much. We will continue the hearings on June 26 and 27 in this same room.

With that, the subcommittee will be adjourned. Thank you very much.

[Whereupon, at 12:35 p.m., the subcommittee was adjourned.]

THE SPACE INDUSTRIALIZATION ACT OF 1979

TUESDAY, JUNE 26, 1979

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS,
Washington, D.C.

The subcommittee met, pursuant to notice, at 2 p.m., in room 2318, Rayburn House Office Building, Hon. R. G. Flipppo, acting chairman of the subcommittee, presiding.

The CHAIRMAN. The Subcommittee on Space Science and Applications will be in order.

This afternoon we continue hearings on the Space Industrialization Act of 1979. Hearings on the proposed legislation, H.R. 2337, were initiated May 22 and 23 of this year.

At this time the subcommittee heard testimony on a number of important issues associated with commercializing space. It is clear that although the benefits can be great, the cost of developing materials and materials processing in space will be quite high and that economically the return on investment can have a long and uncertain payback period.

The investments required to open up space for commercial purposes have been described as high-risk venture capital. In this regard, the Nation must determine the appropriate role of Government in promoting these ventures for private sector innovation and the extent to which financial risks are to be taken, at least initially, with Federal funds.

The Space Industrialization Corporation established by H.R. 2337 would provide a mechanism to accomplish this purpose and must be thoroughly reviewed and perfected to assure that our Nation's interests are well served.

The first witness this afternoon is very familiar to the committee. Dr. George Mueller was the NASA Associate Administrator of Manned Space Flight during Apollo and during the early definition of the Space Shuttle.

Dr. Mueller is now president of the System Development Corp. as well as president of the American Institute of Aeronautics and Astronautics.

The second witness is Mr. Christopher Wright, Sr., analyst for the Office of Technology Assessment.

Following Mr. Wright, the next witness is Dr. A. K. Thiel, Sr., vice president, Defense and Space Systems Group, TRW. He testified on behalf of the Aerospace Industry Association of America last year before the committee during hearings on international space activities.

The final witness this afternoon is Dr. Harry Gatos, professor of electrical materials and molecular engineering at MIT. Dr. Gatos testified during hearings on space industrialization in 1977 and we will be looking forward to his testimony again today.

Mr. Winn, did you have any opening remarks?

Mr. WINN. No; thank you.

The CHAIRMAN. No further remarks. We will be delighted to hear your testimony at this time.

STATEMENT OF DR. GEORGE E. MUELLER

Dr. MUELLER. Thank you, Mr. Chairman.

Thank you for the opportunity to offer my views on the proposed Space Industrialization Act of 1979 (H.R. 2337). I welcome the opportunity to serve as a witness on legislation dealing with this important national issue.

My vantage point on the proposed legislation may well be unique. I am educated as a scientist; served as the Associate Administrator for Manned Space Flight in the 1960's; head a corporation involved in space activities; and am currently president of the largest professional aerospace society, the American Institute of Aeronautics and Astronautics.

Throughout my career, I have always been a strong and sometimes outspoken advocate of the exploration and utilization of space. I am convinced of the enormous potential of space industrialization, and I heartily endorse the goal of fostering entry of the private sector into exploiting the benefits of space.

It is with the greatest reluctance, therefore, that I oppose this bill.

Clearly, the architects of H.R. 2337 recognize the potential of space industrialization, and clearly, they appreciate the need for a mechanism to stimulate investment in space manufacture. As I said, I endorse the goals of the bill. Unfortunately, the mechanism proposed by H.R. 2337 is the wrong mechanism. It opens the door to yet another superagency; and it threatens to extend Government control over the private sector in an activity that depends upon the working of the free enterprise system if it is to succeed.

Since these predictions are directly contrary to the avowed intent of the bill, it is useful to review salient provisions of H.R. 2337 which have generated my concern.

Unquestionably, the Space Industrialization Corporation will function as a superagency of the executive branch of the Government. Although staffed partially from the private sector, the selection of the Board will be largely determined by the President. Moreover, since officers of the Corporation will be expected to divorce themselves from other responsibilities, I think we can assume that they will function as representatives of the public, rather than the private sector. Hence, I believe the Corporation will operate from the outset as a governmental agency.

And it will have awesome powers. If, as seems likely, the Space Industrialization Corporation will monopolize the satellite-launching capabilities available for space manufacturing projects, it will have life-and-death decision power over all U.S. space manufacturing proposals. This new agency will determine whether a proposal "appears

to be one which will contribute to the achievement of the objectives of this act and to be otherwise meritorious." It alone will determine if a project "no longer appears to have reasonable prospects for success."

With this much centralized power, the possibilities for bias, error, or simple lack of imagination are significant. Even with financial assistance offered by the bill, I suspect that corporations would be most reluctant to invest their best ideas and top talent in a project which may be rejected or terminated by external decisions totally outside their control.

Although the bill envisions the eventual transfer of the corporation to private ownership, I suspect that it may well exist forever as a superagency of the Government. Consider the wording of the bill:

At such time as the Board with the approval of the President determines that public ownership can realistically be secured, it shall issue a proclamation to that effect and shall take all steps necessary to accomplish that objective * * *.

That is certainly a very subjective criterion, and the wording effectively gives the President full power to perpetuate the corporation as a public agency.

Moreover, there may be strong pressure to perpetuate this agency, because it may well be a significantly large organization by the time divestiture is considered. There are no provisions in the bill to limit the amount of facilities and equipment the corporation may acquire; and there is no provision to limit the size of the corporation's annual operating budget—either in absolute dollars or as a percentage of its total expenditures for financial assistance, satellite launching purchases, and the like.

Clearly, the staff of the corporation will have to be quite large if it is to perform even the most modest evaluation and monitoring activities. The wording of H.R. 2337 gives us some insight into the size of the bureaucratic staff that may be assembled, since it provides a measure to

fix the salary of such employees as are necessary for the performance of the functions of the corporation, including a special professional staff to provide advice on technical, financial, and legal matters, and may in addition procure outside assistance in evaluating applications for awards and proposals for projects as well as in evaluating the progress being made under projects covered by outstanding awards.

In short, we have all the classic elements of the superagency—life-and-death power over its "customers"; a lack of direct accountability to the electorate or to Congress; opportunity and motivation for self-perpetuation; and a structure and franchise leading to unchecked growth.

I do not think this country wants or needs another superagency.

Still, it is unquestionably in the best interests of our country to pursue space industrialization vigorously and quickly. With the zero-G environment, hard vacuum, isolation from the Earth's biosphere, super-cold temperatures, and other phenomena unique to the space environment, we have the opportunity to establish a new space-based economy, based on new products, improved products, new services, and new sources of energy. We can generate new jobs, strengthen our resource base, and keep our economy healthy and growing. In short, we can solve some of our most pressing problems as we create new wealth.

Moreover, the new wealth will eventually be measured in GNP's rather than dollars. Though we are barely scratching the surface in

discovering products that space manufacture offers, recent work has already identified a rich diversity of such possibilities. For example, the SAI study identifies 147 uses for superior space-manufactured products in the following six categories: biologicals, electronics, electrical, structured, process and opticals. As we begin to accumulate direct practical experience in this area with the Shuttle/Spacelab program, this list will without doubt expand dramatically.

Both Rockwell International and Science Applications, Inc., have recently conducted studies of the opportunities and markets offered by space industrialization. Both agree that, technically, there is no reason why production quantities of these products could not be manufactured in space as early as 1900. The studies are much more guarded about the revenues which space manufacture will generate, since there will be additional products we haven't even identified yet. Still, SAI conservatively projects that the cumulative revenues from space-manufactured products by 2010 might be \$150 billion.

For both sociological and economic reasons, then, it is clear that we should move forward on space industrialization. We need not be deterred by the drawbacks of H.R. 2337. Another recent study by SAI, this one dealing with the Satellite Power System, identified no less than 10 different approaches to financing and managing such a large-scale program. Significantly, the two least attractive approaches were those based on superagencies: (1) the use of existing governmental agencies, and (2) the use of Space Utilization Authority as TVA for space."

The basic drawback of both these approaches, it seems to me, is that they are effectively patches on the crazy quilt of taxes and regulations already in force. They are predicated upon the assumption that the Government is the only entity that is willing to take any significant risk. While that appreciation is uncomfortable close to the truth, bills such as H.R. 2337 perpetuate this potentially disastrous situation.

Why is American business unwilling to assume the risks of long-term projects such as space industrialization? Largely, it is because they are incentivized to do otherwise. Almost as if it had planned to do so, the U.S. Government has discouraged American businesses from making the bold investments this country so badly needs. Peter Drucker described these dynamics quite succinctly in the May 1979 issue of "Science":

The tax system adopted by the United States in the last 20 years or so penalizes basic research and the adaptation of basic research to technology. Worse, through the combined working of corporation income tax and capital gains tax, the system greatly favors short-term, immediate gains and makes long-term investments in an uncertain future unattractive and unrewarding.

Equally inimical to investment in research and innovation is the increasing burden of regulation. It is not primarily that regulation adds cost, but that it creates uncertainty. Whether in respect to the environment, to safety, or to new drugs, regulation makes investment in research irrational, not only increasing the odds against research producing usable results but also making research into a crooked game.

Tax laws and regulations also push industry away from technology focus and toward financial conglomeration. Under the tax laws of the United States—laws which in this form do not exist in many countries—the proceeds of liquidating yesterday are considered profit and are taxed as such both to the company and to the investor. Hence, businesses, instead of liquidating the obsolete, have to find new investments in new businesses for whatever cash is being released by the shrinkage of an old technology, an old product line, or an old market. And this, in effect, imposes conglomeration on them. This policy makes it increasingly

difficult to shift resources from low and diminishing areas of productivity to areas of high and increasing productivity and this impedes innovation. It also shifts businesses from a technological to a financial focus. It makes management increasingly a matter of finding the right financial investment.

This is the root problem deterring space industrialization. American industry is well aware that slighting research and long-term work is dangerous and may be suicidal. Yet few companies can afford to ignore the near-term financial realities imposed by the system of taxation and regulation now in force. Hence, it is not at all surprising that AIAA's recent survey of Fortune 500 companies revealed that "none of the major companies was interested in investing in any enterprise whose commercial payoff was as distant as space processing."

Rather than create another bureaucratic superagency, then, why not attack the root problem? Why not incentivize industry to make the long-term investment required for payoff of space manufacture? Rather than minimize the risk, make the risk affordable.

Our States do this every day. To attract industry, they use such vehicles as periods of zero tax and the issuance of low-interest loans. The approach works; it doesn't require a bureaucratic superstructure, and its costs to the taxpayer are far less than the more typical governmental control vehicles.

In today's environment, American industry reluctantly concentrates its investment in projects with short-term payoffs primarily because of the economic barriers to investing in projects whose return is a decade or more in the future. I can think of no stronger stimulus to making those badly needed, long-range investments than the removal of those barriers. Moreover, the Government can remove those barriers, and greatly accelerate space industrialization, through two straightforward measures:

1. Permit the costs of a space manufacturing venture to be at least a partial direct offset against a corporation's taxes; and
2. Provide for the ready availability of low-interest capital for investment in space industrialization.

Certainly this is not a radical new concept. It has been used throughout the world, perhaps most notably by Sweden. At the end of World War II, when Sweden's economy was still agrarian, its Government decided to stimulate the development of industry by a combination of preferential tax treatment and other incentives favoring private investments in new technologies. Today, Sweden is a major industrial nation producing some of the most sophisticated military aircraft in the world and earning significant export revenues from sales of automobiles and industrial products throughout the world.

With today's sophisticated safeguard, preferential tax treatment, and either Government loans or Government-guaranteed loans, represent a safe and straightforward means of stimulating space industrialization. I am convinced, moreover, that this approach would be far less costly than that proposed in H.R. 2337, and that the taxpayers would be amply repaid from the many and varied benefits of space industrialization.

Without creating a powerful new superagency, these measures would enable industry to take the longer view and assume the risks of space industrialization in pursuit of long-range payoff. As a result of its

studies, the AIAA has concluded that the only viable approach to fostering space industrialization is to "get industry interested." I can assure you that the straightforward measures I have proposed here today will indeed "get industry interested."

Thank you.

The CHAIRMAN. Thank you, Doctor, for your very interesting testimony. Doctor, you support a direct tax credit to permit the costs of space manufacturing ventures to be at least partially offset against a private corporation's taxes.

Do you believe it would be necessary to establish any new governmental mechanisms or expand the present ones in order to determine which research and development expenditures support the space manufacturing ventures and which would therefore qualify for the tax credits?

Dr. MUELLER. My observation of the IRS is it would be a very effective mechanism for sorting out that question.

The CHAIRMAN. Would you have any suggestions as to how smaller businesses might get involved in space industrialization as opposed to permitting only those who have large income taxes to offset, to benefit?

Dr. MUELLER. Smaller businesses pay rather substantial amounts of income tax as well as larger businesses, and if they are successful, I do believe that in order to support a space manufacturing endeavor, it will immediately be a successful small company; and I guess I could say I regard this as a small company, and that kind of venture can be financed.

It is a matter of making sure that the risk that one takes in a corporate enterprise is rewarding or has potential reward in the future.

Certainly, with the payloads available in the Shuttle with the ability to fly substantial payloads with reasonable costs, I believe that even small companies can afford the investment necessary. It is not really the cost of transportation, but it is really the cost of research and development that is required in order to field a reasonable manufacturing experiment prototype.

The CHAIRMAN. Doctor, I certainly share your concern for creating another large bureaucracy. There have been arguments advanced, however, that the size of the Space Industrialization Corporation could be kept within 100 employees and still function effectively as a financing enterprise; the personnel for proposal evaluation would be on an ad hoc basis.

Do you believe it is reasonable to specify the size either directly or, as you suggest, limiting operating expenses?

Dr. MUELLER. I remember some years ago when NASA first started, there was an idea we could limit the size of the headquarters to 50 people. It has somewhat exceeded that number over the years. I have not noticed the headquarters shrinking.

The CHAIRMAN. Perhaps that is an area we should look into. You indicate that the American Institute of Aeronautics and Astronautics' recent survey of the Fortune 500 companies reveal a lack of interest in investing in space processing.

To what extent do these companies feel that the commercial sector should influence governmental research and development in space processing?

Dr. MUELLER. We did not inquire directly into that aspect of the question, so I don't, or I can't, really offer an opinion on that.

The CHAIRMAN. Doctor, if you do not object, I would like to submit some questions in writing for your response for the record.

Dr. MUELLER. I will be very pleased indeed to answer any questions.

The CHAIRMAN. Thank you very much. Mr. Winn.

Mr. WINN. Thank you, Mr. Chairman.

Doctor, I would agree with you and with the chairman that we probably don't need any new bureaucracy. I don't know if we can hold it down to 50 or 100, or whatever figure might be set, but you made the statement that kind of intrigues me about the corporation would have "life or death power" over its customers. I don't know what you mean by that.

Why would it be any different than any other lending institution such as a bank?

Dr. MUELLER. Have you ever borrowed money from a bank?

Mr. WINN. Yes; I am a bank director.

Dr. MUELLER. Well, there is a great tendency on the part of the bank to define rather clearly the activities they are lending to. If they don't like the activities, they don't lend the money.

I rather think that the same thing, only in greater detail, would be the course of any Government agency with which it would deal.

Unfortunately, in an area as new as space manufacturing, there needs to be some creative and independent innovation. We tend, whenever we centralize the control, to minimize or eliminate innovation.

I think it is already; since I was part of the Government at one time, I understand then both sides of that equation to some extent, and I am sure that some of the people who worked with me on the early days of the Space Shuttle thought there were some arbitrary decisions made on the governmental level with respect to the Space Shuttle.

I would surely argue that after I left the Government there were some arbitrary decisions made with respect to the Space Shuttle situation. I think that is a natural thing that human beings do.

I think even bankers sort out the loans they make and choose those that have the lowest risk.

I think that we need to take risks in this new area and we need to create the environment that will permit people to take risks and encourage them to take risks, encourage them to pursue wrong ideas as well as right ideas.

The CHAIRMAN. Well, I don't believe anybody would want to stifle new ideas. We want to encourage productivity and new ideas, but at the same time if there is a board of governors—like there is a bank board—and you pool 8 or 10 ideas or thoughts and the interpretations of them to the board, I would suppose they could well make wrong decisions, but I am sure they could make some right decisions, too.

Dr. MUELLER. I am sure they would.

The CHAIRMAN. You know, two brains are better than one.

I am sure you are aware, although in a little different vein, that there have been some comments about the possibility of expanding the NASA charter to allow them to perform the function of the Space Industrialization Corporation.

Some people think that this might have the obvious danger of diluting the NASA R. & D. capabilities. Do you have any thoughts on that?

Dr. MUELLER. Well, you know, to some extent, within its own budget, NASA could encourage the development of space manufacturing today.

Many of us over the years have encouraged it to do so. However, in the allocation of its funds, it tends to concentrate on science and its applications, rather than on the technology of manufacturing.

So that, I guess, there is not any reason why it could not have a charter broadening; but the problem is that the people in NASA are tending, because of their backgrounds and understanding, not to be particularly sympathetic overall to the ideas associated with space manufacturing.

After all, they are not a production outfit and they don't tend to think in that fashion; so I don't think it is so much that they would be diverted from R. & D., but rather they are not psychologically adapted to providing the leadership or lack of leadership necessary to exploit the whole new arena of really rather mundane things, production of quantities of material.

The CHAIRMAN. I think you make a very good point there. It had not occurred to me, but I think you also may have hit the nail right on the head without realizing it because you said, "NASA could do it within its own budget."

Of course, you and I were discussing budgeting and OMB before the hearing started.

I would say that probably one of the reasons for lack of enthusiasm is that they have budget problems down there already with the programs that have already been approved.

So, to reach out and take on something as large as this might be something that would probably cause them to put it on the back shelf, whether they think about it or not. Thank you.

Dr. MUELLER. And thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Mr. Winn and Dr. Muller, thank you very much.

Next we have Mr. Wright, a member of the staff of the Office of Technology Assessment.

We are delighted to have you and to hear your testimony.

STATEMENT OF CHRISTOPHER WRIGHT

Mr. WRIGHT. Thank you, Mr. Chairman and Mr. Winn.

Mr. Chairman, I am pleased to appear before you to discuss H.R. 2337. I do so as a student of space affairs since 1958 when, as Director of the Columbia University Council for Atomic Age Studies, I contributed to a study on the control and administration of outer space with Ambassador Philip C. Jessup and Howard J. Taubenfeld. In 1960 and 1961, I also contributed to the Brookings Institution study for NASA on proposed studies of the implications of peaceful space activities for human affairs. While such studies were called for in the legislation creating NASA, I believe remarkable little was done to follow up the Brookings recommendation that a continuing capability be created for what would now be called technology assessment. Had this been done at that time, we might now have a solid empirical

basis for discussing the subject of these hearings and for deciding what industrialization opportunities to pursue, why, and how.

Since the early 1960's I have followed outer space activities from various perspectives, but as a secondary interest. My work at the Office of Technology Assessment (OTA) over the past 3 years has not been directly concerned with space programs or their implications, although the development of institutional capabilities for assessing and guiding research and development activities has been of foremost interest to me. Thus, my analysis does not necessarily reflect the views of anyone else at OTA. As you know, OTA has underway one substantial study of solar power satellites and another one on applications of space technologies.

My remarks have to do with the policy issues affecting institutional innovations designed to anticipate and complement the technological innovations that are of primary interest.

In my view H.R. 2337 constitutes a bold attempt to recognize that we must deal with systems, in this case a possible "space industrial system"; that we must engage in systematic efforts to be informed about and learn from entrepreneurial failures as well as successes; and that we must press toward a resolution of some fundamental ambiguities in public policy created by extraordinary aspects of the technologies and applications associated with man's uses of outer space.

The three ambiguities I will mention have to do, respectively, with discovering social control of technological initiatives; with accommodating to or jeopardizing long-term strategies for industrial innovation; and with the intended positive or negative impacts of a space industrial system on existing industries and the economy as a whole.

My observations are less concerned with specific technical and economic assessments of the feasibility of successful industrial ventures using a space industrial system than on what is revealed by the contrasting comments on H.R. 2337 by interested parties and by the bill itself. Some commentators have suggested the bill is premature, others welcome it as timely and a necessary source of funding. Both views tend to overlook the important role which the proposed corporation would play in assessing future prospects.

Consideration of the space industrial system that H.R. 2337 attempts to realize brings to the surface issues that have not had to be addressed as directly in the course of establishing systems for satellite communication or for remote sensing from outer space. H.R. 2337 also brings to the fore many, but by no means all, of the policy issues likely to arise in connection with plans for the solar power satellite.

Interest in each of these applications stems from the Nation's over-arching commitments to the Space Shuttle; to a space lab; to maintaining an international leadership position in the uses of outer space; and to proving the economic, as well as national security and social worth of such systems. Whether we succeed in doing so or not, we are certainly committed to trying to meet these commitments. These concerns drive the search for industrial applications faster than would otherwise be the case.

For these reasons development of a space industrial system through the proposed Space Industrialization Corporation would test the

Nation's capacity for major institutional innovation as a necessary complement to a technological innovation. Thus, the Corporation would be expected to reconcile divergent factors in a number of areas. It would be expected to:

1. Sustain, in the public interest, longer range, higher risk commitments than could be expected of private corporations, yet also be more responsive than the latter need be to changes in public and political priorities;

2. Engage in large-scale governmental and industrial technological projects and in the same context encourage, assist and promote small-scale, creative nonaerospace types of industrial enterprises;

3. Respect proprietary knowledge and profit incentives, yet champion the Nation's ultimate interest in sharing information and benefits so as to broaden the field of potential participants;

4. Promote technological advances, yet also anticipate, guide and even regulate their application by creating an appropriate financial and commercial environment for selected industrial innovations;

5. Balance frequent losses from high-risk ventures with profits from rare successes without excessively diluting the returns to the successful innovator; and

6. Provide a relatively stable operational complement to the R. & D.-oriented mission of NASA, yet remain responsive to the advances resulting from further R. & D., including those that may undercut investments based on earlier findings.

To the extent such expectations are created by H.R. 2337, the Corporation will have to devise means for reconciling their opposing tendencies. In doing so it need not be and cannot just be a specialized funding agency. And yet, it appears that funding is assumed to be its most important function. The need for analysis and evaluation prior to investment is not sufficiently appreciated. Nor is it clear that the Corporation need play a promotional role beyond what emerges from its realistic assessments.

Nevertheless, the Corporation's most significant function might well turn out to be as a source of the kinds of credible information, analyses and assessments or evaluations that would provide inventors, innovators, entrepreneurs, and venture capitalists with more of what they need to know about the space industrial system in order to make more rational decisions as to whether or not they enter the system and how to allocate their resources and talents if they do so.

Even the Corporation's capacity to promote the system by altering the environment for industrialization and commercialization is likely to rest more on its capacity to access NASA's capabilities and make the case for changes in public policies than on allocations of the funds it can provide. Its lending capacity would facilitate access to economic and market information and to the experience necessary for assessment purposes. Such information services could well turn out to be of primary importance.

H.R. 2337 as now drafted does not sufficiently anticipate the need for significant control functions either for promotional or constraining purposes. The provisions for facilitating a space industrial system do not appear to include as yet, explicit review and development of such controlling functions as standard-setting, dispute settlement and avoidance machinery, patent arrangements, property ownership rights,

liability, insurance protection, regulation, taxation, et cetera. Nevertheless, the concept of a space industrial system would seem to cry for research and development concerning the special features of such matters in this context, and for mechanisms that will assure implementation of the findings.

The first of the three policy ambiguities mentioned above is reflected in the significant differences between those commentators on the bill who suggest that institutional developments, including creation of the proposed Corporation, ought to await a clearer understanding of the technological possibilities and market needs and those who assert that this and other institutions should be created early on, so that they may help to guide and shape emerging technologies.

The consideration of H.R. 2337 at this time, given the lack of knowledge about the utility of space industrialization, offers a clear opportunity to adopt the latter approach.

The future shape of the scientific and technological dimensions of public policy may be determined by whether or not, in situations like this one, the Congress recognizes these differences in approach and endeavors to create institutions capable of monitoring, assessing, and guiding technological development, with all that entails, or else waits until technologies have advanced independently to the point where a need for responsive institutional developments is all too apparent but Congress choices are constrained.

Thus, one aspect of our fundamental national policy toward technological innovation is determined by whether we do or do not create special monitoring and governing institutions early in the development of a specific technology. The alternative is for space industrialization systems to wither or advance within established frameworks without specific efforts to understand what is happening, let alone how, or why. It follows that if early warning and developmental institutions are to be created, they must have an unusual built-in capacity for self-correction not required when the institution is created in response to clearly defined promotional or regulatory interests. The proposed Corporation has the potential of being such an institution.

The second policy ambiguity revealed, but not entirely resolved, by H.R. 2337, has to do with the need to reconcile day-to-day political and economic accountability of governmental bodies in sectors of activity susceptible to technological change with the need for systematic and reliable forward planning for systematic investment and implementation of industrial and commercial developments in these sectors. While the mixed Board of Directors and the revolving fund provide some assurances of continuity and stability, major sources of uncertainty remain, because of the impact of broad Government tax and regulatory policies affecting the space industrialization system. The fundamental problem is that each advance in scientific knowledge and technical know-how may require major commitments if it is to be applied, but it may also be a potential threat to prior investment and commitments based on established knowledge and know-how, regardless of who made the past investments. The task of attracting capital resources with which to exploit some new technologies will not be accomplished so much by assuring a more predictable innovation-proof investment environment for venture capital as by increased appreciation of the fact that capital investments of all kinds are becoming less

secure. They are in greater jeopardy of technical obsolescence or irrelevance because of technological advances, increased dispersion of international centers of creativity and innovation, increased interdependencies, and shifts in human priorities and needs. If this is recognized, then new technological ventures become relatively more attractive as old ones are depreciated. The funding role of the Corporation thus tends to become no more nor less significant than its capacity for informed analysis of the system and its risks and for overall evaluation of proposals for participation in it.

The third ambiguity rests on the fact that the space industrialization system to be advanced by the Corporation might either be guided in ways that would profitably displace existing earthly industrial activities in established sectors or else be aimed at creating entirely new kinds of industries. The latter would be a still more difficult course to pursue profitably, but the profits gained in the first circumstance would be at the expense of existing enterprises. Thus, it is necessary for the Congress to provide more policy guidance as to whether the aim of the Corporation would be to achieve economic viability by displacing existing enterprises or not.

Apart from the need to clarify public policy with respect to space industrialization for the reasons mentioned above, international considerations also enter in. As mentioned earlier, one of the pressures for creating a space industrial system is linked to what other nations are considering along similar lines, even though the challenges may be more symbolic than economic or material. While there may be little reason to imitate foreign institutions designed to accelerate industrial innovation in those settings, we can and should learn some things from the approaches abroad to institutional innovation for space and other high-technology activities involving large and small-scale enterprises. We need to advance knowledge of appropriate institutional innovations in parallel with knowledge of potential technological innovations.

Recognizing that every nation has its own distinctive combination of social institutions, it is also true that nations borrow and adapt. This Nation is particularly concerned about the proper relationships between governmental and private organizations, between public responsibilities, goods, and goals on the one hand and private initiatives, interests, and motivations on the other. This creates special international problems and opportunities for us.

The provisions of H.R. 2337 concerning intellectual property rights illustrate the difficulties we have reconciling private and public interests in unconventional areas. The systems aspect of the space industrialization system tends to undercut the idea of such rights and values apart from their place in the system. Historically the relationships of importance to us emphasize independence, pluralism, and checks and balances, all of which tend to complicate the systems we must try to understand.

In this age of science and technology it seems advisable to recognize that the intellectual resources embodied in trained creative individuals constitute an increasingly important and perishable form of private property. Technology is less the property of companies or governments than of individuals. H.R. 2337 does not do this. No nation's institutional innovations or system of economic rewards will

amount to much unless they serve to develop, stimulate, and motivate talented individuals in ways that also serve to implement social goals and public policies. I emphasize this point because such a view helps to deemphasize, in the context of the space industrial system, our traditional confrontational relationship between private companies and government.

Although H.R. 2337 does not fully and explicitly adopt this new approach, it does provide a framework that could be used to develop informed analyses and assessments of the systems aspects of the space industrial system, including the human resources and social, political, and legal environments. To this extent it might also serve in time as a model for similar legislation concerning other prospective technological systems that will also have to rise above the traditional mode of confrontation between private enterprise and government.

Thank you.

The CHAIRMAN. I notice your third ambiguity raised the question of whether Federal funds should be used to advance technology which could have the effect of displacing industry.

Do you believe the Nation can afford not to advance technologies in light of foreign policies toward accelerating industrialization?

Mr. WRIGHT. I think we have to move forward. I think we have to look for choices, however, and realize that some innovations, would add to the net productivity of the country and others may be false advances in that they generate a lot of activity which just displaces other ways of accomplishing much the same end.

I hesitate to go further than that without an example, which I am not prepared to provide. It is not so much a matter of advancing and not advancing, as of recognizing the full range of choices and making educated judgments as to where to put our limited resources.

This is why it is important to have capabilities such as might be provided by this corporation to keep on top of where we are at, where we are going, what the alternatives are, and what are the reasons why individuals and private or public concerns have elected to follow one route rather than another.

It is very hard to get that picture now.

The CHAIRMAN. Would you describe some of the foreign policies toward promoting the private sector in this type of program.

Mr. WRIGHT. Some of the policies of foreign governments?

The CHAIRMAN. Yes; policies of foreign governments.

Mr. WRIGHT. The three countries having the most relevant experience are Japan, Germany, and Great Britain.

Great Britain has national research corporations which endeavor to support innovative activity, some of it through trade associations. These have not been notably successful. On the other hand, Germany and Japan may be having more notable successes in high technology areas.

In Japan the returns are not all in by any means, but everybody is watching with keen interest the concerted effort being made on the part of the Government and industry in collaboration and also, I should add, with competition within the industry, to establish a world position in certain parts of the electronic industry. The nation has established national priorities. Realizing it cannot do everything, it has made certain strategic choices.

Historically, the making of such choices goes back to the opening of Japan to the West, when missions were sent to Europe and the United States. They came back aware of the need to make priority judgments, and to emphasize some areas of education, science and technology, over others.

In Germany, there is also a relationship between Government and industry which allows the setting of certain priorities.

In the case of the European Airbus, which involves more than one country and also some U.S. manufacturers, it strikes an observer that success starts with an educated judgment as to the real choices available. It is necessary to put a number of eggs in one basket so the choice is between baskets. We do not see that very well.

Mr. Winn, any questions?

Mr. WINN. Thank you very much, Mr. Chairman.

Mr. Wright, first, I want to commend you on putting your testimony on both sides of the paper. You can save a lot of paper that way, that is particularly when we get all Government agencies to do that on all of the testimony that we are having before the various committees.

Second, I listened to you and I followed you, I think, as closely as possible. I am not real sure whether you are in favor of this Corporation or not. You sort of speak in favor of it sometimes and then you play the devil's advocate and tear it apart.

How do you really feel about it?

Mr. WRIGHT. Mr. Congressman, I am still a member of the staff of OTA. We are not supposed to advance opinions, but to point out some of the choices and their implications.

Mr. WINN. I found out as a director of OTA they have a lot of opinions over there.

Mr. WRIGHT. What I tried to do in my testimony was to highlight the aspects of the Corporation that are likely to prove most important if it is to move ahead. That is, to exercise a kind of information analytical assessment role, not only for its own benefit, as an investor, but also for the benefit of other investors and interested parties. I could see this Corporation filling that need.

I am less impressed with the need for the funds at its disposal, although having the funds to lend or invest gives a certain credibility to the analyses, since the Corporation would then back its judgments by putting its resources at risk.

I find it hard to believe, though, that there is not venture capital available if the supporting analysis is correct.

I realize this is a controversial view and I do not consider myself an expert in this area, but I am more impressed with the lack of demonstrably good ideas in this area than with the lack of money to pursue them. Some people say there are many good ideas that are not being developed for lack of money. I am less impressed with the arguments advanced for pursuing particular ideas.

Mr. WINN. On page 6 you stated:

Even the Corporation's capacity to promote the system by altering the environment for industrialization and commercialization is likely to rest more on its capacity to access NASA's capabilities and make the case for changes in public policies than on the funds it can provide.

That is basically what you said.

Do you mean the Corporation may act as a technology transfer vehicle?

Mr. WRIGHT. I would have to defer to the drafters of the bill on that point because I am not clear whether the Corporation would have a kind of special entre to NASA or not. It is my reading of the bill that it would. There is provision for NASA to cooperate with the Corporation. Presumably NASA can cooperate with other entities as well, but others may have less sustained interest in doing so.

My point is that in considering why people would want to do business with the Corporation I can't help but feel that the attractiveness of the corporation is not just as a special banking window, but as a kind of informed analyst of the system, with exceptional understanding of what is going on, and what the potential is. Perhaps it could also assist by bringing to bear certain knowledge and capabilities of NASA that would not otherwise be available. That is what I meant there.

Mr. WINN. Do you think, you were saying here and you heard me ask a question prior to this of Dr. Mueller, but do you think NASA's character should be enlarged to handle this?

Mr. WRIGHT. There is a problem. I can't speak as knowledgeably about industrial manufacturing space as I can about another area I have had occasion to look at, having to do with remote-sensing earth resource satellites.

I am concerned about the apparent discontinuity between NASA's capability and in its experimental approach to remote sensing and the need to establish certain kinds of on-line services in a way that would be helpful to public interest groups, State and local governments and others over the long run. Apparently NASA is inhibited from getting itself involved in anything that might look like an operational capability. The existing links with the Department of Interior and others do not seem to demonstrate effectively to potential users of the remote sensing technologies that there is something here valuable to them, that they can rely on it, and should build their own analyses and decisionmaking around it. In that case I would like to see more done to get a working collaboration between NASA, the Census Bureau, and the Geological Survey.

Mr. WINN. Your statements refer to the policy ambiguity of waiting on the development of the institution until the technology is developed versus establishing the institution early to assist in development of the technology.

Now, this seems to assume that an institution will be required whichever way.

Mr. WRIGHT. Over the course of the postwar years, we keep coming back to this notion that technology is a kind of unguided missile, that this creates problems for our society, and that maybe our policymaking bodies should exercise more social control over the institution that tends to generate these technological impacts. Otherwise, they pursue their own tangents.

That is the model or image of technology that has worried a lot of people. This worry is one of the motivations for creation of the Office of Technology Assessment.

Yes; I am assuming that sooner or later society will create institutions to exercise some kinds of control over technologies and applications that might otherwise have a life of their own.

Mr. WINN. Thank you very much for the clarification.

The CHAIRMAN. Thank you very much, Mr. Wright.

Our next witness is Dr. Thiel. We are delighted to have you and to have our comments.

STATEMENT OF DR. A. K. THIEL

Dr. THIEL. Thank you, Mr. Chairman and members of the committee. I am Dr. A. K. Thiel and on behalf of TRW, Inc., I want to thank you for the opportunity to appear and testify on the bill H.R. 2337, a bill to establish a space industrialization corporation and dedicate the United States to a program that will encourage the peaceful utilization of space for industrial purposes. The chairman and committee members are to be commended.

With me today is Mr. Neville Barter, TRW's program manager on the NASA materials processing in space program.

TRW, Inc., is a high-technology company active in automotive, electronics, aerospace, and industrial and energy products. Through our defense and space systems group we are a major supplier of satellites and other space systems to the Government.

Our involvement in the utilization of space dates to 1958. Since that time TRW has been deeply involved in almost every major space activity conducted by both the Department of Defense and NASA.

Our recent activities include participation in the HEAO and TDRSS programs. We have participated in the development of the space shuttle program and currently TRW is performing the NASA/Marshall Space Flight Center materials processing in space (MPS) hardware contract. Under this contract we will build and integrate the first MPS facility to be used on early space lab flights.

In addition, our corporation has been publicly committed to support of space industrialization since the mid-1960's. TRW is the sponsor of a private sector industrial committee on which I am the chairman and whose major purpose is to explore with nonaerospace companies, processes and projects that can be undertaken in a nonterrestrial environment.

The immediate focus of this voluntary group is to communicate the intent and progress of NASA's MPS program and solicit and encourage broad industry interest and participation in those near-term efforts upon which a meaningful and successful space industrialization effort might be built.

TRW, Inc., believes that the American space program is in a very critical period. What we do between now and 1985 will have a very critical and determinative impact on whether we remain preeminent in this field.

While we, along with most other Americans, look with justifiable pride to the tangible evidence of our past accomplishments typified by the displays in the National Air and Space Museum, we are concerned that this interest is in the main retrospective. We are concerned that while our Nation and the world are daily enjoying the benefits of communication satellites, Landsat, Navsat, and the TIROS and NIMBUS

weather satellite programs, our national level of commitment and undertaking are falling off.

We are, in fact, dangerously close to losing our capability and pre-eminence, and we are confronted with rising and decimated competition in the use of space from the Soviet Union, Europe, and Japan.

TRW, Inc., believes that space industrialization deserves careful, mature assessment and that the actions taken on space industrialization by the Congress during the next few years will significantly influence the U.S. position in leading the world in the peaceful utilization of space.

The committee has taken a bold and innovative step in formulating and offering this particular space industrialization proposal.

TRW supports the declaration of a national policy to promote space industrialization and the formulation of an aggressive program that will encourage implementation of this policy. The success of your efforts will depend only on your resolve.

We recognize that some distinguished scientists have expressed doubts about such a program, particularly about the economic and practical utilization of space for industrial purposes.

While they have raised legitimate points of concern that deserve attention, we do not agree with the overall conclusions that space industrialization is really nothing more than a noble, but infeasible concept.

Thus, TRW, Inc., agrees with the purposes of your proposed legislation where it declares space industrialization to be a national policy and where it recognizes that such a policy will not be naturally accomplished without the direct support and financial assistance of the Federal Government.

TRW, Inc., agrees with the committee on the following points:

1. Federal participation in and financial support of a space industrialization effort is essential to the successful pursuit of such a program;

2. Financial considerations necessitate such a governmental presence;

3. Federal participation and leadership can encourage the maximum participation of American industry and thus help assure its full involvement;

4. Such a Federal effort is compatible with other near term applications programs such as Landsat, Metsat, Nimbus and the recently approved Earth radiation budget satellite and should not be considered a competitor. The soon-to-be operational Space Shuttle provides economical launches for all of these programs which are clearly in the national interest;

5. The funding for such a program must be inviolate and assured to effectively encourage and preserve a broad range of participation. Predictability is essential, particularly to instill confidence in that sector of industry until now unfamiliar with the possibilities of space industrialization;

6. The overall objective of this effort should be the development of products that can be fully taken over by private enterprise;

7. The public should get a fair return for the investment of their tax dollars from successful ventures; and

8. Special encouragement should be given to the participation of highly innovative businesses and research organizations.

To summarize, the administration of this effort should have a centralized Federal focus with Federal financial support guaranteed in order to assure total coordination, including the ability to properly utilize and work with other Federal agencies.

Now, I would like to make some additional observations and recommendations concerning the proposed legislation.

1. We do not regard the current language covering the treatment of proprietary data as sufficient, particularly if the objective is to encourage the participation of private industry. We ask the committee in the strongest possible terms to establish the basic policy and guidelines and spell them out in the law. Sufficient flexibility can be provided as the committee has done in some of the energy R. & D. areas.

2. We do not believe that Federal facilities or agencies should compete for funds made available under this proposed program. We believe that the current NASA announcements of opportunity process provides an adequate and legitimate avenue for participation by these Federal agencies. If a commercially viable idea is developed by a Federal entity, there should be a method provided for transmitting this idea to the private sector for further development.

3. The Federal bureaucracy should be required to streamline its administrative process under this act. For example, specific time periods should be established for review of proposals. Time is money to the private sector and meaningful participation and cost effective project management will not occur unless predictability and accountability are delineated.

4. We encourage the committee to specifically address the question of the fate or disposition of proprietary data in an unsuccessful venture. While we agree that a full and complete report on all failures should be made, we also note that failure is not necessarily related to the value of a particular process or discovery used in the undertaking. Some procedure should be established that will permit a separate determination to be made regarding whether some parts of the project retain their proprietary value and should not be revealed. We recognize this is a very difficult area, but given the goals and objectives of the committee's proposal, we believe it must be addressed.

Finally, let me address the major point in the proposed bill H.R. 2337, that being the establishment of a space industrialization corporation. As I stated previously, we fully support your declaration that space industrialization should be a national policy and that such a policy will not be naturally accomplished in a timely manner without the direct support and financial assistance of the Federal Government. It is the execution of this policy which must now be considered and which, because a new Federal entity is proposed, might be considered controversial.

Let us recognize that in the past experiments performed on sounding rockets, Apollo, and Skylab have shown great promise. Let us further recognize that NASA programs planned for the next 5 years must continue in a systematic way to further explore these promises and establish the scientific and technical groundwork for space industrialization.

A new product development goes through these five phases: Conception, technological feasibility, engineering development, demonstration, and commercialization.

The existence of the proposed corporation might not guarantee that the necessary front-end work will be done. Currently TRW is developing R. & D. equipment which will be available in 1982-83 period for continuing the planned NASA programs. The 25 kilowatt power module which will make extended operations in space possible will not be available until the mideighties under the most optimistic predictions.

The establishment of the proposed corporation now could erect an impediment to the successful industrialization of space by ignoring one or more of the essential proven phases of product development.

It is for these reasons, I feel it might be more appropriate to establish the space industrialization charter within the NASA organization at this time.

There should be appointed an associate administrator for space industrialization and an inviolate budget should be established.

In addition, enabling legislation should be passed to provide for the subsequent establishment of a separate corporation at such time as it is determined by this committee that sufficient research and development has been done and sufficient facilities are available.

These steps would provide NASA with a mandate to focus its materials processing experiments toward establishing a basis for space industrialization while at the same time providing immediate access to the space transportation system.

Clearly, this committee faces a dilemma: How to accelerate the industrialization of space while maintaining an orderly progression of development.

I only can hope these comments on the proposed bill will be of value in your deliberations.

Thank you for the opportunity to present our views and let me add that, whatever mechanism you determine is best, the time is right to promote the acceleration of space industrialization and I applaud your efforts.

I would welcome any questions you may have for myself or Mr. Barter.

The CHAIRMAN. Dr. Thiel, thank you so much for your testimony. I don't know whether or not you have had an opportunity to review Dr. Froesch's testimony last month on this bill.

I wonder if you believe that the NASA joint endeavors as currently being formulated can adequately address the needs of the private sector?

Dr. THIEL. Yes; I have read Dr. Froesch's testimony, and I think the idea I have tried to express differs in several ways: (1) I think that we are promoting here the expression by Congress that space industrialization is a national policy, (2) the intent of your proposal to make special funds available for that national policy is significant and goes beyond Dr. Froesch's testimony, (3) when I express the opinion that at the present time the charter for the execution of such a national policy could be given to NASA, I also mean that a separate organization should be set up within NASA with a budget that could only be used to expedite and strengthen industrial participation in such a program, and (4) I seriously doubt that NASA's present funding of its MPS effort will achieve this goal expeditiously.

The CHAIRMAN. I notice with great interest that you suggested that NASA's role be expanded in space industrialization.

I was curious to know whether or not you saw conflicts in NASA serving the needs of industry in commercializing products and encouraging the tailoring of projects to accomplish that purpose as opposed to conducting basic research and developing materials to support NASA's programs?

Would there be emphasis and priority problems and would NASA's basic roles be diluted in that?

Dr. THIEL. First, NASA is in fact primed now to get industry involved. They are holding symposiums, giving lectures, et cetera; they are trying to arouse the interest of industry. Second, would this impair the basic charter of NASA? It might need an amendment to the Space Act, but what we envision is a part of NASA with a separate budget to foster a strong industry involvement. Such a setup could enhance NASA's role as a research organization with a better coupling to industrial needs and processes.

The CHAIRMAN. Doctor, would you submit for the benefit of the committee any language that you feel could improve or strengthen the treatment of the prior data that you expressed here?

Dr. THIEL. I will be glad to do that.

The CHAIRMAN. Thank you.

Mr. Winn, do you have questions?

Mr. WINN. Thank you, Mr. Chairman.

Dr. Thiel, Mr. Flippo covered the general thrust of the main question I wanted to ask you. I think you did a very thorough job of answering that.

I, too, was worried if it was incorporated in NASA that it might influence the integrity of the total NASA R. & D. program, or, financially it might be possible that it could overshadow the other programs that have already been started. But I think your answer has calmed some of those concerns and obviously you are concerned about the same things.

Dr. THIEL. Mr. Winn, I'd like to add another observation. As you recall from previous testimony, there are presently negotiations going on between NASA and an industrial company concerning an industry sponsored experiment for materials processing. The difficulties encountered in these negotiations might strongly suggest the need for an amendment to the Space Act—for NASA's basic charter.

Mr. WINN. I think it would almost be a "must."

I started to say on page 5 of your testimony you make four recommendations. The fourth recommendation was to establish some mechanism to define the project's success insofar as disposal of proprietary information.

Now, are you implying there should be some mechanism other than financial success to establish whether the data should be made public? I am not quite clear.

Dr. THIEL. The proposed bill states that if a company's program is accepted and obtains financial support and it proves to be unsuccessful, it is the obligation of the company to publish a full report about their work and the reason for the failure and no proprietary data or information could be withheld by that company. But even in unsuccessful ventures there might be some proprietary data of value to the company. All I intended to say was that there should be a recognition of

that possibility and a mechanism should be established to protect such proprietary data, provided the company is willing to share some of the financial assistance it obtained in the first place.

Mr. WINN. That is very helpful. In your connection in the scientific community and in private enterprise, could you give us your own personal ideas of what you think the attitudes are that prevail in the free enterprise system on the space industrialization corporation?

Dr. THIEL. Through my participation in a number of meetings of a private sector industrial committee—which I described in my prepared testimony—I have found that there is curiosity and expectation among nonaerospace companies about the potentials of space processing and industrialization. At the same time, I have seen no willingness by these companies to actively participate because of two factors: (1) the financial risk, and to a much lesser degree; (2) a sort of distrust of involving their own private research programs with Government bureaucracy.

Mr. WINN. I don't quite understand that last factor; the mistrust. The same industries don't seem to have too much mistrust if they want to get a Government contract. It does not seem to hold them back.

Dr. THIEL. Let me express it differently and let me emphasize that I am talking about a nonaerospace company spending its own high risk money now on some space research program, which might have some future commercial payoff. Dealing with a Federal agency in this case creates apprehensions of bureaucratic roadblocks which might stymie the best intentions. Further, keep in mind that the companies one would like to become involved are not very familiar with the space program and NASA.

Mr. WINN. It is more of a reservation than a mistrust?

Dr. THIEL. Yes, it is more of a reservation.

Mr. WINN. It is obvious that industry would like for the Government to put up the front money.

Dr. THIEL. That is right.

Mr. WINN. Thank you very much and thank you, Mr. Chairman.

The CHAIRMAN. I have one final question. To what extent do you feel that those associated companies that you are familiar with feel that the commercial sector should influence governmental research and development in the space process?

Dr. THIEL. As I stated before, during our first few meetings we got them acquainted with the MPS program of NASA as planned for the next 5 years. One of the comments we heard repeatedly was regret that, in their view, the NASA program is dominated by the academic world and industry sees no "access system" to influence it.

The CHAIRMAN. Thank you very much for your testimony.

The next witness is Dr. Gatos and we will be delighted to receive your testimony at this time.

STATEMENT OF DR. HARRY G. GATOS

Dr. GATOS. Thank you, Mr. Chairman.

Mr. Chairman, I am very pleased to appear before your subcommittee again to present my views on the opportunities for materials processing in space and for space industrialization.

I would like to state first the points which I will attempt to develop:

A. Materials processing in space offers a unique opportunity for advancing science and for developing materials to meet basic technological and societal needs;

B. The establishment of a space industrialization corporation in the context of bill H.R. 2337 is premature and potentially counterproductive; and

C. The existing organization within NASA provides the most promising nucleus for pursuing the necessary research and development to insure future space industrialization.

When I last appeared before this subcommittee about 2 years ago I discussed the results of our experiments in the Skylab mission and in the Apollo-Soyuz test project. On the basis of those results, which surpassed even our most optimistic expectations, I stated my conviction that near-zero gravity conditions provide great and unique opportunities for advancing our understanding of materials, for obtaining materials with vastly improved performance and for developing new materials for new applications. I still hold that conviction. We simply cannot have such opportunities on Earth. At that time I also pointed out, and I quote—

However, lest I project untimely optimism, I must assess the present status of space technology pertaining to materials processing. I must also consider present and near-future constraints relevant to space industrialization * * * .

It is axiomatic that modern industrialization must be preceded by essential evolutionary stages: a concept of a finding is born; it is then researched, analyzed, and developed to a level where its industrial potential can be assessed; subsequently it is brought into a pilot plant stage where systems and economic analysis can be carried out.

Although there are truly striking concepts and findings pointing to exciting opportunities for space industrialization, the research and development steps toward space industrialization are unfortunately at an embryonic stage. Our experience with materials processing in space is extremely limited. It is essentially confined to two experimentations—in Skylab and Apollo-Soyuz test project—performed under rather severe constraints necessitated by space, power, time, and other limitations. I believe it is far too premature to plan specific near-future space industrialization before further research and development on specific materials systems, apparatus, and instrumentation is carried out.

I still stand by that statement. There has been no additional experimental information from experiments carried out in space since 1975.

Although we have had no new results in the last few years, we have certainly advanced our thinking about materials processing in space. We have examined and reexamined the old results, and we have considered over and over the questions that these results have answered and the many more questions that they have raised. It has become very clear to me that near-zero gravity conditions cause many more effects beyond those that we originally anticipated. Thus, we were expecting that thermal convection in liquids would not be present in space, or at least not to the extent that it would have an adverse influence on the chemical homogeneity of the solids prepared from these liquids. We did indeed observe the elimination of the adverse effects of convection which are unavoidable on earth and which limit the application of materials to existing needs. At the same time we observed changes in structure and composition which are impossible to assess quantitatively and, more importantly, to identify their origin. Unless we do, we cannot possibly take advantage of the zero-gravity conditions for scientific benefits and practical applications.

In other words, the experiments in space can be viewed as a striking demonstration of our poor understanding at this time of the relationships between materials properties and processing parameters in general, and solidification parameters in particular. In addition, the analysis of these experiments pointed out the lack of methods and techniques for the quantitative characterization of the structural and chemical properties on a microscale. On Earth, materials processing is, to a large measure, guided by empiricism and trial and error. I cannot perceive an extension of such an approach to materials processing in space. It is too costly a compromise and, in many instances, not even viable.

The conclusion is irrefutable: Ground-based research relevant to space experimentation is the most critical prerequisite for a successful materials processing in space program. And for maximum efficiency we must direct our thinking toward assessing the nature and the extent of research on earth which is essential for optimizing work to be carried out in space. We must investigate the process parameters such as temperature, the chemical composition and their variations in the liquid, the physical and chemical properties of the liquids under solidification conditions, the rate of solidification, the liquid-container interactions, and the morphology of the solidifying front. Then we must develop a quantitative understanding of how these parameters relate to the resulting solids.

We do not have this kind of understanding, and neither do we have, for the most part, the methods and techniques for assessing the key properties of many solids on a microscale; we cannot rely on average values of properties obtained over a relatively large volume of the solid. I am pleased to acknowledge the fact that NASA is addressing ground-based research as an essential element in its materials processing in space program consistent with the convictions of the materials science and engineering community at large and the recommendation of the recent report of the Committee on Scientific and Technological Aspects of Materials Processing in Space, the Space Applications Board, of the National Research Council.

In this context I would like to point out that, about a month ago, I visited the Space Science Institute of the U.S.S.R. Academy of Science in Moscow. They have been carrying out in recent months, and still are, a number of experiments in space processing of materials on board the Salyut-6 station. In view of the difficulties they are encountering in analyzing the results of these experiments, they have independently reached the same conclusion: Extensive research, experimental and theoretical, must be carried out on the ground for meaningful experimentation in space.

Regarding space industrialization, conceptually it is inevitable. As a scientist and citizen, I am gratified that the Congress of the United States is dealing with it. I see its implementation, however, through the establishment of a Space Industrialization Corporation as untimely. Thus, I disagree with the findings and purposes stated in the bill, and in particular with the following, "space activities have matured to the point where the attributes of space are generally understood," and "the existence of effective opportunities to produce useful materials in space have been demonstrated on the Apollo, Skylab and Apollo-Soyuz flights." Space activities have not matured to the point

where the attributes of space are generally understood; the existence of effective opportunities to produce useful materials in space has not been demonstrated. In fact, I see some potential hazards in the bill. I will amplify:

1. The interest of the materials science and engineering community in space experimentation was very limited up until a few years ago. The potential of materials processing in Space was not fully appreciated for some time. I believe that this is no longer the case. In recent years there have been a number of studies organized, supported or encouraged by NASA. The community on materials science and engineering became heavily involved in advising NASA on its materials processing in space program. There is an International Committee on Space Applications sponsored by some of the international scientific unions. Materials processing in space is often included in the programs of professional technical societies. The U.S.S.R., an observer in the first stages of experimentation with materials processing in space, has become quite heavily involved since the Apollo-Soyuz test projects.

However, the scientific community at large waits to be convinced on a broad and conclusive basis that there are great and unique opportunities in processing materials in space. Until that time I do not believe that a significant segment of the scientific and engineering community will make any appreciable commitment to fundamental or applied studies relevant to processing of materials under zero-gravity conditions. Without such commitment I cannot even perceive realistically sound space industrialization. Industrialization models without a good science and engineering base will be, far more likely than not, wasteful and misleading. More importantly, they are bound to lead to failures with a crippling, if not devastating, impact on the evolution of space industrialization.

2. Thus far, industry—excluding aerospace organizations—has not been involved in materials processing in space. There have been some isolated cases; but even in those cases the involvement has been through a branch of the organization engaged in Government-sponsored rather than corporate-sponsored research and development. This is not at all surprising, if one considers the fact that, in recent years, even industry based on advanced technology has been making very limited commitments, if any, on long-range research and development. Accordingly, I do not believe that industry-generated and supported programs for space industrialization will be forthcoming in the foreseeable future.

On the other hand, NASA's recent efforts to devise mechanisms for working jointly with commercial interests towards identifying and exploring potential fields of space industrialization I find timely, realistic, and potentially very productive. Working with industry, NASA's program will acquire increased relevance; at the same time, industry at a reasonable risk will be provided with the possibility to explore firsthand space industrialization opportunities.

In summary, I view with enthusiasm the concept of space industrialization; however, I consider the establishment of a Space Industrialization Corporation as described in H.R. 2337 as premature and potentially counterproductive.

The CHAIRMAN. Thank you, Doctor, for your testimony. I wonder if you would describe for us the scale of funding levels of the Soviet

effort in processing information as compared to this Nation? Can you make a comparison for us?

Dr. GATOS. I can only speak in terms of men's involvement in the program as I do not have dollars or ruble figures.

The institute that I visited is a new large academy institute in which many hundreds of people are employed and in this particular department of space processing there are several hundred scientists working full time.

In addition, they have involved other academy institutes, and the numbers I am not familiar with.

Furthermore, they have involved other eastern European countries, and in particular Poland, Hungary, Czechoslovakia, East Germany, and France, which is not considered an eastern European country, that is the French experiment is right now under the Soyuz-6 program.

I would say the acceleration of the program in the U.S.S.R. has been far greater than ours in the last 5 years.

The CHAIRMAN. Doctor, what are some of the difficult selection criteria and techniques that can be applied to judge the readiness of materials science projects for development into useful products?

Dr. GATOS. The criteria are many. In some instances they are complex and in some instances they are not very precise. I believe that the first criteria is, "Whether the particular material or particular process is going to directly benefit by the absence of convection in Space," which is by far the most prominent or pronounced adverse effect that gravity has.

Another criteria would be whether containerless experimentation would benefit substantially this particular process, if, of course, possible in space.

Lastly, whether scientific phenomena and effects can better be observed once either the container or the convection are eliminated.

And ultimately, I believe what is the relevance to development of the technology.

The CHAIRMAN. Mr. Winn.

Mr. WINN. Thank you, Mr. Chairman.

Dr. Gatos, do you feel that there is any potential for cooperative effort with the U.S.S.R.? Have you come away from there with a feeling of that type?

Dr. GATOS. Yes, I have. On a scientific basis, I believe so.

I was given a clear message that the Research Institute is not only interested, but is anxious to interact with a counterpart working toward space processing in this country.

From such interaction or cooperation, I believe only benefits can be derived.

Mr. WINN. Was there any discussion when you were over there about space industrialization?

Dr. GATOS. No; we engaged in no particular discussion of that. It was only research experiments that we discussed.

Mr. WINN. On page 3 you said that the trial and error method for developing materials processing techniques would be largely eliminated in space because of the expense.

What level of expense would support the trial and error method?

Dr. GATOS. What I meant by that statement is that we must understand more the science of the processes that we are trying, rather than

attempt a process without understanding it at all. This is what I meant by that statement.

On earth this is done all the time by necessity. In space I would say it would be extremely expensive. In that we may be trying for a number of years on flights, trying to learn only through my mistakes rather than have a plan which is based on some understanding of science.

This is not to imply that we must understand everything there is to be understood before we undertake a risk, but I think at this time we understand so little that it is too premature to proceed with an industrialization model.

Mr. WINN. Do you think that the space shuttle operations will lower the cost sufficiently or are you referring to something like a heavy launch vehicle?

Dr. GATOS. I don't quite understand.

Mr. WINN. What I am trying to get into is, what your dividing line is on the expense because of your earlier statement about the trial and error method.

The space shuttle operations should lower the costs of the potential?

Dr. GATOS. That is correct. If you lower the cost to the point that a research experiment can be undertaken which is not totally and entirely science based; but when we are talking about an industrialization model, then we are talking not only about expense; we are talking about space, we are talking about a large-scale type of a model.

Mr. WINN. Yes; I notice we have a vote on, so we have asked this same question basically of the other witnesses, but as you know, NASA has been established as an R. & D. agency.

We referred to it several times. Do you feel the involvement of NASA in the manufacturing process will seriously hamper their R. & D. effort?

Dr. GATOS. I don't think so, because I perceive for some time to come NASA's involvement will be to demonstrate industrialization in space rather than undertake industrialization in space.

Mr. WINN. Do you think NASA has done a creditable job of trying to interest private industry?

Dr. GATOS. NASA has been in recent years trying very hard and many consider the job is indeed creditable.

I think the industry now is far more involved than it was, even on an advisory level. I am a member of a subcommittee that advises the materials processing space program and out of the six members three are from industry.

So, industry is becoming, not just interested, but actually is active in advising NASA and in examining the possibilities that we have in space.

I have a better feeling now than I did a few years ago.

Mr. WINN. I am very interested in that and basically what you are saying is what other witnesses said, "Advice is a lot cheaper than the front money."

Dr. GATOS. That is true.

Mr. WINN. Thank you very much and thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Dr. Gatos, and we stand adjourned until tomorrow in room 2325 in the Rayburn Building.

[Whereupon, the committee was recessed at 3:50 p.m., to reconvene on Wednesday, June 27, 1979.]

THE SPACE INDUSTRIALIZATION ACT OF 1979

WEDNESDAY JUNE 27, 1979

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10:10 a.m., in room 2325, Rayburn House Office Building, Hon. Ronnie G. Flipppo, presiding.

Mr. FLIPPO. The Subcommittee on Space Science and Applications will be in order.

We will go vote and come back and start the meeting.

[Rollcall recess.]

Mr. FLIPPO. The Subcommittee on Space Science and Applications will be in order.

This morning we conclude this series of hearings on the Space Industrialization Act of 1979, H.R. 2337.

The first witness is Dr. Joseph Roop, senior economist, representing Dr. Michael Evans, president of Evans Economics. We will have two other witnesses this morning and we will introduce them at that time.

STATEMENT OF DR. JOSEPH ROOP

Dr. Roop. Good morning. Our testimony today on the Space Industrialization Act of 1979 focuses on the economic rather than the technical, aspects of the Space Industrialization Corporation. My comments this morning present the major ideas contained in the testimony prepared by Richard K. Evans. For the development of these ideas, I refer you to the longer document. It is our view that one of the primary factors leading to the decline in productivity growth in the U.S. economy during the past decade has been the reduction in the proportion of resources devoted to R. & D., particularly at the Federal level.

It has long been established in economic theory that Government has a role in supporting R. & D. since private industry, left to the profit motive alone, will not engage in enough R. & D. activity. Exactly what is enough is difficult to say. But the events of the past decade clearly suggest that the Federal Government has not devoted adequate resources to R. & D. For this reason we support the Space Industrialization Act of 1979. We contend that Federal expenditures on this R. & D. will have substantial beneficial impacts on the performance of the economy.

In order to try and measure these results, we have in previous work calculated the relationship between R. & D. spending, productivity growth, and the performance of the economy. Today it seems

appropriate to present these results as an indication of how the spillover effects of basic R. & D. benefit the economy in ways which are not directly related to the original investment. For example, the NASA program for manned space flight is generally credited with the vast increase in miniturization, together with all of its benefits for improved productivity and reduced use of natural resources.

It is not possible, of course, to claim that the same benefits emanating from the NASA manned space flight program will accrue to the Space Industrialization Corporation. However, it is important to note the general economic effects of increased productivity and realize that many of the benefits are likely to range far beyond those directly associated with the development of new products, processes, and industries using the properties of the space environment.

In performing this study we have defined productivity as that increase in output which occurs after increases in factors of production have been taken into account; in other words, after the contributions of labor and capital have been considered. Thus it differs somewhat from the more common measure of output per employee-hour. This measure of productivity, often referred to as technological progress, is found to be related to NASA R. & D. spending, other R. & D. study, labor quality, index of capacity utilization, and change in industry mix. Our testimony focuses primarily on the effect of NASA R. & D. spending.

There have been two peak periods of technological growth during the past two decades: 1960-62 and 1970-72. It is no coincidence that these periods correspond, with the proper lag, to the large increase in R. & D. spending (a) following Sputnik and (b) associated with the Apollo expenditures of the mid-sixties to the late sixties.

We have used the results linking R. & D. spending and technological progress to determine how much higher real GNP would be as a result of increased NASA R. & D. spending during the past two decades.

To determine the relationship between R. & D. spending and GNP we need to undertake a two-step approach. First, we need to determine how much technological progress would have increased with higher R. & D. spending. Second, we need to translate this into an increase in real GNP.

Because of time lags, we would expect the increase in technical progress and hence in GNP to be zero for the first few years, increase rapidly for the next few years, and then level out.

To get the new level of technological progress, we must cumulate these figures over time. Thus the new level of technological progress following a \$1 billion increase in NASA R. & D. spending would be about 0.6 percent higher after the full effect was realized 7 years afterward.

We now translate these changes into increases in GNP. This translation requires two steps. The first one, which is relatively straightforward, consists of a direct conversion of changes in technological progress to changes in GNP on the supply side. The second step, which is much more complicated, involves the simulation of the macroeconomic model in order to determine the interactive and dynamic effects which higher levels of productivity have on prices, income, outputs, and em-

ployment. The actual change in GNP will be considerably larger once we include these dynamic effects.

We consider first the "pure" productivity effects. These do not include the demand effects of higher Government spending or the secondary effects in the overall economy stemming from an increase in real disposable income and hence greater consumer spending. These particular results reflect only the increase in the production possibility frontier which is made possible by increased levels of technology. We calculate that these pure productivity effects would add little to GNP until after the fifth year, when GNP increases about \$260 million. Thereafter the increase in GNP steadily rises, reaching \$4.3 billion after 10 years.

We now turn to a calculation of the change in GNP which would result per \$1 billion increase in NASA R. & D. spending. To prepare these results, we first simulated the CEAI macro model out 10 years under standard baseline assumptions. We then superimposed on this run a \$1 billion increase in NASA R. & D. spending. We have measured this \$1 billion increase in constant 1958 dollars, since all the calculations have been in terms of the real rate of increase in technological progress. We assume that NASA R. & D. spending is increased by this amount at the beginning of the first year of the simulation period and the incremental increase remains in force throughout the next decade.

In this simulation we did not assume that the \$1 billion increase in NASA R. & D. spending was offset by a decrease in any other Federal spending or an increase in taxes, so we have assumed the expansionary effect of deficit spending. After 4 years, Government receipts have increased by \$3.7 billion due to the higher level of economic activity, so the actual increase in the Federal budget deficit is only \$0.3 billion.

The demand multiplier effects which we have obtained are not markedly different than those which would have occurred for a similar increase in other purchases of goods and services by the Government sector or for release of funds to the private sector for construction projects. They are, however, substantially higher than the effects which would be obtained from a \$1 billion increase in transfer payments or decrease in taxes. A \$1 billion increase in NASA spending will have an immediate effect on real GNP, raising it approximately \$2.1 billion the first year and \$2.5 billion the second year.

Greater R. & D. spending leads to an increase in productivity, primarily in the manufacturing sector. As a result of this increase, less labor is needed per unit of output. This in turn lowers unit labor costs, which reduces pressure on prices. As prices grow at a less rapid rate, real disposable income of consumers increases at a faster rate. Consumers can then purchase a larger market basket of goods and services, which in turn are now available because the production possibility frontier has moved outward.

The actual simulation results indicate clearly that the demand elements predominate for the first 5 years. The major difference between this run and a typical multiplier analysis of Government spending is that prices do not rise at all. We do not see significant effects of increased technology on aggregate demand until the sixth year after original expenditures. During the first 5 years of the simulation, all this changes in the economy are rather modest.

Once the linkages from aggregate supply to aggregate demand have been established, after the fifth year, the difference in real growth between the two simulations begins to increase at a much more rapid rate. In particular, we find that the growth in real GNP is about \$4 billion per year faster than would be the case under the baseline simulation. Thus constant-dollar GNP is \$6 billion higher in year 6, \$10 billion in year 7, and reaches \$23 billion higher in year 10.

One does not need an econometric model to show that an increase in Government spending will raise GNP and lower unemployment. We learned many years ago that it is easy to spend our way out of a recession if no other constraints are involved. Yet saddled with double-digit inflation and an actual decline in labor productivity, it is clear that alternative policies must be examined not only from the point of view of their effect on demand and employment, but on the real growth rate and the rate of inflation as well.

NASA R. & D. spending increases the rate of technological change and reduces the rate of inflation for two reasons. First, in the short run, it redistributes demand in the direction of the high-technology industries, thus improving aggregate productivity in the economy.

Second, it expands the production possibility frontier of the economy by increasing the rate of technological progress. This improves labor productivity further, results in lower unit labor costs and hence a slower rate of inflation and more rapid rise in real disposable income, which, in turn, permits consumers to purchase the additional goods and services which are being produced.

Turning to the specific figures, a \$1 billion sustained increase in NASA R. & D. spending will raise real GNP \$23 billion 10 years hence, raise labor productivity by 2 percent and lower the level of the consumer price index by 2 percent. The unemployment rate will decline by 0.4 percent, and an additional 0.8 million new jobs will be created because of a more rapid expansion of the labor force. It should be noted that the demand component of increased spending results in only a \$2 billion increase in real GNP by the 10th year, while the remaining \$21 billion is due to the permanent improvement in the level of technology.

It is clear that the rates of productivity and technological change in the U.S. economy have diminished rapidly during the past decade. Per capita income in the United States has moved from a strong first to a weak fifth in the ranking among major nations, as the increase in productivity in the United States trails all of our major competitors, due in part to the reduction in relative R. & D. spending. While increases in virtually all types of Government spending raise aggregate demand and reduce unemployment, most public spending programs eventually add to inflationary pressures because they increase aggregate demand without raising aggregate supply. Increased spending for R. & D., such as the development of the Space Industrialization Corporation, expands the production possibility frontier of the economy by raising the rate of technological change, thus leading to a lower rate of inflation as well as higher output and employment.

Thank you.

Mr. FLIPPO. Thank you, Dr. Roop, for your testimony.

I wonder how you would compare the benefits to the national economy derived through the Space Industrialization Corporation mech-

anism as called for under the bill, how you would measure the benefits to the national economy to that approach as compared to increasing NASA's budget for the purpose of promoting space industrialization?

Dr. ROOP. I am not sure that the analysis on which this testimony is based would be able to distinguish between those two. To the extent that one promotes or induces more basic research than the other, there might be some slight difference. But the effects would not be terribly different.

Mr. FLIPPO. Table 6 in your written statement identifies changes in selected economic variables with a sustained increase in NASA R. & D. spending of \$1 billion per year.

How much difference would you expect in these numbers if spending was for material processing R. & D. for commercial purposes which presumably would have more direct industrial applications than NASA programs generally do?

Would you anticipate much difference?

Dr. ROOP. If you will look on page 8 of the prepared testimony, a response to your question can be gleaned from a survey done by McGraw-Hill that weighted businessman's response to how a change in basic applied or development type of research would have an effect on direct output or result in a change in production, and the weights we use at the bottom of that page.

As you can see from table 4, the weighted average of those responses is much longer for basic research than it is for applied research or development. But if the weights we use approximate—20-percent basic research, 50-percent development—there would be no difference.

My answer, again, suggests that materials research insofar as it is more applied, in the development area, would have a more immediate effect.

Mr. FLIPPO. I would like for you, if you could, to comment on the economic differences between the three approaches to this problem that they talk about before the committee, comparing the Space Industrialization Corporation mechanism with, say, tax credit approach for space industrialization investments and perhaps tax-free profits for a period of time on revenues from material processed in space.

We are really looking at corporation approach, tax credit approach and then specific revenue flow credits that might be available.

I noticed in your testimony that the tax credit approach seemed to have the least favorable multipliers.

Is that an accurate statement? Is that generally true would you think?

In your testimony I believe I recall reading on page 11, down at the bottom it says, "In particular we have found that the real multiplier is smallest and the increase in inflation is largest per unit change in transfer payments."

That is a little bit different.

Just above that you say, "* * * transfer of payments or decrease in taxes."

Dr. ROOP. The statement was directed at personal taxes rather than corporate taxes.

We do not regard a tax credit as a transfer in the sense we are talking about here. Insofar as that tax credit was designed to promote R. & D.

that the Space Industrialization Corporation does directly, they would partially substitute. Again, the effects would not be quite as dramatic because there is not the direct impact of Government expenditure in the first instance. Thus the multiplier effects would be somewhat smaller.

On the other hand, it may have a stronger effect over the long haul by improving technological progress, which ends up, by this testimony, being much stronger, in effect, over a longer time period than does the multiplier effect of the sustained increase of \$1 billion.

So, on balance I would say that the direct expenditure approach would probably have a slightly stronger effect, but if the technological effects were the same over 10 years, the results would be only marginally different, since the effects from a change in technology are largest.

Mr. FLIPPO. Do you believe H.R. 2337, the bill under consideration, can accomplish the purpose of accelerating commercialization of space?

Dr. ROOP. I do.

Mr. FLIPPO. Do you believe the commercialization should be accelerated or should normal forces affecting innovation and investment be allowed to take due course?

Perhaps you replied to that earlier in your testimony when you talked about the need to stimulate productivity.

Dr. ROOP. Because of the risk that any private enterprise would have to incur to be involved in this sort of thing directly, I would be in favor of the Space Industrialization Corporation funding. It would certainly speed up the process of technological development.

Mr. FLIPPO. Dr. Roop, we sincerely appreciate your testimony. I think it has been very helpful. We may ask if, with your permission, that we would be able to submit to you questions should Mr. Winn have questions or other members of the committee have additional questions, may we submit them to you for the record?

Dr. ROOP. Yes, sir.

Mr. FLIPPO. Thank you.

The second witness is Dr. Peter Vajk of Science Applications, Inc.

Dr. Vajk, it is a pleasure to have you with us. I am happy to have your testimony.

STATEMENT OF DR. PETER VAJK

Dr. VAJK. Communications satellites are accepted today as a virtually "traditional" sector of the global economic system. It is difficult to recall the struggle of the early 1960's to devise new institutional arrangements to encourage the development of a global communications satellite system at a time when we could see the technological feasibility and social desirability of deploying such a system. In 1963, Congress enacted the communications satellite bill which created Comsat; and 2 short years later, the first commercial satellite, Early Bird, was launched, initiating private sector involvement in outer space on a profitmaking basis for the benefit of humanity.

Today we are struggling with the next step in the economic use of the environment of outer space as we stand on the verge of Space

Shuttle operations and consider the possibilities of manufacturing products in orbit. From a technical point of view, we realize that the environment of low-Earth orbit offers some unique advantages, including weightlessness, ultrahigh vacuum, biological isolation, a wide range of temperatures, and a wide range of radiation environments. These can be exploited in new processes for converting a variety of raw materials into finished products of high intrinsic value per pound.

Among the hundred of specific possibilities considered thus far, and the thousands yet to be considered, it seems reasonable to expect that some will provide to be commercially successful, providing new products, superior products, or less expensive products than we can manufacture here on the ground for specific industrial, scientific, medical, recreational, military, or consumer purposes.

The key question which the space industrialization bill of 1979, H.R. 2337, attempts to answer is, what kinds of new institutional arrangements can most rapidly and effectively bring the results of Government-funded space research into commercial use, reaping the economic benefits of that research? It is evident from the interest of this subcommittee in this subject that the members of the subcommittee and its staff appreciate the key role of technological innovation in the health and growth of the economy. The postwar economic successes of countries such as Sweden and Japan have been predicated upon vigorous encouragement of technological innovation by deliberate Government policy. For whatever reasons, the United States has not chosen to follow that path, and our leadership and economic advantage in a number of high technologies has slipped so far that inflationary protective tariffs have been proposed to protect our domestic manufacturers; in some cases, such as color television sets, from the reduced costs produced by vigorous innovation abroad.

As an advocate of large-scale extension of human civilization and human affairs into outer space, I am delighted that this subcommittee considers the question of exploiting our technological capabilities in space an urgent matter. My own impression from giving dozens of lectures to civic group, college, high school, and elementary school audiences over the last 4 years is that the grassroots will vigorously support a space program geared to pragmatic, profitable ventures with visible and prompt benefits to people on Earth. Scientific exploration of the solar system and of the universe from space-based observatories are also of interest, but these would be far more acceptable in the presence of a vigorous program designed to exploit our capabilities, experience, and know-how in space. The space industrialization bill under consideration here is a valuable step toward this goal, and I sincerely hope that such a bill be enacted into law in the near future.

I would now like to offer some criticisms of the bill as presently drafted in the hope that some modification will improve and accelerate the desired effects of the bill.

In designing a new institutional arrangement, we must be very careful to design it for success. To do that, it is necessary to consider very carefully a long string of "What if—" cases to determine whether or not the proposed scheme will, in fact, discourage failures, inhibit cheating, and reward success.

A beautiful example of this type of analysis is "The Federalist Papers" written by several of the architects of the U.S. Constitution. Their analysis, which examined in detail how the self-serving interests of less-than-perfect politicians, judges, legislators, States, and factions could lead to various failures of the whole system, resulted in the exquisite system of check and balances which have served this Nation so well for so long.

Let me give one brief example—perhaps controversial—of a system which at the present time appears to be designed for failure rather than success. Many critics, including such respected economists as Nobel Laureate Milton Friedman, have described the present Federal policy toward energy as just such a design for failure. In a nutshell, the worse the energy crisis gets, the more successful the Department of Energy becomes—its appropriations, staff, and regulatory power grow ever larger the further away the Department of Energy brings us from a viable solution to providing the energy we need and want. Should the Department of Energy somehow find a breakthrough solution to the problem, its survival as an entrenched bureaucracy would be severely threatened. Although all its employees may have the best of intentions and may strive sincerely to solve the energy problem, yet the system is designed to reward failure, not success.

My concern here is that the Space Industrialization Corporation as established in the present draft of H.R. 2337 may in part be designed for failure rather than success. To illustrate this concern, I want to digress briefly into a consideration of business investment risks. At the present time, space manufacturing is generally perceived by U.S. industry to be "too risky." It is the legitimate aim of the present bill to reduce that risk and thus to stimulate entry of the private sector into this new field of commercial activity.

As in gambling, risk assessment in the business community must consider two factors: (1) How much can we afford to lose? (2) On a probabilistic basis, what is our expected gain or loss from this particular investment option? If I wager \$1 on some particular number in a roulette game in which the wheel carries the numbers 1 through 36, zero and double zero, I have 1 chance in 38 that my number will win, and 37 chances in 38 that I will lose. If the payoff for winning is 38 to 1, then my expected winnings are exactly zero, and the game is balanced evenly between the bettor and the house. I have a $\frac{37}{38}$ chance of losing my \$1, and the house has $\frac{1}{38}$ chance of losing \$37. The bet is "fair," but I dare not bet more money than I can afford to lose completely, no matter how fair the bet may be.

Now consider the opportunity for a company to invest in R. & D. to develop a new technology to the point of commercial profitability. Suppose market research shows that the company could earn \$50 million if the venture succeeds. Suppose the chances of success are estimated—strictly on an intuitive or "hunch" basis, that is all you really have—to be one chance in five. On that basis, the company would still break even on an expected winnings basis if it had invested \$10 million in the R. & D. program. I am deliberately ignoring such subtleties as interest costs and taxes to keep the basic argument simple. A prudent investor would require that the R. & D. budget be somewhat less than \$10 million or that the prospective earnings be somewhat greater than

\$50 million before making the investment in order to end up better than even, that is, to end up with a profit, a positive return on investment. The investor would also check the overall financial condition of the company to determine whether or not the company could afford to lose completely the funds invested.

If we now contemplate an investment in a new, untried process for the manufacture in orbit of a new or improved or reduced-cost product, we must ask the same questions. How much can we afford to lose completely? What do we expect to gain from the investment, weighing the chances of success against the chances of failure?

In the present environment, space manufacturing is generally perceived as "too risky." The common perception in business and industry today is that the development costs for space manufacturing would necessarily involve millions of dollars of investment before any chance of economic returns in a period of many years, and this sum is in many cases more than medium-sized corporations are willing to lose, no matter how large the payoff may be. Yet a series of well-conceived experiments to develop and test some space manufacturing processes for products of high intrinsic value could be carried through for as little as \$500,000 to \$1 million, particularly if the redtape requirements of NASA could be reduced.

As an example, space jewelry is a product which could be manufactured in the early stages of the Space Shuttle at relatively low cost using, if NASA permitted, the "Get Away Specials" for strictly commercial ventures with little intrinsic scientific merit.

Suppose, however, that a medium- to large-size corporation did invest the necessary funds to bring a space product to commercialization. Unless the product were totally new—implying much higher risks of market acceptance as well as of technical development—the economic returns would be modest because of present tax laws. Thus the returns would be no higher than those of conventional, tested, Earth-made goods. In this context, given the higher uncertainties of the R. & D. phase, any prudent investor would rather put his or her money into a more conventional investment.

The proposed legislation under discussion here today approaches the problem of risk strictly from the viewpoint of reducing the costs of failure, by forgiving the full amount of a "loan" from the Space Industrialization Corporation. I believe this is a serious flaw; it rewards failure of the R. & D. program by removing the pain of failure, but provides no rewards, over and above those modest returns of any conventional manufacturing enterprise, for a successful effort.

Moreover, this approach encourages cheating, especially by smaller companies. Suppose a small company were formed for the primary purpose of carrying out some space manufacturing activities on a commercially profitable basis, and suppose this company received a loan from SIC in the amount of several million dollars. Suppose that halfway through the planned R. & D. phase this company realized that the project would result in a fantastic new product which will earn millions and millions of dollars within just a few years.

The temptation would be very strong to begin at this point to maintain two sets of books on the progress of the work, especially with respect to flight experiments. In one set, the true results and progress

of the work would be recorded, analyzed, and elaborated. In the other set, forged results would show—during the next 40 percent of the total funding available—ambiguous results gradually dwindling down to a dead-end failure. Under the terms of the loan from SIC, the remainder of the funding would be canceled, and the company's only obligation would be to document the "failure," and the loan would be forgiven. Soon thereafter, the company could dissolve completely, and the principals in the company, possessing highly valuable trade secrets, could form a new company which completes the necessary R. & D. from entirely private funding to go into business manufacturing the end product in space, without the inconvenience of sharing their secrets with anyone else or the inconvenience of repaying a loan of several million dollars.

This is not to suggest that the private sector is dishonest; but I think it is most unwise to create an institutional arrangement which rewards failure and provides incentives for cheating.

How could we turn the process around to reward success instead of failure and to stimulate entry into space manufacturing? First we should note that small companies characteristically are more willing to invest in risky ventures than are giant corporations. If a small company makes unwise investments, it can always file for bankruptcy; a large corporation which loses several tens of millions of dollars will survive and have to face its irate stockholders at the next annual meeting.

Mr. FLIPPO. May I interrupt you one moment. I must go to the Chambers for a vote.

[Rollcall recess.]

Mr. FLIPPO. I am sorry for the interruption. Would you please proceed.

Dr. VAJIK. If the Space Industrialization Corporation has an annual budget of \$50 million initially, it would be reasonable to expect that most of its grants will fall between \$0.5 and \$5 million. On this scale, most of the awards would go to small- or medium-sized companies; a few might go to giants of industry, but these are unlikely to be interested unless the prospective earnings in the event of success are much greater than for conventional alternative investments.

Suppose, then, that SIC loans were required to be repaid in all cases, preserving some of the pain of failure. That pain could be reduced somewhat by providing the loans at low interest rates with long periods allowed for repayment. Large companies would find such financing of the R. & D. costs appealing; small investors would be sheltered from total failure by the bankruptcy laws just as effectively as if the SIC totally forgave the debt. Yet the incentives for cheating would be largely eliminated.

To encourage success, suppose all revenues from space manufacturing operations were granted tax-free status for, say, 10 years beginning from the date of the first operational Space Shuttle flight, and 75 percent exemption for the next 5 years, et cetera. The profitability of space ventures would immediately be more than doubled in view of the 46-percent corporate profits tax, encouraging participation by all sizes of companies. The limitation of 10 years, say, before the extent

of tax forgiveness were reduced would encourage early entry into the market in order to maximize gains before taxation is phased in.

Some might argue that exempting profits from space ventures provides an indirect subsidy to industry at the expense of other taxpayers. I would suggest that this is not the case at all, because if no incentives were provided for space manufacturing, no profits or jobs in this field would materialize either. Profits and jobs resulting from successful space ventures would be additions to the economic base; to refrain from taxing these profits, at least in the early stages, would not take away tax revenues since there would otherwise be no profits to tax.

As an example I would like to point out that the Republic of Ireland for a period of more than 10 years has been providing a tax holiday to new industry coming into the country from abroad and this has been very successful in stimulating the economy of that country.

What should the role of the Space Industrialization Corporation be if we reward success as I have suggested above? SIC should still, I believe, provide "seed money" for the development of space manufacturing processes, with low interest rates in the event of failure and normal interest rates in the event of success. Besides financing the technological R. & D. effort, however, SIC can contribute to risk reduction by funding careful market surveys to determine the scale of earnings to be expected if the R. & D. effort succeeds. Uncertainty about the anticipated revenues in the event of success is a major factor in the present assessment of space manufacturing as "too risky."

I believe that SIC would be most effective in carrying out the purpose of the bill if it were required to award 90 percent of its funding to private companies, with no more than 10 percent spent in-house for administrative costs, project review and coordination, and R. & D. These are about the proportions that were used in the Apollo program very successfully.

In order to improve the efficiency of the organization, its employees should not be included in the Civil Service System, especially in view of the intent to move the Corporation out of the Federal Government and into the private sector after a few years. In order to minimize the problems of entrenched bureaucracies, a "sunset" clause should be added to the bill, terminating the Space Industrialization Corporation not more than 20 years after its formation.

In order to allow space industrialization to grow as rapidly as it can, without ceilings imposed by politically determined appropriations and impoundments, I believe it would be most desirable to authorize the Space Industrialization Corporation to issue long-term "space bonds" backed by the full faith and credit of the U.S. Treasury. Given the requirement of full repayment of SIC loans, and given reasonable judgment by SIC in the selection of its investments, the actual subsidy involved in the form of loan defaults would be quite modest. Once SIC has moved over into the private sector, it could continue to obtain funding by selling corporate bonds in the same manner, albeit without Federal subsidy.

I hope these remarks will prove helpful to the subcommittee. I am most concerned that, whatever institutional arrangement results from these considerations, it should be designed for success from the very

start. I further hope that increasing the benefits of success will be considered a more desirable way to reduce risks than merely decreasing the pain of failure. Pain is valuable, and should not always be anesthetized. Positive incentives, I believe, will insure the success of space industrialization.

Mr. FLIPPO. Doctor, I want to thank you for your testimony. It is certainly thought provoking and I think contributes a great deal to the deliberations of this committee and will add significantly to our report. The authors of this legislation did not intend that this legislation be offered as being perfect in every respect, but as a method of stimulating debate and interest, and you have been constructive in your criticisms of it, and your testimony is much appreciated.

I wonder to what extent do you believe income tax credits can be utilized to accelerate space industrialization?

Do you believe smaller firms with less taxes to write off against could be competitive under such tax treatment?

Dr. VAJK. I am generally opposed to the idea of tax credit, if you mean that in the sense of the investment tax credit, because that does constitute, in fact, a subsidy and a distortion of normal economic processes.

I would much prefer the idea of leaving profits untaxed in the corporate sector in space activities. That, I think, would provide major incentives for both small and large corporations.

Mr. FLIPPO. You indicate that the Space Industrialization Corporation approach can reward failure by reducing the cost of failure.

Wouldn't a firm in failing to achieve the profits of success perceive this as failure, particularly in an environment of competing interests for SIC support?

Dr. VAJK. Yes; but the point is that investments in the private sector are never made unless the company is willing to face the possibility of losing completely everything they have invested.

In that sense, if you remove that sting of losing the money you have put into it, you just remove the incentive for striving very hard to succeed.

Mr. FLIPPO. I find your suggestions for a period of tax-free profits from space manufacturing very interesting. Obviously you believe these will be much more effective than the direct income tax credits for stimulating space industrialization.

Dr. VAJK. Yes, because you are, in effect, more than doubling the return on investment.

Mr. FLIPPO. You mentioned Ireland's tax-free attraction. I assume they continue to provide services to the industry. Is that not eroding their tax base of the future?

Dr. VAJK. To the best of my knowledge, it is not, because Ireland has been over the last century or so a country of severe unemployment. The tax benefits of bringing in industry from abroad, new factories, new jobs, far outweigh the minimum services that the Government has been providing to companies. The policy has, moreover, significantly improved Ireland's trade balance.

Mr. FLIPPO. Dr. Vajk, I appreciate very much your testimony. Thank you for being with us today.

Our final witness is Mr. Russell Carson with Welsh, Carson, Anderson and Co. Mr. Carson, I appreciate your joining us today and I regret the delay. We will be happy to receive your testimony.

STATEMENT OF RUSSELL CARSON

Mr. CARSON. Thank you. My name is Russell L. Carson and I am a general partner of Welsh, Carson, Anderson and Co., which is a \$30 million limited partnership formed in 1979 for the purpose of venture capital investing. Prior to the formation of my present activity, I was chief executive officer of Citicorp Venture Capital, a wholly-owned subsidiary of Citicorp and one of the largest venture capital organizations in the country. Since 1975 I have been also a member of the board of directors and membership chairman of the National Venture Capital Association, a trade association representing most of the organized venture capital firms in the country.

My own experience in, and knowledge of, the industrialization of space is extremely limited. I view my role today as one of advising you, from my experience in venture capital investing, of the likely role of the private, risk-oriented financial sector of the economy in financing the commercialization of space.

In my brief remarks I will stress two points: (1) the amount of nonindustrial venture capital in this country is very small relative to the enormity of space industrialization and, (2) the long lead times involved in space industrialization do not match the timing requirements of most venture capital funds.

The venture capital industry in the United States has existed in a meaningful way for about 20 years. During that period of time it has been instrumental in providing startup and growth capital to most of this country's successful new high technology companies. Digital Equipment, Teledyne, Intel, Control Data, and Amdahl Computer are all examples of today's large companies that were started by the venture capital process.

In spite of a history of successes, however, the venture capital industry is a relatively small one. There are perhaps 100 organized firms that could be described as being in the venture capital business on a full-time basis. These firms, which include limited partnerships, business development corporations, small business investment companies, bank subsidiaries, private families, and subsidiaries of industrial corporations, have total assets of approximately \$3 billion. Annual investment activity of the industry is \$250 to \$500 million and of the typical firm is in the range of \$2 million to \$10 million.

Because of the high risks involved, individual firms will rarely put more than \$1 million into a single venture and syndications of venture firms will rarely put up more than \$10 million. These figures appear almost insignificant in the face of the billions of dollars required for space research.

A second major impediment to the meaningful participation of the venture capital industry in financing the commercialization of space is the structure of the industry. The majority of the venture capital firms are, like mine, set up as limited partnerships which typically have 10-year lives. Managements of these partnerships as a rule must invest all

of the partnership assets within 3 to 5 years and then attempt to turn the assets back into cash by the end of the 10th year for distribution to the partnership's investors.

As a result, management has to seek investments which have a 3- to 7-year maturity cycle and can achieve revenue and profit levels sufficient to attract either a public market or merger with a larger company. This investment profile would appear to be inconsistent with a long-term program such as space industrialization.

My conclusion would be that there is no primary role for the private venture capital community in financing the industrialization of space. The only role that I can foresee for smaller, venture-backed companies, is to act as subcontractors to large industrial corporations which have the resources and the longer term view necessary to take on such a massive project.

I read the provisions of H.R. 2337 with interest. The bill appears to do a very good job of addressing the need to encourage the development of American technology in an area of great promise. It recognizes the difficulty of exploiting this area solely with private sector dollars and strikes a good balance between Government funding and industry management.

I enjoyed having the opportunity to appear here today and hope that my remarks have been of some help to you.

Mr. FLIPPO. Mr. Carson, I am certain that they will be of some help to us. And I appreciate your viewpoint and particularly with regard to the background and the experience that you bring to us, your perspective is very important.

I wonder, do you believe it is proper for Government to get into the venture capital business?

Mr. CARSON. I think to the extent the private community is unable to undertake a project which has national significance, that it is an appropriate role for the Government to play.

The small business investment company program was an area where the Government effectively got into the venture capital business to provide dollars that otherwise would not have been available.

Mr. FLIPPO. Since governmental role in promoting the national interest can be inconsistent with individual corporate economic return on investment, do you see any conflict in this regard with the Space Industrialization Corporation?

Mr. CARSON. I think there is some conflict. I think you have the issue of a long-term program where someone is really going to lose if the program is unsuccessful. One can argue because of the national significance a program like this that the Government should share in footing the bill on the downside as opposed to having the private industry bear that responsibility totally.

Mr. FLIPPO. Would small companies have to be subcontracted to large corporations before proceeding on a project, or could they expect to get a significant return from selling whatever proprietary rights they might earn in a project conducted by themselves with the aid of the Space Industrialization Corporation?

Mr. CARSON. I guess the one perspective I don't have is, really, the magnitude of dollars that it is going to take to undertake some of these programs. My guess is you are talking about a program where the

companies need to be in a position to put up \$25-\$50 million over a period of time, and I can't see a small company being able to come up with that much capital and take that much risk. Somebody is going to be the coordinator of these projects. I don't think the small companies are likely to be the coordinators; I think it is more likely they will fill roles in the overall contacts of the big companies.

Mr. FLIPPO. You mentioned on page 2 that the venture capital industry has been instrumental in providing startup and growth capital to most of this country's successful new high technology companies. And on page 3 you state that as a general rule investments must have a 3- to 7-year maturity cycle.

Is that 3- to 7-year maturity cycle related to the tax code that we have?

Mr. CARSON. No; it really is related to the nature of the investors in venture capital funds who typically—either institutional investors or corporate investors—who want to see a return on their money within a reasonable period of time and want to see the ability to get all their capital back within a finite period which typically is 10 years.

The maturity cycle that I defined would basically be the amount of time for a company to get to where you have alternatives to turn your investment into cash.

You have to develop meaningful revenues and profits within that time frame.

Mr. FLIPPO. Mr. Carson, I hope you will continue to follow the activities of the space industrialization. We look forward to your comments in the future.

With your permission, should Mr. Winn or other members of the committee have any questions for you, we would like the opportunity to present these questions to you.

The subcommittee will stand adjourned until 9 a.m. tomorrow where we will take up Shuttle review.

[Whereupon, at 11:30 a.m. the subcommittee adjourned.]

APPENDIX

ADDITIONAL MATERIAL FOR THE RECORD



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COMPARATIVE ANALYSIS OF THE PROPOSED SPACE INDUSTRIALIZATION
CORPORATION WITH SELECTED GOVERNMENT CORPORATIONS AND
GOVERNMENT SPONSORED ENTERPRISES

Susan Schjelderup
Senior Reference Assistant
Government Division
June 12, 1979



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COMPARATIVE ANALYSIS OF THE PROPOSED SPACE INDUSTRIALIZATION
CORPORATION WITH SELECTED GOVERNMENT CORPORATIONS AND GOVERNMENT
SPONSORED ENTERPRISES: A SUMMARY

This report compares a proposed Space Industrialization Corporation (as provided in H.R. 2337, 96th Congress, 1st session) with selected government corporations and government sponsored enterprises in terms of their mission, as stated in the enabling legislation; rationale for incorporation rather than creation as a Federal agency; statutory coverage; accountability to Congress and the President; corporate powers; corporate structure; financial structure; and performance evaluation criteria.

Part I of this report discusses considerations involved in defining the status of government corporations in relation to the Federal Government and non-Federal entities, outlines their formal powers, and summarizes some of the financial controls exercised by Congress regarding them. Part II assesses the structure and operations of the Tennessee Valley Authority (a wholly owned government corporation), the proposed Space Industrialization Corporation (a mixed ownership corporation that subsequently would become a private corporation), the Corporation for Public Broadcasting (a non-profit enterprise), and the Communications Satellite Corporation (a for profit public enterprise). Part III compares the proposed Space Industrialization Corporation

ii.

with the selected corporations for purposes of identifying characteristics it shares with wholly owned corporations, mixed ownership corporations, or government sponsored enterprises.

Congress has enacted no law setting out the general powers, functions, duties or legal status of government corporations, other than the Government Corporation Control Act (59 Stat. 597, 31 U.S.C. 841 et seq., December 5, 1945). That Act requires certain government corporations to submit financial reports to Congress. Because there is no comprehensive "government corporation law," the organic authority and charter of each government corporation and each government sponsored enterprise provides its legal authority and stipulates its legal responsibilities. Therefore, each government corporation and government sponsored enterprise is a hybrid of organizational structure, powers and responsibilities.

This report finds (1), that the proposed Space Industrialization Corporation is unusual in that it is designed to begin its corporate existence as a mixed ownership corporation, and that when its Board of Directors has determined that it can be financially self sufficient, it would change its status to that of a private corporation. Other government sponsored private corporations, or "public enterprises," such as the Federal National Mortgage Association (Fannie Mae), have made a transition from government corporation to private corporation after many years and statutory transfers.

iii.

In addition, (2) unlike the wholly owned government corporation, most of which were created in times of national economic emergency, the proposed Space Industrialization Corporation, similar to other mixed ownership corporations, would be created to establish a commercial line of credit to assist a private sector industry whose financial needs are declared to be in the national interest.

Further, (3) as a mixed ownership corporation subject to the Government Corporation Control Act, the proposed Space Industrialization Corporation would be required to undergo a regular audit by the General Accounting Office. Unlike some mixed ownership corporations, however, the proposed Space Industrialization Corporation would be required to submit annually a detailed report of its financial operations to the President and Congress. After its transfer to private corporation status, the Space Industrialization Corporation would be subject to the District of Columbia Business Corporation Act and to Federal and State taxes.

Finally, (4) to carry out its mission of facilitating the transfer of space technology to practical applications, the Corporation initially would be authorized specific powers similar to those exercised by most government corporations. When the Corporation becomes a private corporation, its corporate powers and duties would derive, in part, from the District of Columbia Business Corporation Act.

iv.

As in the case of most mixed ownership corporations, the proposed Space Industrialization Corporation would be managed by a Board of Directors. For the first two years its finances would be supplied by Congressional appropriations, and afterwards appropriations would be provided as necessary. After the Board's proclamation that the corporation could be self-sustaining, all finances would be provided through the sale of common stock. As a private corporation, the proposed Space Industrialization Corporation could evaluate its performance on the basis of its earnings, expressed as a percentage of assets, as growth in earnings from year to year, or as earnings per share over time.

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I. INTRODUCTION TO GOVERNMENT CORPORATION

History

A "government corporation," in the Federal context, is a corporate entity chartered by the Federal Government with powers, authorities, obligations and legal status determined solely by the provisions of its enabling legislation and charter.

The term has been "applied to corporate bodies formed on the initiative of the Federal (or a State) government in which the governmental body owns some or all of the proprietary interest. Such corporations have been chartered in a variety of ways. They have been established, for example, by special statute and under general laws; they have been created by executive orders and by government employees acting in their official capacities or, occasionally, as private individuals. They have been financed by outright grants of government funds, by annual appropriations, by government purchase of the stock and/or bonds of the corporation, by public subscription to some part of the corporation securities, and by other means. They have been chartered both for charitable ends and for financial purposes." ^{1/}

The history of the early use of government corporations indicates that they were often the products of emergencies.

"The major objective in the creation of most government corporations has been to carry out, under emergency conditions, functions of a commercial nature clothed with a public concern...Wartime corporations [such

^{1/} Livingston, Helen. Government Corporation: Their Purpose, History and Present Organizations. Congressional Research Service typed report. May 4, 1949. See also Robert Poling. Congressional Research Service. Corporations Chartered by Act of Congress. CRS Multilith 73-31A. January 5, 1973.

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as the U.S. Grain Corporation, the U.S. Housing Corporation, the U.S. Sugar Equalization Board, the War Finance Corporation, the War Trade Board of the U.S. Russian Bureau, Inc., the U.S. Spruce Corporation and the Emergency Fleet corporation, all formed during World War I], after serving their purpose, have usually been liquidated in due course. Corporations brought forth by economic emergency, however, have not so uniformly moved through such a life cycle. In some instances the economic emergency caused the formation of corporations that survived to perform functions of lasting importance. Thus the Federal Deposit Insurance Corporation emerged from the banking crisis of the thirties as a permanent institution. 2/

Government Corporation Control Act

The proliferation of government corporations during the Great Depression and World War II, as well as the lack of uniform procedures of accountability for appropriations they received, prompted the adoption of the Government Corporation Control Act (59 Stat. 597, 31 U.S.C. 841) in 1945. According to the Congressional pronouncement on the statute:

In the case of many government corporations, the Congress has not adequately exercised its power to control public expenditures. This bill is designed to bring government corporations and their transactions and operations under annual scrutiny by the Congress and provide current financial control thereof through the regular fiscal agencies of the government. 3/

2/ Marx, Fritz Morstein. Elements of Public Administration. Englewood Cliffs, Prentice-Hall, Inc., 1959, p. 224-5.

3/ U.S. Congress. House. Committee on Expenditures in the Executive Departments. Providing for the Financial Control of Government Corporations. Report to accompany H.R. 3660. (79th Congress, 1st session) July 5, 1945. Report No. 856. p. 4.

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The Act provides two main control mechanisms: 1) a business-type budget, and 2) an audit of financial transactions by G.A.O.

Section 102 of the Act states that the budget is to contain

estimates of the financial condition and operations of the corporation for the current and ensuing fiscal years and the actual condition and results of operation for the last completed fiscal year. Such budget program shall include a statement of financial condition, a statement of income and expense, an analysis of surplus or deficit, a statement of sources and application of funds, and such other supplementary statements and information as are necessary or desirable to make known the financial condition and operations by major types of activities, together with estimates of administrative expenses, estimates of borrowings, and estimates of the amount of Government capital funds which shall be returned to the Treasury during the fiscal year or the appropriations required to provide for the restoration of capital impairments.

Section 105 of the Act describes the features of the audit to be conducted annually by G.A.O. and states that the audit shall be "in accordance with the principles and procedures applicable to commercial corporate transactions and under such rules and regulations as may be prescribed by the Comptroller General of the United States." The Act also provides for such additional control mechanisms as requiring the banking and checking accounts of certain government corporations to be maintained by the Secretary of the Treasury or other fiscal agent of the United States (Section 302), and requiring the bonds, notes or other obligations issued by certain government corporations to be "issued in such forms and denominations

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. . . in such manner and at such times and sold at such prices as may be approved by the Secretary of the Treasury" (Section 303). Because many government corporations have been established under the laws of the States and the District of Columbia, their charters had escaped the scrutiny of Congress. The Act thus requires all government corporations serving as agencies or instrumentalities of the Federal government to be chartered by Act of Congress. The Act originally required the liquidation of all wholly owned government corporations by June 30, 1948, and provides for their re-incorporation by Act of Congress.

While the Government Corporation Control Act distinguishes between "wholly owned government corporations" (31 U.S.C. 846) and "mixed ownership corporations," (31 U.S.C. 856) it does so by merely identifying specific corporations for each category. In terms of a general distinction, however, it is noted that wholly owned government corporations are required to submit a business-type budget and to undergo an audit by G.A.O. every three years; 4/ mixed ownership corporations are not required to submit a budget, but still must undergo the G.A.O. audit every three years.

4/ The annual audit required of wholly owned and mixed ownership corporations by the Government Corporation Control Act of 1945 was replaced by an audit to be made every three years, pursuant to P.L. 93-604 (88 Stat. 1962, January 2, 1975).

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Not all government corporations are subject to the Government Corporation Control Act. By 1974, there were at least 345 government corporations chartered by Congress. ^{5/} Diagram 1 provides some examples of corporations authorized under Federal law and illustrates their relationship to the Government Corporation Control Act.

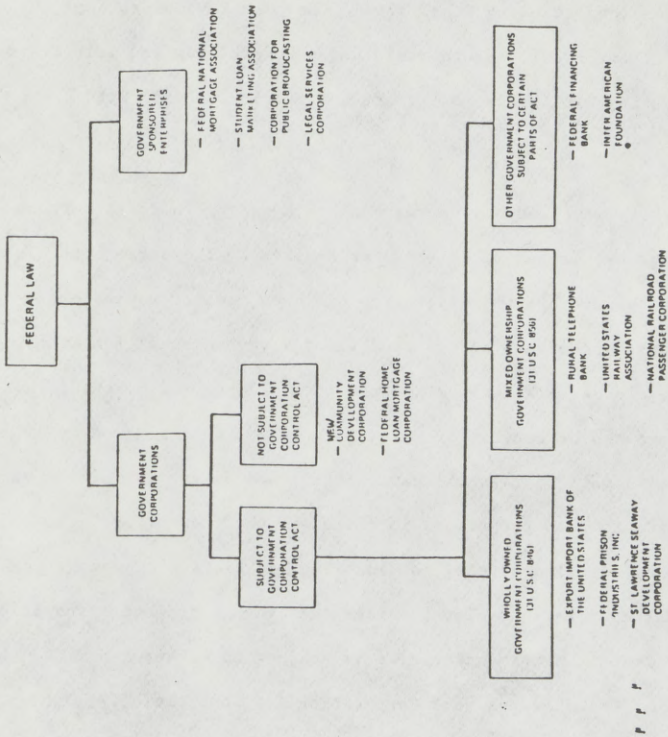
Powers

A review of corporations carrying on some governmental purpose and having some financial interest maintained by the Government indicates that each such corporation has been created separately with specific powers to carry on designated governmental functions. Most Federal charters include the power to: 1) sue and be sued; 2) contract and be contracted with; 3) acquire, hold and convey property; 4) make by-laws; 5) have a seal; and 6) appoint officers.

In addition to the powers specified in their enabling legislation and Federal charters, the enabling legislation of many recent government corporations also provides that the government corporation or government sponsored enterprise is subject to either the District of Columbia Business Corporation Act (68 Stat. 177, June 8, 1954) or the District of Columbia Non-profit Corporation Act (76 Stat. 265, August 6, 1962). These laws set out the authorities granted to profit and non-profit private corporations in provisions similar to those of many of the States.

^{5/} See Robert Poling. Congressional Research Service. Corporations Chartered by Act of Congress. CRS Report 73-31 A. January 5, 1973.

Diagram 1
EXAMPLES OF CORPORATIONS AUTHORIZED UNDER FEDERAL LAW



Source: U.S. General Accounting Office. Is the Administrative Flexibility Originally Provided to the U.S. Railway Association Still Needed? Report to the Congress by the Comptroller General of the United States. CMD-73-19. February 27, 1973: 4

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Financial Controls

Prior to the adoption of the Government Corporation Control Act, corporations with funds available for expenditure without annual appropriation were required to obtain the approval of the Bureau of the Budget for expenditures on "administrative expenses." 6/ Beginning in 1935, a series of Executive orders required certain government corporations to provide annually to the Bureau of the Budget estimates of funds needed for administrative expenses and also required such corporations to incur obligations only within the limits approved by the budget director. 7/ Executive Order No. 9159 of May 11, 1942 extended these requirements to all major government corporations.

Congressional review of administrative expenses was the next step in the development of financial control of government corporations. The First Deficiency Appropriation Act of 1936 included a provision that prohibited nine government corporations from incurring any administrative expenses "except pursuant to an annual

6/ Marx, Fritz Morstein. Op. cit., p. 23.

7/ Executive Order No. 7126 of August 5, 1935 and Executive Order 7150 of August 19, 1935.

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appropriation specifically therefor." 8/ "This provision would have resulted in expenditures being made from the Treasury rather than from corporate funds." 9/

The third step toward effecting greater financial control of government corporations took form in subsequent appropriation acts for various corporations. The control mechanism was a "limitation on the amount of corporate funds which might be spent for administrative purposes, rather than of an appropriation from the Treasury." 10/ The effect of this mechanism was to limit the amount which could be spent for administrative purposes while at the same time holding the administrative expenses apart from the control of the regular appropriations process to which government agencies are subject. A complicating factor in the matter of limiting administrative expenses is that the distinction between administrative expenses and nonadministrative expenses is not clear. Because there was no restriction on "program expenditures," the lack of a distinction between administrative and nonadministrative expenses permitted government corporations to have access to more funds in the nonadministrative expense category than in the administrative expense category.

8/ 49 Stat. 1648.

9/ Marx, Fritz Morstein. *Op. cit.*, p. 231.

10/ Marx, Fritz Morstein. *Ibid.*, p. 232.

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Finally, implementation of the Government Corporation Control Act achieved the first uniformly applied, financial control mechanism for most government corporations. By requiring wholly owned corporations to submit a business-type budget to Congress, Congress achieved budgetary control over all wholly owned government corporations. The regular audit by G.A.O. of both wholly owned and mixed ownership corporations was a second mechanism to assure accountability for appropriations already received.

Legislative restrictions on the budget, audit, accounting, financing, and business operations of government corporations and government sponsored enterprises may differ. These criteria, presented in Table 1 below, can be used to compare the system for financial control of government corporations with the system for government sponsored enterprises (and certain other governmental entities). 11/

11/ The system for government sponsored enterprises is usually a revolving fund, defined in the FY 1980 Budget as "collections that are netted against spending and outlays reported as the net amount. For more information on revolving funds, see U.S. Congress. House. Committee on the Budget. Revolving Funds: Full Disclosure Needed for Better Congressional Control. Washington, U.S. Govt. Print. Off. September 1977.

Table 1
Financial Controls over Federal Government Corporations and Public Enterprise
Revolving Funds

	Corporations subject to Government Corporation Control Act	Revolving funds subject to Budget and Account- ing Procedures Act
1 Budget		
Form:	Business-type budget required	Business-type budget required
Provision for repayment of capital funds or payment of dividends:	Occasionally	Not usually
Operating expense limita- tions:	Occasionally	Occasionally
Administrative expense limitations:	Occasionally	Not usually
All costs shown:	Generally	Generally
2 Audit		
Type of audit:	By GAO in accordance with generally accepted principles and procedures applicable to commercial corporate transactions	As determined by GAO and internal audit staff
Subject to GAO disallow- ance:	No	Yes
Frequency of audit:	Every three years	As determined by GAO
3 Accounts		
Principles and standards:	Developed by corporation	Developed with GAO
System subject to approval by:	Corporation	GAO
Nature of system:	Accrual	Most on accrual
4 Financing		
Fiscal year limitation on capital appropriations:	Varies	Varies
Use of receipts for operating expenses:	Yes	Yes
Use of receipts for capital expenses:	Yes	Often limited
Need for legislative author- ization for individual con- struction projects:	Generally no	As provided by exist- ing law
Charges reflect costs such as interest, depreciation, and overhead:	Generally yes	Not usually
Interest paid on net govern- ment investment:	Generally yes	Generally no
Authority to sell nonguar- anteed obligations to public:	Can be authorized by law	No
5 Operations		
Restrictions:	Specific statutes and regulations applicable to corporations	Statutes and regula- tions applicable gener- ally to executive agencies and civil servants
Sue and be sued in own name:	Yes	Usually no
Litigation handled by:	Corporation or Depart- ment of Justice	Department of Justice
Property acquired in the name of:	Corporation	United States
Contracts made in the name of:	Corporation	United States
Limitations on authority to make contracts:	Regulations and stat- utes applicable to corporations	Regulations and stat- utes applicable to agencies
Claims settled by:	Corporation	GAO and adminis- tering agency

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Incorporation Versus Creation as a Federal Agency

The Congressional decision to create a governmental entity in the form of a government corporation or government sponsored enterprise, rather than in the form of an executive agency, is the result of several considerations. These considerations include such factors as 1) insulation from politics, 2) a primarily business as opposed to governmental function to be performed, and 3) advantages gained from exemption from certain operating requirements with which most executive agencies must comply.

The first consideration is illustrated by the fact that many such corporations are not as subject to political, and often partisan, influences as are "independent" agencies of the Federal government. Avoidance of political decision-making was cited by a group of public administrators as another reason why legislative bodies create "public enterprises" rather than executive agencies. 12/

A second consideration is that certain public interest business activities have been found necessary to meet national objectives. This was particularly evident during the Great Depression and wartime era when the first government corporations were chartered. Harold Seidman, a noted author in public administration, observed that:

12/ Office of Personnel Management, Federal Executive Institute, Proceedings: Research Conference on Public Enterprises, Charlottesville, Virginia, June 1, 1978, p. 12.

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All of these activities had certain unique characteristics which clearly set them apart from what up to then had been construed to be "normal" and acceptable Government functions: (1) the Government was dealing with the public as a businessman rather than a sovereign; (2) users rather than the general taxpayer, were expected to bear a major share of the cost for goods and services; (3) expenditures necessarily fluctuated with consumer demand and could not be predicated accurately or realistically financed by annual appropriations; (4) additional expenditures to meet increased demand did not necessarily in the long run increase the net outlay from the Treasury; and (5) operations were being conducted within areas in which there were well established commercial trade practices. 13/

A third consideration in establishing a government corporation or government sponsored enterprise is that such corporations are not subject to the same managerial and financial control mechanisms as are executive agencies. For example, many government corporations and government sponsored enterprises (and some Federal agencies) maintain an off-budget status and are exempt from the Budget and Accounting Act of 1921 (42 Stat. 20, 31 U.S.C. 1, June 10, 1921). Thus, their finances are not as dependent upon meeting the rigors of the appropriations process as are the finances of most executive agencies.

The difficulty of determining a viable organizational form for certain ventures in which the Federal Government has taken an interest is illustrated by the corporate history of the Federal National

13/ Seidman, Harold. Politics, Position and Power, The Dynamics of Federal Organization. New York, Oxford University Press. 1975: 254-5.

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Mortgage Association (FNMA or Fannie Mae). Fannie Mae's seven changes in corporate status range from being chartered as a wholly owned government corporation on February 10, 1938, having its functions transferred four different times to three Federal agencies by 1954, being designated as a mixed ownership corporation in 1954, having its functions transferred to the Department of Housing and Urban Development in 1965, to finally becoming a private corporation in 1968. 14/

14/ For documentation of each statutory transfer, see General Services Administration. National Archives and Records Service. Office of the Federal Register. United States Government Manual 1978/9. Washington, U.S. Govt. Print. Off. Appendix A, page 759.

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II. ANALYSIS OF SELECTED GOVERNMENT CORPORATIONS AND GOVERNMENT SPONSORED ENTERPRISES

In many regards, each government corporation and government sponsored enterprise embodies a unique composite of various authorities, obligations, and organizational and financial structures. The corporations examined here were analyzed according to their enabling legislation and mission, rationale for incorporation rather than creation as an executive agency, responsibility to Congress and the President, corporate powers, corporate structure, financial structure and performance evaluation criteria. For this analysis, the Tennessee Valley Authority was selected from the category of wholly owned government corporations, the proposed Space Industrialization Corporation was selected from the category of mixed ownership corporations, the Corporation for Public Broadcasting was selected from the category of government sponsored nonprofit enterprises, and the Communications Satellite Corporation was selected from the category of government sponsored for profit enterprises.

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TVA

Enabling Legislation

The Tennessee Valley Authority (TVA), created as a "body corporate" under the Tennessee Valley Authority Act of 1933 (P.L. No. 17; 48 Stat. 58, May 18, 1933), was established "for the purpose of maintaining and operating the properties now owned by the United States in the vicinity of Muscle Shoals, Alabama, in the interest of the national defense and for agricultural and industrial development, and to improve navigation in the Tennessee River and to control the destructive flood waters in the Tennessee River and Mississippi River Basins."

Federal interest in the development of the Tennessee River basin spans six Congresses and the administrations of seven Presidents. Congressional attention was first focussed as early 1899 on the problem of navigating the Tennessee River, which drops 134 feet near Muscle Shoals, Alabama. A dam for this site was approved by Congress, but the authorization expired without any further action being undertaken. Between 1917 and 1932, a series of eight measures to provide for the use of this property site received varying degrees of congressional support but suffered vetoes by Presidents Coolidge and Hoover. ^{15/}

^{15/} For further discussion of the history of this controversy, see Charles H. Pritchett. *The Tennessee Valley Authority, A Study in Public Administration*, New York, Russell and Russell, 1943: 5-30.

Additional literature on the creation of the Tennessee Valley Authority may be found in such sources as David Lilienthal, *TVA: Democracy on the March*, New York, 1944; Philip Selznick, *TVA and the Grass Roots*, Berkeley and Los Angeles, 1953; Roscoe Martin (Ed.), *TVA: The First Twenty Years*, University, Ala., 1956, and Joseph Ransmeier, *The Tennessee Valley Authority*, Nashville, Vanderbilt University Press, 1942.

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Among these measures were: a plan to designate the site for nitrate production for use in the manufacture of explosives during World War I, a plan to use the site to produce nitrate for fertilizers, and six proposals to either separate or combine the fertilizer and power production functions.

Rationale for Incorporation

The fifteen year controversy over the Muscle Shoals development concerned not only the question of whether to separate or combine the fertilizer and power production functions, but also whether the Wilson dam power plant was to be operated by a private corporation or by a government-owned corporation. Finally, on April 10, 1933, President Roosevelt suggested in a message to Congress that the development of Muscle Shoals would best be served by the creation of

"a corporation clothed with the power of government but possessed of the flexibility and initiative of a private enterprise. It should be charged with the broadest duty of planning for the proper use, conservation, and development of the natural resources of the Tennessee River drainage basin and its adjoining territory for the general social and economic welfare of the Nation. This authority should also be clothed with the necessary power to carry these plans into effect." 16/

16/ U.S. Congress. Message from the President of the United States. Muscle Shoals Development. 73rd Congress, 1st Session. Washington, U.S. Govt. Printing Off., April 10, 1933, R. 1. House Document No. 15.

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The Section 11 of the Tennessee Valley Authority Act states that the Muscle Shoals properties are to be used "to improve, increase and cheapen the production of fertilizer and fertilizer ingredients". Moreover, the conference report states that the purpose of the House bill was to insure cheaper power to the public. 17/ As to the method to implement these objectives, the conference report declares: " We intend that the corporation shall have much of the essential freedom and elasticity of a private business corporation." 18/

The Act does not provide a terminating date for TVA. TVA was designated a wholly owned government corporation in 1945, upon the enactment of the Government Corporation Control Act (P.L. 248, 59 Stat. 597).

Statutory Coverage

As a "wholly owned" government corporation, TVA is subject to most of the provisions regarding wholly owned government corporations. It is free from State regulation (except as Congress may permit). 19/

17/ U.S. Congress. Conference Committees, 1933. Operation of Muscle Shoals Properties; Conference Report to accompany H.R. 5801. Washington, U.S. Govt. Printing Off. May 15, 1933. (73rd Congress, 1st Session. House Report No. 130: 18)

18/ Ibid., p. 19.

19/ Tennessee Valley Authority v. Kinzer, 142 F. 2d 833 (6th cir. 1944); Posey v. Tennessee Valley Authority, 93 F. 2d 726 (5th cir. 1937); Malone v. Tennessee Valley Authority, 86 F. Supp. 961 (D. Ky. 1949).

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TVA pays neither State income nor State property taxes, but it does make payments to States and counties in lieu of taxes. 20/

Except for the extension of benefits under the Federal Employee's Compensation Act (P.L. 64-267; 39 Stat. 742, September 7, 1916) upon injury during performance of their duties, employees of TVA are not covered by any civil service laws. Thus, TVA sets its own salary scale.

Section 21(a) of the TVA Act provides for coverage of TVA by general penal statutes relating to larceny, embezzlement and to the improper handling of public moneys or property of the U.S. to the Corporation.

Responsibility to Congress and the President

TVA is required by its enabling legislation to "maintain complete and accurate books of accounts" (Section 8(b)), to submit to the President and to the Congress an annual financial statement and a complete report of its business operations, including power costs at each power station (Section 9(a)), and to undergo an annual audit of its transactions by the Comptroller General (Section 9(b)). The Government Corporation Control Act restated TVA's responsibility for the annual audit and expanded the requirement for a financial statement to make it conform to "a business-type budget program."

20/ See Pritchett, op. cit. pp. 111-115. For further discussion of the payment in lieu of taxes issue, see L.L. Durisch and H. Nacon, Payments in Lieu of Taxes by the T.V.A., Journal of Politics, v. 3, 1941: 318-334; and A.T. Edelman, Public Ownership and Tax Replacement by the T.V.A., American Political Science Review, v. 35, 1941: 727-737.

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TVA is subject to Federal supervision and control in other areas of its activities. Certain proposed contracts must receive the approval of the Federal Power Commission (16 U.S.C. 831 n-3); with the abolition of the Federal Power Commission, this approval authority was transferred to the Secretary of Energy. In the case of a war or a national emergency, the President is authorized by Section 20 of the TVA Act to seize any TVA property in order to manufacture explosives. In addition, the President is authorized by Section 17 to conduct an investigation to determine whether the control and management of any TVA dam or property has resulted in "any undue or unfair advantage" to private persons or corporations and whether the Government, in any such matter, has been deprived of any of its rights.

In the event that TVA engages in any transaction that is in conflict with the powers conferred by its statutory authority, the Comptroller General is required by the Tennessee Valley Authority Act to make a report to the President and to the Congress.

Corporate Powers

TVA possesses corporate powers similar to those authorized for a private commercial corporation under the District of Columbia Business Corporation Act (P.L. 389, 68 Stat. 177, June 8, 1954).

The responsibilities vested in the Board of Directors, in addition to producing, distributing and selling electric power, include such duties as: contracting with commercial fertilizer producers for

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fertilizer; arranging with farmers and farm organizations for wide-spread application of new forms of fertilizers; cooperating with Federal, State, district, or county experimental stations for the use of new forms of fertilizers; manufacturing and selling nitrogen, fertilizer, and its products to reduce the cost of producing fertilizer; and manufacturing and selling nitrogenous explosives to the Secretaries of Defense and Navy.

New programs to be undertaken by TVA originate with the President's recommendation of legislation to Congress. Section 23 of the TVA Act provides six objectives for such legislation. These objectives are:

(1) the maximum amount of flood control; (2) the maximum development of said Tennessee River for navigation purposes; (3) the maximum generation of electric power consistent with flood control and navigation; (4) the proper use of marginal lands; (5) the proper method of reforestation of all lands in said drainage basin suitable for reforestation; and (6) the economic and social well-being of the people living in said river basin.

Amendments to the corporate charter can be made only by Congress.

Corporate Structure

The managing body of TVA is a Board of Directors, consisting of three persons who are citizens of the U.S., and are appointed by the President by and with the advice and consent of the Senate for nine year terms. The chief administrative officer is the General Manager, 21/ who is appointed

21/ A reorganization of TVA's offices and divisions was announced by Board Chairman, David Freeman on February 26, 1979 to "focus TVA's attention on the principal tasks facing the Agency," according to his testimony March 28, 1979 before the Senate Appropriations Subcommittee on Public Works. The number of managers reporting to the General Manager will decrease from 13 to 6. New offices of natural resources and community development have been created.

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by the Board. Neither officers nor employees may be selected or promoted on the basis of political tests or qualifications. As previously mentioned, officers and employees are not covered by civil service laws, with the exception of the Federal Employee's Compensation Act for injuries sustained while on the job.

Conflict-of-interest provisions in the Act prohibit Board members from having financial interests in public power utilities and companies manufacture, sell or distribute fixed nitrogen or fertilizer. Board members are also prohibited from engaging in any other business than TVA business.

Financial Structure

TVA receives funding from three sources: Congressional appropriation for its non-power functions, sales of power and sales of bonds. Unlike the annual appropriations process for most Federal agencies, which requires first, an authorization bill and second, an appropriation bill, the authority to appropriate funds to TVA is granted in advance by Section 27 of its enabling legislation. TVA testifies only once a year for its appropriations.

TVA is afforded another financial privilege. "By virtue of an amendment to the Act in 1941, the General Accounting Office, which normally has the power to disallow agency expenditures that it determines are not authorized by statute, has no such power with respect to expenditures by TVA." 22/

22/ Wirtz, Richard. The Legal Framework of the Tennessee Valley Authority. Tennessee Law Review, v. 43, Summer 1976: 578.

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For its nonpower functions; for FY 1978 \$138,510,000 was received and for FY 1979 \$154,531,000 is estimated. Nonpower functions are also financed in part by receipts from fertilizer sales. TVA's power functions are financed principally from its power earnings. The plants, dams and facilities controlled by TVA are financed through bonds authorized by Congress. The bonds may or may not be fully and unconditionally guaranteed (as to interest and principal) by the United States.

TVA is not authorized to issue stock.

The financial statement submitted by TVA for inclusion in the FY 1980 budget includes the following information:

	(in thousands of dollars)			
	<u>1977 actual</u>	<u>1978 actual</u>	<u>1979 est.</u>	<u>1980 est.</u>
Total funded operating cost	—	2,121,374	2,624,124	2,882,347
Total Assets	9,160,474	10,851,844	13,135,744	15,116,907
Total Liabilities	6,305,815	7,795,724	9,770,348	11,611,908
Total Government equity	2,854,659	3,056,120	3,365,396	3,504,999

Evaluation Criteria

Community and economic development are important measures of TVA's success in performing its mission. In these areas, TVA evaluates its performance on the basis of the jobs it creates, and on per capita income in the area, which in the last five years has risen to about 80% of the national average.

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For its electricity program, the evaluation criterion is based on the ratio of total kilowatt hours produced to total production costs.

For its fertilizer development program, TVA evaluates its performance using the ratio of amounts of fertilizer produced to production costs.

Flood control benefits and freight navigation along the channel created by TVA dams are measured in dollar savings to consumers, merchants and shippers.

The Land between the Lakes area in west Kentucky and Tennessee provides recreation and tourism to the region which can be measured in number of tourists to the area each year.

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SPACE INDUSTRIALIZATION CORPORATION

Enabling Legislation

The proposed (H.R. 2337, 96th Congress, 1st session) Space Industrialization Corporation, would be established as a mixed ownership corporation to "promote, encourage, and assist in the development of new products, processes, and industries of the space environment," by facilitating the transfer of space technology to practical applications, "creating an ongoing program for understanding the attributes and opportunities in space-related research," and encouraging the financing and development of products and processes derived from space research.

Rationale for Incorporation

Assigning mixed ownership status to the Space Industrialization Corporation is believed by the sponsors of the bill to be the best method to gain the research expertise of private industry in an otherwise high risk investment. The bill declares it to be the finding of Congress that "private investors are generally unwilling or unable to take the risks involved or to make the large initial investments required because of the long period of time which will be needed to develop their activities into viable and profitable industrial or commercial ventures." Therefore, the involvement of the Federal Government through its initial appropriations into the

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"proposed Space Industrialization Trust Fund" is indicative of the Federal Government's commitment "to support the objectives and purposes of this Act over a sufficient period of time to assure private industry of an effective and realistic opportunity to develop the activities involved into viable and profitable commercial ventures."

The Corporation's primary objective, according to Section 101(d) of the bill, is to "secure the participation of industry and the general public in the operation of the Corporation . . . as rapidly as possible." To signify the achievement of this aim, the Board of Directors will make a proclamation of the Corporation's ability to operate solely under public ownership (that is, a private corporation owned by the general public through its shares of common stock). The issuance of this proclamation will prompt the transfer of the Space Industrialization Corporation from mixed ownership status to ownership by the public at large. This transfer will allow private investors to participate in the management and control of the Corporation, subject to the District of Columbia Business Corporation Act (63 Stat. 177 et seq.)

To effect this transition from mixed ownership status to that of a private corporation, it is necessary to resolve certain inconsistencies between provisions of the enabling legislation on the one hand and, on the other, the Government Corporation

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Control Act (59 Stat. 597 et seq.) and the District of Columbia Business Corporation Act. Thus, the enabling legislation stipulates that after the proclamation, the provisions of Title I insofar as they pertain to the rights and duties of the Corporation as a mixed ownership corporation will no longer apply. However, the provisions of Title I (to the extent they are consistent with Title II)--will continue to apply to the Corporation after its transfer to the status of a private corporation.

Statutory coverage

In the initial stage of its operation, the Space Industrialization Corporation, as a mixed ownership corporation, is subject to most of the provisions of the Government Corporation Control Act. It is not, however, subject to provisions requiring the banking and checking accounts of government corporations to be kept with the Treasurer of the U.S. or with a Federal Reserve Bank; requiring that all bonds, notes and debentures issued by government corporations be issued "in such manner and at such times and sold at such prices as have been or as may be approved by the Secretary of the Treasury"; or limiting the purchase by government corporations of "any direct obligation of the U.S. or of an obligation guaranteed as to principal and interest to an aggregate of less than \$100,000 at any one time." Such exemptions are applicable only if Government capital

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has been entirely withdrawn from the Space Industrialization Corporation. When the Space Industrialization Corporation has repaid into the Treasury all the appropriations made to the Space Industrialization Trust Fund, the controlling provisions of the Government Corporation Control Act will cease to apply.

After the proclamation by the Board of Directors that public ownership can be "realistically secured," the Space Industrialization would be subject to the District of Columbia Business Corporation Act.

Any contracts made by the proposed Space Industrialization Corporation are authorized by Section 101(e)(2)(F) to be made without regard to authority (31 U.S.C. 529) limiting payments of public money under contracts for the performance of any service to the value of the services rendered. The effect of this exemption would permit profits to those individuals or companies under contract to the the Space Industrialization Corporation for performing services.

In carrying out its mission, the Space Industrialization Corporation would be authorized to grant financial assistance to individuals and companies that have submitted acceptable proposals for "projects involving the conduct of industrial processes in space." All rights to "intellectual properties and discoveries pertaining to or disclosed in "such proposals would be retained by the applicants for financial assistance. Furthermore, these

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rights are subject to patent and antitrust laws. In order to encourage proposals of the highest quality, information relating to these proposals, applications for financial assistance, and management plans for conducting industrial processes in space, would be exempt from the Freedom of Information Act (5 U.S.C. 552).

Responsibility to Congress and the President

The Corporation would be required to submit to the President and Congress a comprehensive and detailed report of its operations, activities and accomplishments each year, including a review of its progress toward achieving the purposes of the bill. Any recommendations for changing the structure or scope of its mission will also be included. It is not explicit in the bill whether this reporting requirement will be discontinued upon the transfer of the Corporation to public ownership.

The Corporation would be subject to the close supervision of the President, who will review and otherwise aid the planning and development of a space industrial system. The President also is authorized to coordinate the activities of Government agencies "with responsibilities in fields related to space industrialization." The Corporation also is required to notify the State Department whenever it enters into business negotiations with foreign or international entities. The National Aeronautics and Space Administration is required to advise and assist the Corporation in its research and development programs.

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Corporate Powers

The bill establishing the Space Industrialization Corporation provides for certain corporate powers, including conducting or contracting for research and development for a space industrial system, acquiring physical facilities and equipment, purchasing satellite launching and related services from the U.S. or other entities approved by the Board of Directors, contracting for the services of a space industrial system, and participating with financial institutions, agencies or foundations in loans or guarantees under the Act. When the Board of Directors issues its proclamation that the Corporation would be viable under public ownership, all the additional authorities and responsibilities conferred in the District of Columbia Business Corporation Act would be assumed by the Corporation.

Corporate Structure

The managing body of the proposed Space Industrialization Corporation is a Board of Directors, consisting of twelve members who must be U.S. citizens and be appointed by the President. The Chairman, who serves a term of five years, is selected from the private sector; three Board members are selected from the public sector, and eight Board members are selected from the private sector. All serve staggered terms of five years. Qualifications for ten of the Board members include special expertise in industrial research and development, and four of these must be familiar with aerospace research and development.

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Whether officers and employees of the Corporation are to be considered employees of the U.S. is an issue that is not addressed by the language in the enacting bill, H.R. 2337. The members of the Board and officers of the Corporation are to be compensated at rates fixed by the Board.

Conflict of interest provisions prevent the officers of the Corporation from receiving any salary from any source other than the Corporation during the term of their employment by the Corporation.

Financial Structure

The Space Industrialization Corporation will be financed initially by Congressional appropriations of \$50 million per year for each of the first two fiscal years after the date of enactment. Provision also is made for additional "sums thereafter as may be necessary."

The finances of the Corporation would be held and administered by the Secretary of the Treasury in a "Space Industrialization Trust Fund," consisting of appropriations received, repayments of assistance given to industrial ventures, and gifts and bequests made for the general purposes of the trust fund or for specific projects, and any other amounts. All payments made by the Board and all administrative and other expenses incurred by the Board in carrying out the mission of the Corporation will be made from the Fund.

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The Secretary of the Treasury is authorized to invest "such portion of the Fund as is not, in his judgment, required to meet current withdrawals." These investments are limited to U.S. bonds or any obligation guaranteed by the U.S. as to both principal and interest. The Secretary of the Treasury is authorized to sell these obligations, the proceeds and interest from which would be credited to the Fund.

Upon the proclamation of the Board of Directors that the Corporation has demonstrated its ability to operate "successfully, effectively and profitably" as a private corporation, the Corporation will relinquish its corporate status as a mixed ownership corporation and will become a stock corporation under the District of Columbia Business Corporation Act. Its finances would derive from the issuance of capital stock without par value (that would carry voting rights and bear dividends), and from the issuance of nonvoting securities and bonds. The proceeds from the sale of all stock and other securities would be deposited in the Space Industrialization Trust Fund. When the Corporation has paid an amount equal to the total of all Congressional appropriations from the Space Industrialization Trust Fund into the Treasury, the Fund will be transferred from the control of the Secretary of the Treasury to the exclusive control of the Board of Directors.

Evaluation Criteria

As a mixed ownership corporation, the Corporation could evaluate its effectiveness in terms of the general purposes of its organic act. Such purposes as providing "a basis for the profitable utilization of the space environment," encouraging "innovation and creativity in the uses of space for the benefit of mankind," • facilitating "the orderly financing of meritorious projects in space which contribute to the general welfare while creating and supporting profitable business ventures," and encouraging "general public participation in the opportunities for the use of space" are, however, difficult to measure. As a private corporation, the proposed Space Industrialization Corporation might evaluate its performance according to earnings expressed in either of three ways: (1) as a percentage of assets, (2) as growth in earnings from year to year, and (3) as earnings per share over time.

CORPORATION FOR PUBLIC BROADCASTING

Enabling Legislation

The Corporation for Public Broadcasting (CPB), established as a government-sponsored private, nonprofit corporation under the Public Broadcasting Act of 1967 (P.L. 90-129, 81 Stat. 365), was created to encourage the growth and development of noncommercial educational radio and television broadcasting and to make such a broadcasting service available to all U.S. citizens.

Rationale for Incorporation

In presenting a congressional declaration of policy, the Public Broadcasting Act offers an explanation for incorporation as a private entity: Congress believed that a private corporation would best facilitate the development of the educational broadcasting service and, at the same time, provide it with the greatest protection from "extraneous interference and control." Senate Report 222 23/ cites the independent, nonprofit corporation as a "bold and imaginative concept" which would aid the expansion of educational broadcasting and "provide programs free of political pressures." The Senate Report refers to the fears aired before the Senate Commerce Committee that

23/ U.S. Congress. Senate. Committee on Commerce. Public Broadcasting Act of 1967. Washington, U.S. Govt. Printing Off. May 11, 1967. (90th Congress, 1st Session, Senate Report 222).

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the Federal Government would attempt to control or interfere with program content. Such fears were alleviated in part by the private nature of the corporation and in part by provisions prohibiting the Corporation from owning any station, network or program facility; prohibiting the Corporation from engaging in any political activity or using political tests in personnel policies; and requiring an independent accounting firm, rather than the General Accounting Office, to conduct the audit mandated by Section 396 (1).

The intent that the Corporation would eventually be financed entirely from private sources is expressed in the legislative history. 24/

The Act does not establish a terminating date for CPB.

Statutory Coverage

The Corporation for Public Broadcasting, a nonprofit corporation, is subject to the provisions of the District of Columbia Nonprofit Corporation Act (76 Stat. 265). The enabling legislation provides that members of the Board are not employees of the U.S. Government, thereby exempting them from civil service laws and payscales. Moreover, the enabling act specifically provided that compensation for the Corporation's officers be set at rates fixed by the Board of Directors. Because officers of CPB had no statutory ceiling on their salaries, that provision was amended by the Public Telecommunications Financing Act of 1978 (P.L. 95-567, 92 Stat. 2405) to state that "no officer or employee

24/ Ibid., p. 8

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of the Corporation may be compensated by the Corporation at an annual rate of pay which exceeds the rate of basic pay in effect from time to time for level I of the Executive Schedule under 5 U.S.C. 5312".

As a private corporation, CPB is exempt from the Government Corporation Control Act (P.L. 248; 59 Stat. 597). As a nonprofit corporation subject to the District of Columbia Nonprofit Corporation Act, it pays no Federal or State taxes. IRS has granted CPB 501 * C3 classification (educational, instructive nonprofit organization) which affords additional privileges.

Responsibility to Congress and the President

The Corporation submits an annual report to the President for transmittal to Congress; this report consists of a detailed and comprehensive description of the Corporation's "operations, activities, financial condition and accomplishments."

An annual audit is made of the Corporation in accordance with "generally accepted auditing standards," by independent certified public accountants or independent, licensed public accountants, but it may be conducted by G.A.O. in accordance with "the principles and procedures applicable to commercial corporate transactions." However, recipients of CPB grants for program production or other broadcasting activities (other than a fixed price contract awarded through competitive bidding) are required to keep detailed records of such assistance.

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Corporate Powers

The Corporation for Public Broadcasting is authorized to exercise all the corporate powers set forth in the District of Columbia Non-profit Corporation Act, except owning or operating any television or radio broadcast station, network, or program production facility.

Its enabling legislation permits CPB to operate for certain specific purposes and to perform certain designated functions. Its purposes are: (a) to facilitate the full development of educational broadcasting, (b) to assist in the establishment and development of interconnection systems for the distribution of educational television and radio programs, (c) to assist in the establishment and development of noncommercial educational television and radio broadcasting stations, (d) to operate so as to assure the maximum freedom from interference with noncommercial educational television and radio broadcasting systems.

The functions CPB is authorized to perform are: (a) to obtain grants and make contracts, (b) to contract or make grants for program production for noncommercial educational television and radio, (c) to make payments to noncommercial educational broadcast stations to aid in financing local educational broadcasting, (d) to establish and maintain a library of noncommercial educational television and radio programs, (e) to arrange for the distribution and transmission of educational television and radio programs to noncommercial educational

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broadcast stations, (f) to accept the voluntary services of consultants, (g) to encourage the creation of new noncommercial educational broadcast stations, (h) to conduct training and research in matters related to non-commercial educational television and radio broadcasting.

The Corporation is not authorized to issue shares of stock or to declare or pay any dividends. It is not permitted to support in any way any political party or candidate for elective office.

Corporate Structure

CPB is managed by a Board of Directors, consisting of fifteen members who serve six year terms. Board members, who must be U.S. citizens, are appointed by the President by and with the advice and consent of the Senate, but no more than eight of them may be members of the same political party. Eminent in such fields as "education, cultural and civic affairs, or the arts, including radio and television," board members are selected to maintain a broad representation of various geographic regions, various professions and various kinds of experience appropriate to the functions of CPB.

Members of the Board of Directors are not employees of the U.S. Government, and therefore, no civil service laws apply to them. However, as mentioned earlier, the Public Telecommunications Financing Act of 1978 placed a ceiling on the salaries of officers and employees at not more than \$69,600 per year.

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Conflict of interest provisions prevent all officers of the Corporation except the Chairman and any Vice Chairman from receiving any salary or other compensation from any source other than CPB during their period of employment at CPB.

Financial Structure

Funded through congressional appropriations and through financial contributions from non-Federal and private sources, the Corporation issues no stock.

The original \$9 million authorized for the creation of CPB was intended to be "'seed money' pending a long range financing plan to be submitted by the administration," 25/ Since the initial authorization was for one year only, Congress authorized another appropriation the following fiscal year. The lack of a long range financing plan which was to have been forthcoming from the Administration prompted the enactment of the Public Broadcasting Financing Act of 1970 (P.L. 91-437, 84 Stat. 888), which provided for annual appropriations for the Corporation for FY 1971, 1972 and 1973. Part of the authorized appropriations were to be used for Federal matching on a dollar for dollar basis of non-Federal contributions. Long term

25/ U.S. Congress. Senate. Committee on Commerce. Public Broadcasting Financing Act of 1970; Report to accompany S. 3553. Washington, U.S. Govt. Print. Off., 1970. (91st Congress, 2nd Session. Senate. Report no. 91-437) p. 1.

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financing finally was realized with the enactment of the Public Broadcasting Financing Act of 1975 (P.L. 94-192, 89 Stat. 1099) which established a "Public Broadcasting Fund" in the Department of the Treasury. The Public Telecommunications Financing Act of 1978 (P.L. 95-567; 92 Stat. 2405) increased the ratio of Federal to non-Federal contributions to the Public Broadcasting Trust Fund from which matching funds are to be granted for fiscal years 1981 to 1983.

The following amounts represent Federal appropriations for CPB for 1969 through 1978:

Federal Appropriations for the Corporation for Public Broadcasting

Fiscal Year	Dollars (thousands)
1969	\$ 5,000
1970	15,000
1971	23,000
1972	35,000
1973	35,000
1974	47,750
1975	62,000
1976 <u>1/</u>	96,000
1977	103,000
1978	119,200 <u>2/</u>
	<u>\$ 540,950</u>

1/ Includes the transition quarter.

2/ Includes a supplemental appropriation of \$12.25 million.

SOURCE: Carnegie Commission on the Future of Public Broadcasting, A Public Trust, New York, Bantam Books, 1979, p. 42.

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The CPB 1977 Annual Report contains the following financial information regarding CPB's operating expenses for the fifteen month period ending September 30, 1977.

Direct support to local television and radio stations (Community Service and Expansion Grants).....	\$ 67,659,805
Support for television program production.....	14,351,952
Support for television program distribution.....	15,144,853
Support for radio program production and distribution.....	8,383,670
Other grants and projects [such as engineering research and development].....	4,677,073
Project administration costs [such as staff and travel costs incurred for administering grants and projects in all program areas].....	<u>3,017,058</u>
Total projects and activities.....	\$ 113,234,411
Corporate direction and administration [such as personnel, occupancy and professional services].....	<u>3,610,543</u>
	\$ 116,844,954
Excess of revenues over expenses.....	8,746,812
Net assets at beginning of period.....	<u>14,557,053</u>
Net assets at end of period.....	\$ 23,303,865

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Evaluation Criteria

As a nonprofit corporation, CPB has no financial gain standard against which to evaluate its performance. Alternative accomplishment standards that might be applied, according to a CPB attorney, 26/ include how well grants are distributed or the number of programs funded by CPB that are broadcast on public television or radio stations. Other performance considerations are the assessments resulting from congressional oversight hearings, appropriations hearings, and the opportunity for public expressions of satisfaction provided by provisions in the Public Telecommunications Financing Act which call for open meetings for member broadcasting stations. Private evaluations of CPB have been made by the Carnegie Commission on Educational Television (1966) and the Carnegie Commission on the Future of Public Broadcasting (1979).

26/ Telephone conversation with Paul Symczak, Office of the General Counsel, Corporation for Public Broadcasting, March 9, 1979

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COMSAT

Enabling Legislation

The Communications Satellite Act of 1962 (P.L. 87-624; 79 Stat. 419) established the Communications Satellite Corporation (COMSAT), a government-sponsored private, for profit corporation, created to enable the U.S. to participate in an "improved global communications network". This "commercial communications corporation . . . will be responsive to public needs and national objectives . . . will serve the communication needs of the U.S. and other countries . . . and will contribute to world peace and understanding."

Rationale for Incorporation

The corporate form of enterprise was selected to carry out the declared policy of the Act so that COMSAT could facilitate the development of global telecommunications services and provide for the widest possible participation by private enterprise. In fact, the formation of COMSAT was fraught with controversy. According to the legislative history, one group favored government-sponsored ownership of the proposed communications satellite system and the other group favored its creation as a wholly-owned government corporation. 27/

27/ President Kennedy favored private ownership and operation of the U.S. participation in the global telecommunications system, and initiated the introduction of S. 2814 to achieve this aim. A substitute bill would have established a Communication Satellite Authority as an agency of the Federal Government. See U.S. Congress. Senate. Committee on Commerce. Communications Satellite Act of 1962. Washington, U.S. Govt. Print. Off., June 11, 1962 (87th Congress, 2d Session Report No. 1584).

The controversy over COMSAT's legal status centered on two issues: giving COMSAT the status of a private corporation would establish a "Government-created private monopoly.... "and bestow on that single monopoly the benefits of billions of dollars of taxpayers' money;" 28/ also, by granting COMSAT private corporate status, it would have the right to negotiate treaties and agreements with foreign governments on behalf of the U.S. Government. 29/

The problem of COMSAT's anticipated negotiation with foreign governments was resolved by a provision of the enacted bill, requiring the President to supervise the corporation's activities with foreign governments to assure that they would be consistent with the national interest and U.S. Foreign policy.

The "Government-created monopoly" issue was resolved by the following provision:

"It is the intent of Congress that all authorized users shall have nondiscriminatory access to the system; that maximum competition be maintained in the provision of equipment and services utilized by the system; that the corporation created under this Act be so organized and operated as to maintain and strengthen competition in the provision of communications services to the public; and that the activities of the corporation created under this Act and of the persons or companies participating in the ownership of the corporation shall be consistent with the Federal antitrust laws."

The term of duration for the Corporation is stated in its Articles of Incorporation as "perpetual."

28/ Ibid, U.S. Congress. Senate Committee on Commerce. Senate Report 1584: Minority Views.

29/ U.S. Congress. Senate Committee on Foreign Relations. Communications Satellite Act of 1962. 87th Congress, 2d Session. Senate. Report No. 1873: Minority Views.

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Statutory Coverage

COMSAT is subject to the provisions of its enabling legislation and, insofar as it is consistent with the Communications Satellite Act, the provisions of the District of Columbia Business Corporation Act (P.L. 389, 68 Stat. 177). Because COMSAT is a common carrier within the meaning of the Communications Act of 1934, its satellite communications are regulated by the Federal Communications Commission. It is also required to notify the Department of State upon entering into business negotiations involving facilities, operations or services with any international entity.

As a private corporation, COMSAT is exempt from Federal statutes covering government corporations. It is, however, subject to Federal antitrust laws.

Responsibility to Congress and the President

COMSAT is required to submit an annual report on its operations, activities and accomplishments under the Act to the President and to the Congress.

In the event that COMSAT engages in any action inconsistent with its declared policy, or if any of its actions violate or threaten to violate the Communications Satellite Act, an appropriate Federal court has jurisdiction on petition of the Attorney General.

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Corporate Powers

The corporate powers as set forth in the Act are as follows:

- a) plan, initiate, construct, own, manage and operate itself, or in conjunction with others, a communications satellite system.
- b) furnish, for hire, channels of communication to domestic communications common carriers, and to other authorized entities, foreign and domestic.
- c) own and operate licensed satellite terminal stations.
- d) to arrange for necessary research and development.
- e) to acquire necessary physical facilities.
- f) to purchase satellite launching and related services from the United States.
- g) to contract with authorized users, including the United States, for services of the communications satellite system.
- h) to develop plans for the technical specifications of all elements of the Communications Satellite Corporation.

In addition to the powers stated in the D.C. Business Corporation Act and the D.C. Code, the corporate by-laws of COMSAT (Article III, Section 3.02) permit it to:

- a) engage, to the extent permitted by applicable law, in any phase of telecommunications and related research that may further or carry out any or all of the corporate purposes.
- b) acquire (by purchase, exchange, lease, hire, or otherwise) hold, use, sell, assign, lease, and grant the absolute interest in and to, and license or sublicense in respect of, franchises, indeterminate permits, certificates of convenience and necessity, certificates of authority, letters patent, patent rights, licenses, privileges, inventions, improvements, processes, copyrights, trademarks and trade names.

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- c) to act, in the District of Columbia and in any State, Territory, district or possession of the United States, or in Puerto Rico, or in any foreign country, as agent or representative for any government or person or business entity respecting any business related to the purposes of this Act.
- d) enter into lawful profit sharing arrangements, a union of interest, reciprocal or cooperative association with any government or business entity - including a general or limited partnership - for carrying on any business or activity within the corporation's authority.
- e) make any guaranty respecting stocks, contracts and obligations created by any person or entity, to the extent such guaranty is made in pursuance of the stated purposes of the Act.
- f) issue, subject to applicable provisions of law, and these Articles, shares of stock to such persons and on such terms as may be in the interest of the corporation.
- g) subject to applicable provisions of law and these Articles, pay and establish pensions and pension plans, stock options, and other incentive plans for any or all corporate officers or employees.
- h) perform such other acts, engage in such other operations, and exercise such other powers as are or may be authorized, are not forbidden by applicable law, and as may be necessary, desirable, advisable or convenient to further or carry out any or all of the purposes of this act.

Corporate Structure

COMSAT is managed by a Board of Directors, consisting of fifteen persons, each of whom must be a citizen of the United States. Three board members are appointed by the President for three year terms, by and with the advice and consent of the Senate. Six directors are elected by Series I (Public) shareholders, and six directors are elected by Series II (Carrier) shareholders. The Board Chairman and the elected directors are elected annually by the board and the shareholders respectively.

A President and other such officers as may be named and appointed by the Board of Directors are also required, by the Act, to be citizens of the United States and serve at the pleasure of the Board, receiving such compensation as may be fixed by the Board.

Conflict-of-interest provisions set out in COMSAT by-laws prohibit directors from participating in the negotiation of contracts between the corporation and any firm, corporation, association or other entity in which such director has a substantial financial interest or of which he is a director, trustee, officer or employee. Board members are required to advise the Board of their interests in such contracts. Officers are prohibited by the Act from receiving any salary from any source other than COMSAT during the period of their employment by COMSAT.

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Financial Structure

COMSAT receives no congressional appropriations; it is financed solely from the sale of common stock. Corporation by-laws authorize the issuance of 10,000,100 shares of common stock, without par value. COMSAT's initial operating expenses were paid from a portion of the \$5 million line of credit offered by commercial banks and approved by the FCC the same month as COMSAT's effective date of incorporation (February 1, 1963) 32/

The following is a five year summary of COMSAT's financial operations.

	(in thousands of dollars)				
	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>
Operating Revenues	119,291	133,470	142,581	153,649	168,187
Operating Expenses	89,867	97,122	101,655	120,635	140,589
Investment Income	6,875	8,570	5,317	5,257	3,415
Net Income	36,299	44,918	46,243	38,271	31,013

Evaluation Criteria

As a private corporation, COMSAT evaluates its performance according to net income and net income per share.

30/ Telephone conversation with Robert Brobst, Information officer, at COMSAT, May 8, 1979.

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III. COMPARISON OF THE PROPOSED SPACE INDUSTRIALIZATION CORPORATION WITH SELECTED GOVERNMENT CORPORATIONS AND GOVERNMENT SPONSORED ENTERPRISES

Rationale for Incorporation

Of the government corporations and government sponsored private corporations analyzed here, the corporate form was selected in three of the four cases for the purpose of executing a primarily business, as opposed to a governmental, function. TVA was incorporated to promote the economic development of the Tennessee River basin and to produce hydroelectric power. The proposed Space Industrialization Corporation would be incorporated to encourage commercial investment in space technology transfer. COMSAT was incorporated to promote the development of a global telecommunications system. The only corporation of the four selected for this analysis that was not incorporated primarily for a business purpose, as opposed to a governmental function, is the Corporation for Public Broadcasting. CPB was incorporated as a government sponsored enterprise to avoid potential political interference with program content had it been created as a Federal agency.

Statutory Coverage

As a wholly-owned government corporation, TVA is subject to the Government Corporation Control Act, and is exempt from Federal and State income and property taxes.

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As a mixed ownership corporation, the proposed Space Industrialization Corporation would be subject to provisions of the Government Corporation Control Act. Provisions in its enabling bill exempt the the Corporation from the Freedom of Information Act. Upon becoming a for-profit corporation, the Corporation would be subject to the District of Columbia Business Corporation Act.

As a private non-profit corporation, the Corporation for Public Broadcasting is exempt from the Government Corporation Control Act but is subject to the District of Columbia Nonprofit Corporation Act. As such, it pays no Federal or State taxes.

As a private for profit corporation, COMSAT is exempt from the Government Corporation Control Act and must comply with Federal antitrust laws. It is also subject to Titles II and III of the Communications Act of 1934, to the supervision of certain matters of concern to the State Department, and it may consult with NASA.

Responsibility to Congress and the President

As a wholly owned corporation, TVA is required to submit to the President and to Congress a complete report of its business operations and to undergo an annual audit by the Comptroller General. TVA is required to have certain contracts supervised by the Department of Energy.

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As a mixed ownership corporation, the proposed Space Industrialization Corporation would be required to undergo an annual audit by the Comptroller General. Unlike many other mixed ownership corporations, however, the Corporation would be required by its enabling bill to also submit an annual report of its business operations to Congress and to the President as well.

A government sponsored non-profit corporation, the Corporation for Public Broadcasting nonetheless is required by its enabling legislation to submit an annual report of its operations and financial activities to the President, and also to undergo an annual audit which may be made by an independent certified public accounting firm.

A government sponsored for profit corporation, COMSAT is required to submit an annual report of its operations and business activities to the President and to Congress.

Corporate Powers

The corporate powers authorized to TVA, to the proposed Space Industrialization Corporation, to the Corporation for Public Broadcasting and to COMSAT are those that are specified in their respective enabling legislation and those derived from the application of the District of Columbia Business Corporation Act or the District of Columbia Nonprofit Corporation Act.

Corporate Structure

The managing bodies of government corporations and government sponsored private enterprises vary in the degree to which the public sector, and presumably, in many cases the President, is represented on the Boards of Directors. Although most of the wholly owned government corporations and mixed ownership corporations have many of their Board Members appointed by the President, the percentage of Presidential appointees tends to be less in mixed ownership and government sponsored private enterprises than in wholly owned corporations.

There appears to be a slight correlation between the type of "government" corporation (wholly owned, mixed ownership, or government sponsored private enterprise) and the degree to which the public sector is represented. While one might assume that wholly owned corporations would have a greater proportion of Board Members from the public sector, this does not appear to be the case. However, among the mixed ownership corporations and government sponsored private enterprises, there tend to be more Board Members appointed from the private sector.

In many wholly owned corporations there is no designation for appointments from the public or private sectors. For example, all three of the TVA Board Members are appointed by the President, but there is no specific language limiting appointees from the public or private sectors, or from a particular political party. At the

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Import-Export Bank, all five Board Members are appointed by the President, but no more than three may be from the same political party. While on the other hand all Board Members at the Overseas Private Investment Corporation are appointed by the President, a majority of six are appointed from the private sector and five are appointed from the Federal Government.

Many mixed ownership corporations have a greater proportion of their Board Members appointed from the private sector. For example the Space Industrialization corporation would have all twelve Board Members appointed by the President, but nine (including the Chairman of the Board) would be designated from the private sector, and only three would be designated from the public sector. Amtrak and Conrail also are served by Board members selected predominantly from the private sector. Amtrak is authorized to appoint seventeen members of the Board: one is the Secretary of the Treasury, nine are appointed by the President, three are elected annually by the common stockholders, and four would be elected annually by the preferred stockholders. 31/ All

31/ Section 3(a) of the Amtrak Improvement Act (P.L. 93-146, 87 Stat. 548, November 3, 1973) increases the authorized number of Board Members from fifteen to seventeen, and requires that the Presidential appointees be appointed on a bi-partisan basis. Although Amtrak legislation provides that four Board members are to be elected by preferred stockholders, Amtrak has not yet issued preferred stock. These four seats on the Board therefore remain vacant.

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thirteen Members of the Board serving Conrail are selected from the private sector: six are selected by the "holders of the Corporation's debentures and series A preferred stock," three are selected by the holders of the Corporation's series B preferred stock, and two are selected by the holders of the Corporation's common stock. 32/ Two final Members of the Board are the chief executive officer and the chief operating officer of Conrail.

Many of the government sponsored private enterprises have a majority of Board Members appointed from the private sector. For example, of the fifteen Board Members at COMSAT, three are appointed by the President, six are elected by public shareholders and six are elected by the carrier shareholders. For the Corporation for Public Broadcasting, all fifteen of its Board Members are appointed by the President, but instead of a public/private

32/ Section 301(d) of the Regional Rail Reorganization Act of 1973 (P.L. 93-236, 87 Stat. 1004, January 2, 1974), the

- enabling legislation that created Conrail, provided for fifteen Members of the Board. Five Board Members were appointed by the President, and as long as fifty percent or more of the Conrail's debt was owed to or guaranteed by the U.S., three Board members were the secretary of Transportation, the Chairman and the President of the United States Railway Association. The number of Board Members was decreased, however, from fifteen to thirteen by Section 611(b) of the Railroad Revitalization and Regulatory Reform Act (P.L. 94-210, 90 Stat. 124, February 5, 1976).

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sector designation there is a limitation to no more than eight members being from the same political party. FNMA, having evolved from a wholly owned corporation in 1938 to a private enterprise by May 1970, has five of its fifteen Members of the Board appointed by the President. Of these five Presidential appointees, however, one must be designated from the home building industry, one from the mortgage industry, and one from real estate. The remaining ten are elected by the stockholders.

Financial Structure

Congressional appropriations constitute a source of revenue for most government corporations (whether wholly owned or of mixed ownership) and government-sponsored private enterprises. Among the corporations that do not receive Congressional appropriations are COMSAT and the Export-Import Bank. In addition, government corporations derive income from borrowings from the U.S. Treasury, interest on Federally-insured loans, off-budget loan guarantees, sales from U.S. bonds or obligations guaranteed by the U.S., and sales from common stock. Sales from common stock generally appear to be a more prevalent source of revenue for mixed ownership corporations and government sponsored private enterprises than for wholly owned corporations.

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The financing of wholly owned corporations varies from corporation to corporation. For example, TVA receives Congressional appropriations for its nonpower functions, while other income is derived from the sales of hydroelectric power and from bonds. The Export-Import Bank derives its income from the sale of notes payable to the Federal Financing Bank and other U.S. institutions. The Overseas Private Investment Corporation receives Congressional appropriations, sales from capital stock and loans under the Mutual Security Act of 1954, as amended.

Similarly, the financing for mixed ownership corporations varies from corporation to corporation. However, Congressional appropriations and the sale of capital stock are two primary sources of income. For example, the proposed Space Industrialization Corporation would receive Congressional appropriations, gifts and bequests, and income from the sale of bonds. After the private status proclamation of the Board of Directors as required in the enabling legislation, all income would be derived from the sale of capital stock. AMTRAK also receives income from the sale of capital stock. This income is supplemented by three types of grants from the Department of Transportation. As identified in the FY 1980 budget, they are: operating grants, labor protection and capital grants, and debt transactions from the retirement of AMTRAK loans. Although Conrail received "initial capitalization" from the sale of common

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stock and continues to receive Congressional appropriations through the United States Railway Association for its purchase of Conrail securities, it was intended to become financially self sufficient. Its inability to do so as yet has been a source of Congressional concern. 33/

The types of financing for many government sponsored private enterprises have tended to include some form of Congressional appropriations. (One exception is COMSAT, which has derived its income from the beginning from the sale of common stock.) 34/ One example of a congressionally financed corporation is the Corporation for Public Broadcasting, which receives both Congressional appropriations and financial contributions from nonFederal sources. Another example is Fannie Mae in its early operation. Its initial capital was received from the Reconstruction Finance Corporation, which was abolished by the Reorganization Plan 1 of 1957 after its functions were transferred to several executive agencies.

33/ General Accounting Office. Report by the Comptroller General of the U.S. Conrail Faces Continuing Problems. Washington, D.C. Report No. CED-78-174, October 6, 1978. Congressional Research Service. Dr. Stephen J. Thompson. Conrail: Experience, Forecast, and National Transportation Policy Implications. CRS Report No. 78-202 E. October 26, 1978

34/ Telephone conversation with Robert Brobst, Information Officer at COMSAT, May 8, 1979.

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Until 1954, Fannie Mae was financed through borrowings from the U.S. Treasury with the approval of Congress. After the implementation of the Housing Act of 1954 (68 Stat. 590, 12 U.S.C. 1701), Fannie Mae was supported from the sale of non-voting preferred stock. Pursuant to Title VIII of the Housing and Urban Development Act of 1968 (82 Stat. 536, 12 U.S.C. 1716b, September 1, 1968), Fannie Mae became a private corporation and was financed by the sale of common stock.

Evaluation Criteria

While the purpose and mission of many government corporations and government sponsored private enterprises may be specified clearly in their charters and enabling legislation, it is often difficult to identify objective criteria by which to determine whether they are achieving their missions. One could expect more difficulty in identifying such objectives if the government corporation or government sponsored enterprise performs a non-profit or a primarily governmental, as opposed to economic, function. For example, the Corporation for Public Broadcasting as a private non profit enterprise may evaluate its performance in achieving the growth and development of noncommercial educational radio and television broadcasting by an increase in the number of CPB programs broadcast. On the other hand, the primarily economic function performed by TVA is

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outlined by six objectives, such as "maximum generation of electric power consistent with flood control and navigation" and the "maximum development of the Tennessee River." These two objectives can be evaluated in terms of total kilowatt hours per production costs and new jobs created by TVA operations. COMSAT and the proposed Space Industrialization Corporation (when it obtains its private status) as profit-making private corporations, do or could evaluate their performance according to net income per share.

Susan Schjelderup
Senior Reference Assistant
Government Division
June 12, 1979

SS/rla;mb

1284 Craff Court, Apt. 1B
Annapolis, Maryland 21403
June 13, 1979

The Honorable Don Fuqua
Chairman, Committee on Science
and Technology
Room 2266
Rayburn House Office Building
Washington, DC 20515

Dear Representative Fuqua,

Thank you for the opportunity to present testimony from the District Five Energy Committee of B'nai B'rith in support of the Space Industrialization Act of 1979 for the May/June 1979 Hearings on this legislation before the Committee on Science and Technology. Enclosed is the testimony and an abstract for publication in the records of the hearings.

Sincerely,

Bruce Friedman

Bruce Friedman, Chairman,
District Five Energy
Committee of B'nai B'rith

Abstract of Testimony in Support of the Space Industrialization Act of 1979
for the May/June 1979

Hearings in the United States House of Representatives -

Dr. Bruce Friedman, Chairman,

District Five Energy Committee of B'nai B'rith

Space industrialization could provide an increasingly large number of products, services, and benefits to the people of the United States and of the world through the utilization of the extra-terrestrial environment. The Corporation that would be created by the Space Industrialization Act of 1979 would be invaluable as an instrument to encourage the participation of and to aid in obtaining a more effective participation of the private sector of the United States economy in more expeditiously bringing these products, services, and benefits, both immediate and long-term, of space industrialization into being. Consequently, B'nai B'rith fully supports the timely passage into law of the Space Industrialization Act of 1979.

Testimony in Support of the Space Industrialization Act of 1979
for the May/June 1979

Hearings in the United States House of Representatives -
Dr. Bruce Friedman, Chairman,
District Five Energy Committee of B'nai B'rith

The District Five Energy Committee of B'nai B'rith sincerely appreciates this opportunity to testify in support of the Space Industrialization Act of 1979. District Five of B'nai B'rith comprises the Washington, D.C. area, Maryland, Virginia, North Carolina, South Carolina, Georgia, and Florida.

B'nai B'rith feels very strongly that it is essential to extend the domain of humanity and to expand the environment in which humanity lives wherever and whenever it is possible. The expansion of humanity into new environments presents new opportunities and new options for action. These new opportunities and options represent an increase in the chances of survival for humanity and more freedom to make choices. B'nai B'rith believes that an increase in freedom of choice is truly a desirable goal. Space industrialization represents a prime means for increasing the freedom of choice of humanity. A simple illustration of what space industrialization means is a man deciding to go for a walk on an overcast day. If he does not have an umbrella he might be more likely not to go for a walk than would be the case if he did have an umbrella. After all, if he has an umbrella he can take it along with him and leave it unopened if it does not rain. On the other hand, if he does not have that umbrella and he goes for a walk and it rains, he runs a good chance of getting soaked. That is, he cannot use an umbrella that he does not have. Space industrialization can provide many "umbrellas" for all of us in many areas.

The concept of space industrialization is essentially based upon the fact that it is now feasible to extend the sphere of human activity into the extra-terrestrial domain to a far greater extent than has been done to date in order to provide products and services that will benefit the people of the United States of America and of the world. Space industrialization encompasses a broad range of developments which include manufacturing, remote sensing, communications, and energy options. In order to bring these developments into fruition it will be necessary to make a certain capital investment. The question naturally arises as to what should be the source or sources of this capital investment. Before answering this question it is necessary to first examine in some detail some of the projects that might be undertaken as part of a comprehensive program of space industrialization.

In April 1978, the National Aeronautics and Space Administration (NASA) published two comprehensive reports on space industrialization. One report was the result of a study by Rockwell International (RI) and the other was the result of a study by Science Applications, Incorporated (SAI). These studies enumerated and investigated a wide range of space industrialization opportunities. One category of studies was the area of communications and data and information acquisition, transfer, and services. This is the aspect of space industrialization which is most likely to develop in the immediate future as compared to other aspects of space industrialization. Indeed, this aspect of space development already exists to a certain extent as the Communications Satellite Corporation (Comsat). In addition to its already existent facilities, Comsat has recently expressed interest in acquiring remote sensing capability and providing this capability as a routine commercial service. The intent of the Space Industrialization Act of 1979 is to provide a means, the Space Industrialization Corporation

(Corporation), in order "to promote, encourage, and assist in the development of new products, processes, and industries using the properties of the space environment". As this proposed legislation notes there is a reluctance among the general business and industrial community to make investments in space development because of the generally longer term to profit, higher than usual risk nature of this development. However, in this particular area of communications there has already been some private investment and further investment is planned as, for example, the Western Union Company is currently in the process of doing. Although the intent of the Space Industrialization Act of 1979 does not seem to include, at least as one of its primary functions, the supply of further stimulus to the general business and industrial community for participation in the communications, data, and information sector of space industrialization, it is nonetheless of interest to consider this sector first before other aspects of space industrialization in this testimony in the light of the RI and SAI reports. This is because even here in the relatively most mundane aspect of space industrialization the federal government via the proposed Corporation can play a legitimate and valuable role in expediting applications in order to enrich the national economy and to provide benefits to the public in a more expeditious manner.

It is in the area of communications, data, and information that the benefits of space industrialization are most clear at this time. The RI report considers what it feels are essentially two non-overlapping categories, namely, information transmission and data acquisition. The study has as one of its pivots the investigation of needs and opportunities. By opportunity is meant a solution to a preceived problem. The relationship between needs and opportunities can be quite complex since every opportunity satisfies some need, real or imagined, while each need stimulates the creation of some solution or opportunity and possibly more than one such solution.

One possibility presented in the RI report is that of electronic telecommuting wherein electronic communication replaces commuting by automobile. This would certainly save on the utilization of petroleum, be a blow against traffic congestion, and help improve the quality of the atmosphere. The alternative to an appropriate satellite system would be the installation of a conventional cable network. The satellite approach is more economical and it becomes more attractive as the commuting distance is increased, because with a satellite system there are basically no geographical limitations.

With electronic telecommuting, a worker instead of driving to work every day operates from either his home or a small subsidiary office, from which location communication would be made electronically with equipment at a central location. This saves the worker transportation expenses and commuting time. From the point of view of the employing businesses and industries, the regained commuting time could now be used in a productive manner. In addition, all of the working staff of a company would now no longer have to be employed at one central or several major installations which installations in many cases incur high overhead costs for the owners and managers. If the worker operates from his own domicile, he is clearly paying for this "overhead". (In fact, electronic telecommuting should provide an interesting situation for the Internal Revenue Service with regard to all of those workers taking deductions because they are using their homes as places of employment.) If the worker cannot work in his domicile, very often the required subsidiary facility could be located at a point both more convenient to the worker than is the central location and simultaneously situated under circumstances more economical for the owner to operate.

A variation of electronic telecommuting is electronic teleconferencing. Aimed at the executive, electronic teleconferencing utilizes electronic

means for the transmission of visual images of the executive to another location instead of actual bodily transportation. Again, there would be significant time savings for the busy executive.

Electronic telecommuting could result in 20 percent of the jobs in the United States being decentralized.

Extrapolating from current data, in the year 1990 Americans could be driving a total of about 1800 billion miles with the corresponding figure for 2005 being about 2200 billion miles if electronic telecommuting does not materialize. With such telecommuting, the figure for 1990 could drop by 15 percent and in 1990 the drop could be 30 percent as compared to their respective figures without such telecommuting. The anticipated fuel consumption by these automobiles in 1990 is about 3300 billion gallons and in 2005 this consumption is expected to be about 3600 billion gallons without electronic telecommuting. With electronic telecommuting, the figures come out to be about 2800 billion gallons and 2500 billion gallons in 1990 and 2005, respectively. The RI report assumes oil costs of \$15 per barrel which translates into consumer savings of about \$60 billion in 1990 and about \$120 billion in 2000. If anyone is going to start worrying about the loss of profits for the oil producers and refiners, that person should stop doing so immediately. Although the RI report does not mention the fact, very often crude oil is more valuable as stock for petrochemical production than it is as a fuel source. The petrochemical industry could quite readily expand to take all of the crude oil which the oil producers wanted to supply. It has already been thought for some time by a number of people that it is a waste to burn up such a valuable resource. Electronic telecommuting hence would serve a very useful purpose in aiding this diversion.

What would such an electronic telecommuting service entail from the point of view of equipment? In space, there would be one or more high-

power relay communication satellites which would be useful only for long distance communication. There would be regional linkages via fiber optic bundles which linkages would be similar to current telephone or cable television installations. The satellites themselves would be similar to the Satellite Business System satellite, obviating the need for new federal government-funded satellites. At the ground end of the system, there would be many small remote intelligent terminals for the users with the number of terminals running up to ten million. On the ground there would also be numerous low-power, extremely high frequency (10 to 90 GHz) transmitters having several thousand audio band channels for multiple random access. Originally, cable television and/or television networks would be extended to individual terminals in small, neighborhood centers which centers would service ten to one hundred workers and further extensions would later be made to individual homes. These neighborhood centers would include rooftop antennas for satellite connections. The cost of a satellite would be about \$50,000,000. The ground terminals would cost about \$3,000 each.

How could the Space Industrialization Corporation which would be created by the proposed Space Industrialization Act of 1979 aid in expediting this relatively mundane aspect of space industrialization? It is true that many companies and businesses would see obvious benefits to be attained in their operations by this type of decentralization. These organizations would see no risk involved in making the necessary investments for purchasing the facilities and training personnel for this new way of "going to work". However, there may be numerous other firms, presumably towards the smaller end of the scale of operations, where questions could legitimately be raised as to the profit and risk involved in going to this new way of doing business. Under this sort of circumstance, a particular firm would be able to go to the Space Industrialization Corporation and say to the Corporation

that its situation is unclear but that if it received some financial aid it would try to see if electronic telecommuting would be suitable to its own circumstances. The Corporation could either supply some of its own funding to the company or else help it to negotiate funding from some other suitable federal agency, such as the Small Business Administration, or perhaps even some kind of joint arrangement between the Corporation and another agency could be arranged. If the experiment turns out to be profitable, arrangement for repayment of the funding would be made, in full or in part, or perhaps even in full and with an added profit, depending on the full success of the experiment. If the company in the course of the experiment, had made innovations in equipment and procedures that may have meant the difference between success and failure, it would have the right to apply for appropriate patents. This example illustrates how the Corporation could play a significant role in accelerating the utilization of space for benefits down here on the earth without even bringing any actual material products down from the extra-terrestrial environment. In this example, even if the experiment should fail, this result could still be considered positive because it would aid in delineating the actual scope of the applicability of utilizing electronic telecommunications with satellites for improving business operations.

The Corporation could play an important role in obtaining private enterprise participation in the development of even such a complex enterprise in the area of communications and information and data acquisition and transfer as the Orbital Antenna Farm (OAF). This concept was originally proposed by B. I. Edelson and W. L. Morgan of Comsat Laboratories in the September 1977 issue of *Astronautics and Aeronautics*. Under this concept a multitude of communications, data, information, and remote sensing missions would be combined on one spacecraft in geostationary orbit, replacing a large number of single mission satellites in that orbit. Such a concept has such

advantages as easing interference caused by crowding of the geostationary orbit, thus allowing smaller ground facilities, permitting interconnecting of multiple missions, gaining economy of scale by providing common support functions to multiple payloads and complex antennas and feed systems. The multiple communications and related systems support functions provided by this complex spacecraft would include electrical power, structure, thermal control, orientation, stationkeeping, tracking, telemetry, and command. The services provided to the earth would encompass telecommunications (intercontinental, regional, domestic), aid for the merchant fleets, airlines, and land transportation systems, and means of aiding navigation and providing meteorological data and forecasts. Transmissions could be between two points on the earth or be in the form of a broadcast from one point to a number of points. Data and information could be collected from numerous points and sent to a single point. A geostationary OAF would allow combination and hybrid services to be made more readily available. When more than one OAF would be created, telecommunications could take place both within and between these spacecraft. The term "antenna farm" arises from the fact that such spacecraft, in order to carry out their varied tasks, must bear an array of complex antennas and feed systems of assorted sizes, varieties, and frequencies. Typically, an OAF could have at least four different types of earth-pointing antennas, namely, a center-fed parabolic reflector for multiple spot beams, a smaller parabolic reflector for centimeter waves, a millimeter-wave reflector, and a lens array for shaped beams.

However, combining missions on a single OAF could result in attempting to mate missions that could be technically or politically incompatible with each other. There could also be difficulties in making inter-institutional arrangements which arrangements would allow the effective combination of missions. The yet-to-be formed Corporation could be instrumental, at least

with regard to the technical aspects, in resolving some of these difficulties while increasing participation by private enterprise in the OAF endeavour. Suppose, to take a specific scenario, an OAF were to be owned and operated by Comsat. Comsat may decide it would like to add another service, another capability, to the OAF. Comsat then finds that the operation of this service would interfere, electronically or some other way, with one or more services already aboard and supplied by the OAF. An attempt is made by Comsat Laboratories to solve the problem but the laboratory is unable to do so within the budgetary and temporal restraints under which it labors. NASA also tries for a while and fails also and its budget will not allow it to pick up the problem again within the immediate future. However, all is not yet lost. Company X, a non-aerospace company, let us say, a small electronics firm, has heard of the difficulty which Comsat has been having with adding this new service to the OAF. This company ponders the problem and comes up with an ingenious idea which the company believes could solve the problem. Unfortunately, Company X does not have the funding to do the research and development to bring the idea to fruition. The same is true of Comsat and NASA. The company does know of the existence of the Corporation, so X applies to the Corporation for funds. One of the major goals of the Corporation is to encourage the private segment of the national economy in developing space technology for the benefit of humanity with the emphasis being on encouraging business and industry outside of the aerospace sector. (This emphasis on non-aerospace enterprise encouragement is the reason why Comsat would be highly unlikely to go to the Corporation for funds and why, if it did, the Corporation would be highly unlikely to give it such funds. The very existence of Comsat is based upon the known profitability of a certain type of space application, i.e., communications. Even if some possibilities in this area of application encounter difficulties in their

realization, or even if some possibilities cannot be realized at all, Comsat needs no further encouragement from the federal government to continue on its profitable way.) The Corporation reviews the proposal of Company X and deems this proposal to be a reasonable risk except that some points are a bit too unclear. At this point, the Corporation gives the company a small grant to clear up these points. The proposal is now in proper form and the Corporation is completely satisfied, so it gives the company funds from the Corporation Space Industrialization Trust Fund (Fund) to work out the solution. Unfortunately, Company X encounters an unexpected snag and is unable to solve the problem. It submits a report to the Corporation and publishes a full description of its approach to the problem and the reason for the failure to attain a solution. This is not the end of the story. Company Y, another small electronics firm, peruses the report of Company X and perceives what Company X overlooked. Company Y now goes to the Corporation with a proposal which is approved and funded by the Corporation out of the Fund. This time success is obtained. Company Y repays the full amount of money which it obtained from the Fund with an added profit. Comsat purchases the solution from Company Y and finds itself now operating a very profitable new service from the OAF. Comsat is so gratified that it gives a substantial monetary gift to the Fund to be used in any way that the Corporation feels is suitable.

The authors of the Space Industrialization Act of 1979 probably had actual material products from space mostly in mind when they were preparing this proposed legislation. These are products which would be processed entirely or in part in the extra-terrestrial environment. The RI report breaks these products into two major categories: organic and inorganic. There have been many proposals in recent years for space manufacturing processes. The experience of this nation in space to date indicates that there is a strong possibility that a significant proportion of these proposals could turn into profitable operations.

Many of the proposals in the organic area are based upon separation processes. Some of the biological and organic entities under consideration within the separation and isolation category are kidney cells, T-and B-lymphocytes, bone marrow cells, hormones, isoenzymes/proteins, interferon, antibiotics, lipoproteins, immunoglobulins, chalones, and hypothalamic factors.

The most discussed possibility in the organic area is urokinase. About half of the yearly deaths in the United States are caused by cardiovascular diseases which diseases include heart failure, stroke, and arteriosclerosis. The deaths of these one million people is generally preceded by blood clot formation. The enzyme urokinase which is produced in the kidney can dissolve these clots. Because urokinase is produced by a costly separation process from urine, treatment with this enzyme costs about \$1200 per dose, so that it is used only clinically instead of therapeutically. The expense of production renders this enzyme unavailable to the general public. It is possible that rapid processing and separation in space could lower the cost to about \$100 per dose. It is anticipated that there will be a joint project of NASA and Abbott Laboratories, which Laboratories are in the business of developing the methods to culture the urokinase-producing kidney cells, to produce urokinase in space. It is estimated that space-produced urokinase will satisfy half of the market demand by the latter part of the coming decade.

The utilization of the free-fall environment should expedite the production of urokinase. The means of separation in orbit would be an electro-phoretic device which device would separate urokinase producing cells from a culture of kidney tissue prepared on the earth. In the environment of space, with the absence of convection arising from gravitation and the similar lack of sedimentation, the separation would be accomplished with a higher throughput and purity than is possible in an earth-bound production facility. This degree of separation has already been demonstrated on the Apollo 14

and Apollo 16 flights and on the Apollo Soyuz Test Program. The ground-based production involves the processing of 1500 liters of urine per dose, while the production started in space commences with specific kidney cells, which shift in raw material procurement decreases the volume of material to be processed and makes it easier to obtain source material. Although the minimum time to obtain Federal Drug Administration (FDA) approval for making urokinase available to patients would not be before 1985, this time factor will not appreciably extend the time before which space-processed urokinase will actually be used for routine treatment. It should only be about one or two years after urokinase in space starts being produced that it will be available to patients because the FDA needs only to identify the space product and ascertain the purity of the product. This short period is all that is necessary because the FDA has already given approval for the clinical utilization of urokinase. The initial facility for processing kidney cells will presumably be in the European Spacelab and the electrophoretic apparatus will be completely automated.

It is natural to ask the question, "Since NASA is cooperating with Abbott Laboratories in the space-based production of urokinase, why cannot NASA do the same with regard to other pharmaceuticals by further cooperative ventures with Abbott Laboratories and/or other companies?" The answer is very simple. Before Abbott Laboratories entered into its agreement, the concept for urokinase production had already been checked out and confirmed on actual space flights. Hence, Abbott Laboratories already knows that it has a good thing going for it. NASA itself can only do a very limited amount of research and development on pharmaceutical production in space because of its very restricted budgetary situation. After all, it has to cover a lot of ground with only a relatively small amount of money, with projects ranging from making airplanes more quiet to probes of Jupiter.

It would be nice if the private sector would be more venturesome. However, if NASA cannot supply much money to investigate pharmaceutical production in space, it might be asked if other federal agencies could supply such funding. This a possibility but it is nowhere as effective a possibility as would be the proposed Corporation. For example, legislation could be passed giving funding to the Food and Drug Administration (FDA) in order for this agency to undertake a research and development program directed at ascertaining the feasibility of certain pharmaceutical production in space. However, the Food and Drug Administration has many concerns. The impetus for such legislation would have to come from outside of the FDA. Also, the FDA would have to take the results of this research and development and try to get companies interested in making a commercial proposition out of these results. Again, the FDA cannot devote very much of its time and effort to this endeavour because of its other concerns.

Furthermore, what would be done in the area of pharmaceuticals with the FDA would have to be done separately for other space industrialization endeavours in other areas with other appropriate agencies. The process of stimulating the private sector into being more venturesome in the development of space would be very combersome by this route. A far more feasible approach to this stimulation problem is the creation of an organization dedicated to the endeavour of stimulating the participation of the private sector in the utilization of space. The creation of such an organization, namely, the Space Industrialization Corporation, is exactly the objective of the Space Industrialization Act of 1979. The Corporation would not only aid a company by acting as a source of funds, both directly and indirectly, but agreements between the Corporation and that company would provide for adequate protection of the proprietary rights, including patents and copy-rights, of the company at all stages of the project.

As has just been mentioned above, the stimulus situation is similar in the area of inorganic products from space as the situation with organic products. Possible products in the inorganic category include high-strength permanent magnets, large dc crystals, new optical glasses, higher-temperature turbine blades, and large scale integration circuit chips. The mode of processing for most of these products would arise from the fact that very pure crystals can be grown in the free-fall environment of space from a liquid mix in such a manner that the materials for the product are suspended without being in contact with the surfaces of a container.

One strong possibility is the fabrication of large silicon crystals for electrical power application. For this application crystals of up to 150mm in diameter are very desirable, yet it is not feasible to produce them via current processing techniques upon the earth with its gravitational environment. Float zone refining is the technique utilized to refine silicon for these power applications. In this approach, the surface tension of a molten zone in a silicon rod holds that zone in place. The heat source is either a ring-shaped resistive heater or an induction coil. The source is moved along the rod which motion causes the molten zone to move along the rod. In this manner, the impurities are swept along the rod, leaving behind what becomes a homogeneous monocrystalline structure. In the earth-bound environment, for given values of the density and surface tension of the molten zone, the limiting height of the molten zone is proportional to the inverse of the square root of the acceleration due to gravity. This functional relationship imposes, in turn, a practical limit upon the maximum attainable diameter in the earth-bound environment because a correspondingly large height is required to melt the entire section of a large diameter rod. There is apparently no limit in space to the diameter that could be float zone refined because, in this case, the integrity of the molten zone would be maintained by surface tension.

An alternate approach that may be preferred to float zone refining is Czochralski pulling in a free-fall environment. This possibility exists because a major hindrance to utilizing silicon wafers larger than 40mm to 50mm in diameter has been the existence of a proportionally higher dislocation density in these crystals. The float zone approach may not lower the dislocation density enough, whereas the Czochralski technique would lower, in fact, could yield the lowest possible dislocation density. This lower dislocation density results in a more uniform distribution of the electrical parameters in a crystal. This enables effective use of the larger diameter of the semiconductor with respect to carrying larger voltage and current loads.

There is definitely a growing need for this larger size silicon wafer. These wafers would be used in semiconductor rectifiers. The use of these rectifiers in electrical power distribution systems is growing along with the increased utilization of high voltage direct current (HVDC) electrical energy transmission. The reasons for increased utilization of HVDC are because it reduces reactive power transmission losses and makes large-scale underground power transmission feasible. The largest sizes of wafers currently available commercially are 40mm and 50mm in diameter. The power industry would like to have sizes available in the 100mm to 150mm range, depending upon the particular design situation under consideration. For example, a General Electric rectifier-inverter installation under construction, at the time the RI report was issued, at the HVDC Facility in New Brunswick, Canada, will use 9600 forty-mm silicon wafers to deal with up to 360 megawatts of power. Each semiconductor device in this rectifier-inverter installation has to have heat dissipation, load balancing, controls, and electrical protection provided for by peripheral equipment. Thus, the design advantage of less peripheral equipment being required is obtained by reducing the number of semiconductors needed to handle the same power load.

Given that there is a definite need for such large silicon wafers and the fact that there are at least two approaches that could lead to this desired end, it is quite possible that only a relatively small request for funding to develop the correct approach being accepted and approved by the Corporation could induce the firm that submitted the request to put up a substantial amount of its own capital. It is possible that one of the results of the operations of the Corporation will be an upsurge of confidence and a renewal of spirit of the private sector of the economy. Some people have referred to this time that the nation is enduring as an "age of timidity". The Corporation could play a significant role in giving the firms and businesses of the private sector a transfusion of "true grit".

Another good point of the proposed legislation is the exemption of the Corporation from the provisions of section 552 of title 5 of the United States Code, which title has the heading "Public information: agency rules, opinions, orders, records, and proceedings", with regard to the information content of the applications, proposals, management plans, or financial or assistance agreements between the Corporation and a given firm. A company would certainly hesitate before coming to the Corporation if it felt that its ideas and thoughts that constitute its very means of existence could be given away to others just for the asking.

The question could be raised, "Is the Space Industrialization Act of 1979 the most reasonable way of attaining the goal of vigorous participation of the private sector of the economy in helping to accelerate the growth of space industrialization?". In fact, a further question could be raised, namely, "Does there have to be any federal government participation at all in order to attain the above mentioned goal?". The answer to both questions is an extremely firm "yes"!

The government has already made a large investment in one of the basic tools required for space industrialization. This tool is the Space Transpor-

tation System (STS), more popularly known as the space shuttle. It is difficult to realistically imagine that the STS could have been developed by private enterprise with its own funds whether the attempt was made by a single firm or by a consortium. Picture even a consortium, realizing that it does not have the financial capability to finance STS development on its own, going to the private banking system for some kind of loan arrangement. It would be extremely probable for the banks to turn down the request for a loan arrangement with the reason that the investment is too much of a risk with too little amount of a return in sight in the immediate future. One of the major purposes for which the federal government exists is to undertake tasks and to carry out functions which could be undertaken only with great difficulty or not at all by private enterprise. For example, the defense of the nation is rightly and definitely considered to be a federal government function and not a function of the private sector. In a sense, the large role which the federal government must assume in accelerating the growth of space industrialization might be considered as a legitimate extension of the defense function, that is, that this role constitutes a defense of future options which options could prove necessary to the survival of the nation and of humanity.

B'nai B'rith knows of only one attempt to commence the acceleration of space industrialization without employing a significant federal government support structure. This is the closed-end diversified management investment company known as International Satellite Industries, Incorporated (ISI) which was incorporated in August 1978. This company seeks to earn the income necessary to fund the research and development required to make space industrialization a profitable enterprise for the company while it maximizes the level of unrealized capital gains in accord with this objective. The company is attempting to obtain income for research and

development by investing in equity securities of corporations which appear likely to profit from space industrialization. The company is attempting to lessen the risk of its venture by investing only in securities issued or guaranteed as to principal or interest by the United States until the completion of its third public offering and net assets greater than thirty five million dollars have been attained. As soon as the company determines that space industrialization has become economically feasible with the level of assets it manages to accumulate at a certain point in time, the company intends with the approval of the holders of a majority of outstanding common stock of ISI to convert from being an investment company to becoming an operating company occupied in space industrialization.

The approach to space industrialization embodied in ISI has at least two major difficulties. First, it is difficult to see how such a firm could ever accumulate sufficient funds from stock offerings to the general public. The preliminary prospectus of ISI of March 5, 1979 itself recognizes the uncertainty of raising these monies. In order to invest, people would have to be willing to forego getting a return on their investments for an extended period of time consisting of years. It should also be considered that a certain number of the research and development avenues followed by the company would prove to be failures as far as leading directly to a profit and would be a non-productive drain on ISI. The result of research and development projects that do not lead to near term results would be an even longer period of time before ISI could become an operating company and commence yielding profits. Second, ISI suffers from another severe problem compared with the proposed Corporation of the Space Industrialization Act of 1979. ISI has to understand and anticipate on its own, plus any aid it can obtain from consultants outside of its own framework, what are the needs within the national economy which can most readily and earliest be fulfilled in part or as a whole by a space industrialization approach. On

the other hand, the Corporation would be operating with the experience and insight of a far greater base, namely, the entire business community of the United States of America. A firm that comes to the Corporation with a proposal is presumably going to come with a proposal that relates to and is founded on the experience of that firm. The Corporation can depend on a firm drawing on at least something approximating the best efforts of the personnel of that firm to come up with a proposal that according to the firm would have a reasonable chance of success. The firm would presumably have a certain number of people working on this project on a regular basis. It would be a long time, if ever, before ISI could form a staff that would have the requisite size and embody the requisite expertise to manage a number of space industrialization projects each of which would have a reasonable chance of success. It is not at all probable that a particular ISI team could be organized to look into a particular possibility, such as, for example, ball bearing manufacture in the free-fall environment, and follow this project through to completion in as cost-beneficial manner as the proposed Corporation would operate in conjunction with the firm actually doing the work on that project. In order to match the operations of the Corporation, ISI will have to accumulate far more than the one hundred million dollars that the Corporation will have in its Trust Fund within two years after its organization. Essentially, the Corporation would have the citizens of the United States as its stockholders giving it a far greater base of support than ISI can ever reasonably expect to obtain. It would not be surprising if the Corporation were to become a publicly owned corporation standing on its own feet within five to ten years after its establishment. It is very uncertain if ISI could attain this stage of being self-sufficient by the year 2000 if ever and it is just about as uncertain if ISI can even survive for very long.

A very attractive feature of the proposed Space Industrialization Act of 1979 is that it directly addresses one of the key problems involved in getting the concept of space industrialization off of the ground. That problem is the one of uncertainty and risk. The Corporation that would be created provides a mechanism to allow the private sector to find out what is profitable and, what is just as important, what is not profitable in the way of enterprises within the environment of space. From a broader perspective, this proposed legislation allows the first toeholds to be attained in realizing the tremendous potential benefits for humanity which the industrialization of space offers. In essence, the Corporation would empirically deal with a problem that has arisen in connection with the RI and SAI reports, namely that, according to some analysts, the conventional economic analysis embodied in these reports is inadequate to depicting the true richness of the benefits to be obtained by the people of the world. It is true, however, that these reports do give a tantalizing hint of the fruitfulness of space industrialization. The trial and error approach of the Corporation would be a way of maximizing the benefits to be obtained in a minimum amount of time with a relatively small amount of funding.

However, it is always useful to try to make predictive studies before an event in order to better plan for that event. In fact, one of the functions of the Corporation should be to make predictive studies on a routine basis and to use the results from completed and on-going projects as part of the input to those studies. The question arises: "What is the most appropriate approach to use for economic development and policy analysis in order to give the most accurate picture as to the benefits being derived and to be derived from space industrialization?".

The RI and SAI reports represent the utilization of elementary micro-economics and cost-benefit analysis. Cost-benefit analysis, even when it is utilized under conditions of uncertainty and risk, incorporates the concept of discounting.

In their book Cost-Benefit Analysis: Theory and Practice (Barnes & Noble Books, a division of Harper & Row Publishers, Inc., New York, 1972), Ajit K. Dasgupta and D. W. Pearce outline ways in which cost-benefit analysis attempts to grapple with the problem of uncertainty and risk. They make a distinction between "uncertainty" and "risk". If, in a given situation, there is sufficient information to justify the assignment of probabilities to different outcomes of that situation, then that situation is defined as "risky". If there is not sufficient information to assign such probabilities, then the situation is defined as "uncertain".

If the situation is risky, then a decision must be made as to what is meant by probability. The two main approaches to this question are the "frequency" or classical approach and the other is the "degrees of belief" or Bayes approach. In the first approach, probability is called objective and in the second approach probability is called subjective.

In the objective approach, the analyst knows exactly what the consequences of each decision concerning a project would be for given circumstances or states of nature, so that the probability distribution of circumstances can be used to obtain a probability distribution of outcomes for each decision. The analyst must then have a value designation for each outcome. With this information the analyst can then derive a corresponding probability distribution of utilities. By utility is meant some sort of return or gain. The expected annual benefit of the project is then computed from the probability distribution of returns using accounting prices for inputs and outputs. In a broad sense, an accounting price is a price assigned to a

good or factor in an economic analysis on the basis of an argument that this price is more appropriate for the purpose of the calculations involved than the price that may exist in actuality. An appropriate rate of discount is then used to calculate the current value of the time-stream of expected benefits over the period of the life of the project. The determination of an appropriate discount rate is itself a major concern. For an individual a "benefit" is an outcome for which that individual expresses a preference. The calculation of benefits yields a measure of the worth of the project to society.

The subjective approach commences with the idea that some events or propositions may be considered to be more likely or probable than others without the implication necessarily of a frequency or statistical interpretation of probability which interpretation is the basis of the objective approach. Probability in the subjective mode is a "degree of belief" which means a degree of confidence that a person has about a certain event occurring or about the truth of a given statement. In order to obtain a conceptually meaningful theory from the subjective probability notion two further elements must be integrated with that notion. One element is to make the concept of a degree of belief operational by joining that concept to action. The second element is an axiomatic system to enable the making of consistent choices between gambles or uncertain choices. Once this second element is added, both the numerical probabilities or degrees of belief and the utility indices are simultaneously determined. The result of this integration is a theory that allows the analyst to be justified in choosing risky projects according to the expected utility criterion although there is not enough information to be able to use statistical probabilities. (The expectation of utility is an exact mathematical function composed of subjective probabilities and utility functions. Comparison of two expectation

of utility functions yields the expected utility criterion.) This means that the subjective approach leads to the same decision rule as does the objective approach that the project to be chosen is the one with the highest expected utility.

The subjective approach to probability for cost-benefit analysis under risk was introduced because the frequency approach may not always apply in economic life. However, there are a number of criticisms of the subjective approach. One drawback is that the axioms upon which this approach depends on to lead to the expected utility rule exclude emotional factors. These factors can be influential in the decision-making process under the condition of uncertainty. A second problem arises from the fact that subjective probability is derived from the degrees of belief of the individual decision-maker, while cost-benefit analysis must make a decision with regard to choosing a project from the point of view of the total society. A third criticism arises from the question of making a decision on the basis of the assumption that the axioms of the subjective approach are valid for the individual if these axioms are simultaneously true for the total society.

If a project is of such a nature that the variance or spread of the probability distribution of utility about the expectation value of the utility must be considered in addition to that expectation itself then in evaluating that project it may be necessary for society to make an adjustment in the analysis, this adjustment being known as risk aversion. In

this event a project with a large variance is penalized relative to a project with a smaller variance. From the point of view of evaluating the worth of the Space Industrialization Act of 1979, it is observed that one effect of the Corporation is to reduce the variance of space industrialization projects for the private enterprise sector. B'nai B'rith feels that this reduction in variance is a worthy goal.

One way of introducing risk aversion in cost-benefit analysis is through the use of a quadratic utility function to derive curves known as indifference curves wherein expected value is expressed as a function of standard deviation at a given level of risk aversion. There are problems with this approach not only because the indifference curves cannot be derived without restrictive assumptions being made but also because paradoxes are encountered as a result of the use of the quadratic utility function. This difficulty leads back to the recourse of estimating the expected social utility of a project in the usual manner and lowering this utility by a certain amount which amount is a function of the degree of risk aversion judged appropriate. However, Dasgupta and Pearce mention a situation described as a paradox by Arrow and others, namely, that a quadratic utility function implies that as an individual or a nation becomes more wealthy then the amount of risky investments will tend to diminish, that B'nai B'rith feels is not at all paradoxical. Dasgupta and Pearce feel that experience and intuition indicate that as a society becomes wealthier it is more likely to make more investments that are a risk. The B'nai B'rith experience and intuition indicate just the opposite situation exists with respect to the United States of America at this juncture of history. This nation is now the most wealthy nation that has ever existed. It certainly has the wealth to indulge to a much greater extent in investments that bear risk than it is currently doing. The mood of the nation does not permit this investment. Perhaps, when a nation becomes so wealthy, as in the case of an individual it can become very fearful of losing that wealth through investments that could fail. The Corporation of the Space Industrialization Act of 1979 has as one of its aims the reduction of this fear in the private sector of the economy. Dasgupta and Pearce are quite correct, however, in expressing the view that the appropriate degree of risk aversion should

have a dependence on the general level of prosperity. Also, both on the individual and societal levels, the appropriateness of the degree of risk aversion is a function of the degree to which the existing liquidity position is perceived to be satisfactory. Finally, religious and moral values can affect the degree of risk aversion.

In a situation of complete ignorance wherein no probabilities at all can be assigned, it is not possible to apply the expected utility criterion for project choice. This situation can be handled, at least in principle, by the application of tools similar to those used in game theory. This approach assumes that the pay-off matrix of the situation is known, which matrix consists of knowledge of the possible actions, the possible states of nature and the utility or pay-off of the results of actions under each of these states. Four possible decision criteria which have been proposed for this approach are the maximum pay-off (Wald) criterion, the minimum regret (Savage) criterion, the index of pessimism (Hurwicz) criterion, and the principle of insufficient reason (Laplace-Bayes). All of these criteria have their defects. The Wald criterion leads to a conservative bias in the social choice of projects which bias could inhibit long term growth and development because this criterion utilizes only that part of the information in the pay-off matrix that relates to the worst outcome for each selection of strategy. The Savage criterion also results in a conservative bias. It also has the difficulties that the appropriateness of measuring regret by the difference between actual and potential utility is questionable and that this criterion does not have to be independent of irrelevant alternatives. By "independence of irrelevant alternatives" is meant that the social ordering of a given set of alternatives is independent of the existence or ordering of any alternatives outside this set and depends only on the orderings of individuals with regard to the given set. The Hurwicz

criterion encounters difficulties because the degree of pessimism, a psychological variable which this criterion introduces, making this criterion more realistic and more general, is left undefined and must be estimated in some manner. The Bayes-Laplace criterion is criticized because it is apparently based upon the contradiction that it attempts to re-introduce probability which probability a complete ignorance situation is supposed to exclude by definition. The attempt to resolve this quandary via the utilization of the principle of insufficient reason which principle states that a decision maker under "complete ignorance" should assume that there is an equal likelihood of all possible states of nature existing is itself of doubtful validity because knowledge, such as the equiprobability postulate, cannot be deduced from ignorance.

All of the above approaches for grappling with risk and uncertainty in cost-benefit analysis are more or less sophisticated so it is to be expected that when it comes down to actual real world cases these approaches are all more or less ignored and empirical rules of thumb utilized instead. Apparently, these sophisticated approaches are too complex to manipulate in a convenient manner. Some of the approaches used in actual practice are to add a risk premium to the "pure" rate of discount when the present values are calculated, to raise the costs items or lower the benefits items that seem uncertain by a certain amount, and to use a project life smaller than the formal economic life for comparable but relatively risk-free projects. One significant question is whether any or all of these rules of thumb is adequate even in part for analyzing such a new concept as space industrialization and the activities envisaged for the Corporation.

If the space industrialization concept is examined from the point of view of its longer term benefits to humanity in addition to simply the point of view of obtaining relatively near term products and services from

business and industry involved in profitable space enterprises, it is possible to consider new types of cost-benefit analysis beyond the approaches dealt with so far. Before undertaking this consideration, it is of some importance to consider the opinions and analyses presented by W. W. Rostow in his book Getting From Here to There (McGraw-Hill Book Company, New York, 1978).

In this book Rostow presents the case for taking the long run seriously. He states the belief that humanity by the end of this century will have drastically restructured its patterns of investment, including the magnitude and directions of research and development, to accomplish a number of goals. These goals include lowering the gross annual birth rate to 20 per 1000 or lower, increasing the level and productivity of agriculture, developing a new economic energy system based on renewable or essentially nonfinite sources, overcoming raw material shortages by expanding production, substitution, economy, and recycling, controlling environmental pollution, and providing for the technologies in agriculture, energy, and raw materials that are needed in the twentieth century. The Corporation should be envisaged as part of the beginning of this restructuring of the patterns of investment. Although, for some reason, Rostow does not mention the concept of space development and industrialization in his book, space industrialization can make very important contributions towards attaining all of the goals which he feels should be accomplished.

Rostow suggests that the world economy is now in the early phase of a Kondratieff upswing, namely, the fifth upswing. A Kondratieff cycle is a long cycle of from forty to fifty years duration which the Russian economist Kondratieff suggested that capitalist economies experience. During a cycle, prices and production oscillate about an equilibrium path. The explanation of Rostow for Kondratieff cycles focuses on the prices of food

and raw materials relative to the prices of industrial products. Although other forces are acting, these cycles basically reflect periods of relative shortage and relative abundance of food and raw materials. The characteristics of a Kondratieff cycle, which characteristics are shifts in income distribution, the directions of investment, and in trends in interest rates, real wages, and the general price level, are all underlaid by changes in relative prices.

The much greater length of a Kondratieff cycle as compared to a conventional business cycle apparently has its origin in the substantial amount of time to obtain and develop new sources of food and raw materials. The combination of the lag involved in responding to a relative rise in food or raw material prices and the need to develop whole new regions as a response to the situation leads to an overshooting of world requirements and a period of surplus. This situation then leads to a relative decline in the prices of food and raw materials. This fall continues, although it gradually slows down, until the expansion of world requirements overtakes this excess capacity and supply generated in the Kondratieff upswing. The distinguishing marks of an upswing are an accelerated general inflation, high interest rates, pressure on the real wages of urban labor and on persons on fixed incomes, and a relative prosperity for those who are producing food. During downswings, with the exception of the one from 1951 to 1972, the general price level tends to fall, interest rates are low, and real wages are forced upwards by the decline in living expenses. (The reason for the exception is that although between 1951 and 1972 the relative prices of energy, raw materials, and food tended to decline, the general inflation prevalent at that time tended to limit the absolute fall of basic commodity prices in the 1950's and to yield a slow rising tendency in the 1960's.)

A major factor in shaping the Kondratieff cycles has been the impact of technology upon the world economy. There have been four great waves of technological innovation impact upon society since the 1780's. The first wave was let loose at that time upon Great Britain and include cotton textile machinery, techniques for producing good quality iron with coke, and the improved steam engine of James Watt. At the same time, the cotton gin of Eli Whitney was making its contribution in the United States. The second wave between 1830 and 1890 was the railroad with its affect upon the cost of transportation. The third wave between about 1875 and the end of the nineteenth century was a result of the inexpensive production of steel. The fourth wave impacting upon society started early in the twentieth century and includes the internal combustion engine, chemicals, electricity, and the still developing ramifications of electronics. The advent of the acceleration of space industrialization via the instrumentality of the Corporation could well prove to be the beginning of a fifth wave of technological impact that will have an eventual effect more profound than that of the previous four waves.

The fundamental theme that Rostow enunciates in his book is that compensatory investments are now required to return the economy of the world to a situation of balance and that this investment during the fifth Kondratieff upswing will call for a greater and more aware government role than was previously needed. B'nai B'rith agrees with this theme. If the economy of the world is facing an increase in relative prices of basic commodities, the appropriate course of action is to alter the directions of investment. In operational terms, this means that more resources must be assigned to increase the supply or to minimize the use of those commodities in those cases where demand has run ahead of supply from existent sources. Rostow believes that one difference between this Kondratieff upswing and

the first three upswings is that there are no major physical frontiers from which new resources could be obtained and that the only frontier that can save the situation is the frontier of new technology. B'nai B'rith believes that Rostow is only partially correct although he is definitely on the right track. The Corporation and its activities in the course of the new developments in technology will also simultaneously be opening up a new physical frontier, enormously larger in terms of orders of magnitude than anything in the history of humanity. It will be several decades before actual physical material resources from, for example, the asteroids will be having a major impact on the national economy, but much before then, within a few years of its inception, the Corporation will be interacting via new technologies and improved versions of old technologies with the national fabric to increase the productivity factors of the country and to increase the quality of life of the citizens of the United States. For example, if ball bearing manufacture and solar cell manufacture in space should prove advantageous as a consequence of Corporation-supported private sector work, such manufacture would have a direct beneficial effect on the energy posture of this nation. In addition, and just as or perhaps even more importantly, the filtering of this new technology into the entire mainstream of American industry would give a whole new dimension to the struggle to improve the high relative price for commodities problem by getting those prices lowered. After all, the space program that is currently in existence has developed many new materials that are of value to the economy in general. This beneficial effect has come about as a by-product or spin-off of the NASA program. A combination of a directly funded government space industrialization effort which would surely accompany the efforts of the Corporation and the firms with which it would have arrangements in the private sector would have several orders of magnitude

greater beneficial impact in the immediate future on the economy than does the current NASA endeavour. Rostow believes that part of the reason for the federal government to be much more involved and to play a greater role with respect to the investments necessary for the adjustment of the world economy than was done in the past is the nature of the sectors involved, such as, for example, energy production and environmental problems. The Corporation would allow a closer meshing and integration of the efforts on the federal governmental and private sector levels. The Corporation through its activities will aid in the process of gradually getting the United States acclimated to the increasingly major impact which the development of space will have on the national economy by the beginning of the twenty first century.

Rostow in Getting From Here to There discusses the complex relationship between basic science, invention, and innovation and their resultant effect upon the world economy. He notes that among futurologists it is standard practice to coalesce science, invention and innovation whereas they are more or less distinct phases in a more or less continuous process. That is, he states, their optimistic or pessimistic prognostications are based upon the assumption that the progress of basic science will or will not lead to insights resulting in more or less productive inventions which through the innovative process shall be introduced in an effective manner into the mundane transactions of the economy and thus successfully or not so successfully combating the law of diminishing returns. Rostow believes that the realization of hopes for bettering the human condition expressed by the futurologists is a function of a successful transition through the next quarter century, which period of time is the fifth Kondratieff upswing. The relationship between science, invention, and innovation is not straightforward. The rate of productivity increase is a function of all three of

these factors. The deceleration in the productivity of the United States during the last decade or so is related in some manner to the significant net decline in the total and relative research and development expenditures of the nation, relative referring to the entire gross national product. One of the major effects of the Corporation will be an enhancement of the interaction between science, invention, and innovation in the private sector. The consequence will be a significant increase in the innovation rate throughout the economy and not just in the industries directly dealing with the Corporation. This increase in the innovation rate, in turn, will stimulate an acceleration in the rise of the productivity rate of the national economy.

The Corporation will also play an important role in the fight against inflation. Rostow believes that inflation is the consequence of the interaction of three major elements. One element is the ratio of the effective demand for labor to the effective supply of that labor. The second element is the abundance of food, raw materials, and energy within the context of the global economy and the dependence of the nation on the importation of supplies. The third element is the strictness with which the nation makes wage increases correlate with the average level of productivity increase. The labor demand-supply ratio is linked to the factor of productivity increase. The activities of the Corporation will tend to decrease the labor demand-supply ratio by lessening the demand for labor in established businesses and industries because the innovation spurred by the Corporation will lead to an increase in productivity of the individual worker. In order to produce more of a given quantity of merchandise, an organization can utilize an increase in the efficiency of the worker instead of only having the option of going to the labor market and hiring more workers. Thus, as a consequence of the creation of the Corporation a blow

will be struck against a major element contributing to the inflation problem. However, it should not be supposed that this lessening of demand for workers in some sectors of the economy means that the Corporation has an anti-labor bias. As a further result of the innovative activities of the Corporation, it is to be anticipated that many jobs will be created within the economy that could not have arisen without the existence of the Corporation. The creation of these jobs will not be inflationary because these jobs will become available as a consequence of new products, benefits, and services flowing from the process of space industrialization. These new products, benefits, and services represent an addition to the national wealth and are consequently non-inflationary. It is quite possible that the creation of new jobs in some sectors of the economy will more than counterbalance the lessened demand for labor in other sectors. With regard to the second major element contributing to the inflation problem according to Rostow, it has already been emphasized in this testimony how space industrialization will make an increasingly larger contribution as the years go by to improving the food, raw materials, and energy postures of the United States. The creation of the Corporation will provide a much-needed impetus to accelerating the process of space industrialization in order to improve these postures more rapidly. Further, although the Corporation and its activities will not have a direct impact on maintaining a proportionality between wage increases and productivity increases, the productivity increases produced by space industrialization innovation will give more room for maneuvering when it comes to wage negotiations. Hence, the Corporation will aid in preventing wage increases from becoming inflationary.

From the point of view of the economic analysis of Rostow, it is readily observed that the Corporation would also have an important part in aiding the growth of the developing nations of the world. The development of the United States is a determining factor in the growth of the nations comprising

the Organization for Economic Cooperation and Development (OECD). The growth of the United States and the OECD nations is a determining factor in the capacity of the developing nations to trade on an international level and to grow. For example, energy development investment requirements in the United States are so large that these investments should allow the United States to lead the OECD world on the road to full employment and hence sustained growth. Some of the activity funded by the Corporation would be part of that energy investment. Although it might be only a small fraction of the total United States energy investment, the Corporation funding would be in a high innovation area and this innovation would tend to have a magnifying affect on Corporation-funded activity. Further, Rostow emphasizes the importance of research and development for the international community. It is quite possible that after the United States establishes a leadership position in the commercial research and development for space industrialization upon the establishment of the Corporation, an organization to accomplish the same goals as the Corporation would be formed to accomplish similar goals on an international level. The relationship between the Corporation and the international entity could be analogous to the already existent relationship between the Communications Satellite Corporation (Comsat) and the International Satellite Consortium (Intelsat).

From the analysis so far presented of the Corporation and its relationship to and interactions with the United States and the world, it is thus seen that the Corporation would be more than just another federal government aid to the activities of the private sector of the economy. Even from its inception the Corporation would be making a significant contribution to the maintenance, health, and growth of both the American economy and society, and, also, a similar contribution to the global economy and society. The

Corporation would increasingly become an important instrument for aiding in the fulfillment of such basic needs of society as energy, the fulfillment of which needs are required for the very survival of the kind of society which the United States now typifies and which society most United States citizens want to see survive and flourish. From this point of view, it is not at all clear that the most appropriate way to evaluate the Space Industrialization Act of 1979 and the richness of the concept of space industrialization itself lies in any of the approaches to cost-benefit analysis previously mentioned herein.

P.J. Werbos of the University of Maryland in his work, particularly the article "Changes in Global Policy Analysis Procedures Suggested by New Optimization Methods and Required for Global Survival" published in the January 1979 issue of the journal Policy Analysis and Information Systems, addresses this problem and provides a possible valid approach. His study leads him to four conclusions. The first conclusion is that essentially all of the policy decisions, both domestic and international, by the United States and other governments, should be explicitly ruled by the objective of global survival. The second conclusion is that shadow prices which are both explicitly time and socioeconomic condition dependent should be used to ascertain future benefits instead of interest rates. (A shadow price is the same as an accounting price.) The third conclusion is that although the market mechanism is inadequate to meet the requirements of global survival, planning in the sense of attempting to choose policies assuming that the future can be planned in a deterministic way is even more inadequate. The fourth conclusion is that it is absolutely essential to develop an open set of explicit designs and contingency plans, in order to both insure accuracy in the estimation of shadow prices and to attain the goal of global survival. By an open set is meant the capability of adding new designs and plans as they become available to the set.

The work of Werbos is based upon the assumption that people should care about the distant future. This is an explicit ethical assumption. In operational terms, this means that rational behavior requires the exercise of foresight.

Werbos is not alone in his concern with ethics and with the future as part of the decision-making process. Ralph L. Keeney and Howard Raiffa in their book Decisions with Multiple Objectives: Preferences and Value Tradeoffs (John Wiley & Sons, New York, 1976) note that often society aggravates its future problems while attempting to ameliorate its immediate difficulties. The decision-maker must decide what are the obligations of the existent society to the society of the future. A process of constant tradeoff should be occurring in the mind of the analyst in order to balance what is the correct course of action for the current generation against a determination of the requirement to provide for future generations. As Werbos does, Keeney and Raiffa raise the question as to whether a discount rate approach to decision-making is even appropriate in some situations. Werbos has already decided, it has been noted herein, that discounting is invalid when it is a matter of global survival. Furthermore, Arnold Kaufmann in his book The Science of Decision-Making: An Introduction to Praxeology (McGraw-Hill Book Company, New York, 1968) asks the question, "Can ethics provide us with a system of measurement?". Kaufmann feels that it is a question that must be answered in the affirmative. He believes that if such a measurement system had been developed before now, there would not be so much suffering and indifference within human society. This system could lead to radical improvements in the relationship between the various segments of humanity. E'nad E'rith agrees with these comments of Werbos, Keeney, Raiffa, and Kaufmann, and, in particular, firmly believes that Werbos is definitely moving in the right direction.

How does the analysis of Verbos relate to the proposed Corporation and the concept of space industrialization? There are a number of facets to the answer to that question.

It is to be expected that the first projects of the Corporation would be relatively simple and small-scale and the results fairly predictable with any uncertainties involved being approximately statistically independent of uncertainties in major global problem areas. In this event, the approach of Verbos appears to be somewhat similar to that of cost-beneficial analysis. For each of these early projects, both a conventional cost-benefit analysis including discounting and the Verbos analysis utilizing shadow prices should be undertaken. (The conventional cost-benefit analyses should be undertaken at a higher level of sophistication than was presented by both RI and SAI in their pioneering reports.) In fact, this sort of analysis could be undertaken now before the inauguration of the Corporation on the basis of anticipating what sort of projects the Corporation would most likely be involved with in its early life. For example, the projects given as examples earlier in this testimony might be expected to be undertaken in the first ten years of the operation of the Corporation. In addition to showing how the discount and shadow price approaches compare to each other, these studies would serve the very useful purpose of being a learning experience with regard to the determination of shadow prices as applied to space industrialization projects. This determination is neither simple nor easy because these shadow prices are not the same as the expected market prices. This determination will require a number of trained people with access to as much information as possible in such areas, for example, as space industrialization, the national and global economy, and the policies, programs, and actions of national and global institutions. The determination of these shadow prices is extremely important because these shadow prices

are also part of the input for the more general approach of Werbos when this approach would be applied to ascertaining the worth of space industrialization in terms of such industrialization aiding in the long-term maintenance and growth of American society and the assurance of global survival.

The evaluation of an early project under the simplified Werbos approach would commence with the expression of the expected costs and benefits by year for that project as functions of tangible output variables. Then the expected shadow price for each type of output and year is found. This expected shadow price is the shadow price for that variable in that year after that shadow price has been averaged over the circumstances affecting the shadow price which circumstances might occur in that year according to the probability of those circumstances occurring. The total net benefit in a given future year is evaluated by the addition of the product of benefits and price over all the different types of benefit. The shadow prices already account for the tradeoffs between years so that there is no necessity for discounting.

After this elementary application of the Werbos approach has been made to space industrialization and to the operations of the Corporation, it would then be appropriate to use his technique to ascertain the value and richness of the Corporation and space industrialization in the context of the continuance and enhancement of American society and of the very survival of human civilization on this planet. The approach of Werbos in its most complete form for this study is an extension of the already existent technique known as dynamic programming.

In conclusion, B'nai B'rith strongly believes that the proposed Corporation would be invaluable as an instrument to encourage the participation of and to aid in obtaining a more effective participation of the private sector of the United States economy in more expeditiously bringing the benefits, both immediate and long-term, of space industrialization to the society of the United States of America and to the people of the world. Consequently B'nai B'rith fully supports the timely passage into law of the Space Industrialization Act of 1979.

BIOGRAPHICAL DATA

Born June 21, 1939, Brooklyn, New York. Graduated Brooklyn College, Brooklyn, New York, June 1960, B. S., Physics. Graduated Syracuse University, Syracuse, New York, Ph. D., January, 1969, Physics. From July 1967 to January 1970, worked in Naval Applied Science Laboratory, Brooklyn, New York. Most of the time between that job and my reporting to my present job at the David W. Taylor Naval Ship Research and Development Center, Annapolis, Maryland in September, 1974, I worked at the American Institute of Physics, New York, New York. Here in the Annapolis R&D Center, most of my time has been spent in the Environmental Protection Division.

STATEMENT FOR RECORD
CONCERNING THE SPACE INDUSTRIALIZATION ACT OF 1979
SUBMITTED BY
AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC.
TO THE
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
COMMITTEE ON SCIENCE AND TECHNOLOGY
U. S. HOUSE OF REPRESENTATIVES

August 1979

The Aerospace Industries Association of America, Inc., representing the nation's major manufacturers of space systems, launch vehicles, satellites, and their subsystems, components and support equipment, welcomes this opportunity to express our comments regarding H. R. 2337, the Space Industrialization Act of 1979. The United States will soon be in the enviable position of possessing the world's most advanced manned orbital transportation system, but we need a more aggressive plan to utilize this capability. If we allow other nations to use our Shuttle to gain a substantial headstart in space manufacturing, we may find ourselves in the role of a national trucking service, hauling high technology, space produced components to Earth markets for foreign space industries. We should establish our own space industrialization program to properly exploit our present lead in earth orbital transportation systems and protect this nation's previous space technology lead that resulted from project Apollo.

We agree with Congressman Fuqua that, to become a long-term economic asset, space must become an extension of commercial pursuits on Earth. This means that before space commercialization opportunities will attract private capital, the risks to anticipated rates-of-return must be competitive with other investment opportunities.

The cost of using the Space Transportation System as a laboratory to verify the process and product technology in the high risk front-end of a program will discourage most, if not all, potential developers. This enormous expenditure for space verification, well before commercial feasibility has been established, is a radical departure from normal product developments on Earth. To help reduce this enormous front-end investment and risk, we believe the government should provide focused support for the space verification research and development efforts of the innovative companies willing to take the initial steps to develop the commercial potential of space. This type of government support, we emphasize, does not remove the burden of risk from the shoulders of industry. Industry will still carry the conventional R&D risk. Such government support would simply allow space to become a competitive environment for private investment through a jointly sponsored space verification R&D phase and pilot demonstration.

In recent testimony before the House Subcommittee on Space Science and Applications, the NASA Administrator announced the creation of guidelines regarding the use of space for industrial purposes. Within the scope of the National Aeronautics and Space Act of 1958, NASA will engage in joint arrangements with domestic firms. Such arrangements may include flight time on the Space Transportation System, technical support, and joint research and demonstration programs where each party funds its own participation. This no-transfer-of-funds arrangement will allow adequate patent and proprietary right protection. This cooperative approach with NASA, we believe is one way to lessen the risk by reducing the capital investment needed to establish commercial feasibility. The initial

company-funded, ground-based development phase would be followed by a jointly sponsored phase for space verification and pilot demonstration. Additionally, cooperative programs with NASA will better identify the needed space services and facilities that must be planned for and provided by the late 1980's to support commercial operations.

While we cannot say that joint endeavor arrangements with NASA will meet all the needs of companies that want to work in space, NASA's goal closely parallels the basic intent of H. R. 2337. We, therefore, urge that NASA's policies of support for commercial companies be encouraged and expanded where practical.

Should these new policies attract more activity than NASA can support or should they fail to attract adequate industrial participation, then a Space Industrialization Act will be necessary. In our desire to promote the goals of space industrialization, we would like to offer the following comments and suggestions to be considered in the Space Industrialization Act of 1979.

H. R. 2337 has its good points. It is specifically responsive to AIA concerns expressed on page 3 of our earlier AIA statement on S. 244:

- o It puts the government in the "proper role of underwriting some of the colossal cost of risky technological ventures."
- o And, it "further clarifies, legislatively, the nature of government/industry cooperation" -- albeit with emphasis on the non-aerospace sector.

In the present draft of H. R. 2337, certain provisions and omissions concern the AIA:

- o Rather than rewarding success, the bill stresses anesthetizing failure.
- o Compensating provisions should be included for the length of high technology space investments.
- o The potential for competition exists between the Space Industrialization Corporation and participating private firms.

- o No provisions exist for planning and integrating the requirements for government-sponsored space facilities and services needed to support commercial operations.

Dr. Peter Vajk, in his June 27, 1979, statement to the Subcommittee, made some important points on ways the Space Industrialization Corporation could add incentives for success. Tax-free status on revenues for a period of ten years followed by decreasing the exemptions with time could encourage early participation by all sizes of companies. While it's important that we preserve the pain of failure by requiring loan repayments, this pain can be reduced by providing low-interest rates with long repayment periods.

We further believe that appropriate screening by the Corporation of the companies' technology backgrounds and investments of R&D resources, along with restricting loans to the space verification phase of the R&D program, will help eliminate many premature or poorly defined endeavors.

Most companies estimate that it will take ten years or longer for initial commercial space product developments. Several years of ground research and development of the process and products would be followed by technology verification in space. Pilot plant demonstrations and regulatory approvals, if needed, would then be required before commercial operations could begin.

Recognizing the time value of money, the potential of predatory encroachment, and the threat of new technology developments, many companies shy away from programs requiring more than five years to develop. Specific tax law revisions could greatly enhance the attractiveness of long-term space projects. As Dr. John S. Benjamin of Inco, United States, Inc., testified recently before the Subcommittee,

increasing the allowable deduction for current R&D expenditure to 150%, increasing the investment tax credit to 25%, and decreasing the depreciable plant life to five years cuts in half the level of earnings needed to achieve an acceptable return on investment. In other words, such revisions could make long-term space development projects far more attractive to both small and large businesses.

There is general concern within private industry that the Space Industrialization Corporation, as currently defined, could become self-serving and a competitor with participating firms. The Corporation should never conduct its own research and development. Otherwise, it would become both a player and an umpire.

In order to minimize the problems of entrenched bureaucratic organizations, a "sunset" clause should be added to the Act, terminating the Space Industrialization Corporation not more than twenty years after its formation. One reason for this is that we are convinced that private industry will ultimately invest on its own in new commercial space ventures on a routine basis. Once the innovators have demonstrated the potential of manufacturing products in space, have established legal and regulatory precedents, and have verified operational procedures, the second-to-market firms will invest and eventually new product line companies will follow.

Although we believe that significant technology verification and pilot demonstrations can be conducted with the currently defined Space Transportation System, long to continuous operations on-orbit will be required for ultimate commercial success. The number of on-orbit operating days per year for producing

a required annual quantity of product depends on the availability of space facilities and services eight to ten years from now. Studies show that the problem is not the economic feasibility of using the Space Shuttle as a logistics carrier. The problem is gaining the increased operating times that will, in addition to reducing the plant size, significantly reduce the on-orbit power, volume, and supporting services that must be provided. Therefore, the economic attractiveness for private industry to initiate space manufacturing ventures, now or in the near future, may well depend upon some form of guarantee that such facilities will be available by the late 1980's for lease or purchase. A major function of the Space Industrialization Corporation should be that of integrating and planning the needed supporting space facilities and services of the participating firms. The Corporation should also serve as a broker with NASA, OMB and the Congress to ensure the future availability and continuity of government-provided supporting space facilities and services.

In summary, we believe that the industrialization of space will provide great social and economic value to this nation. Exploration of this potential by private industry is being restricted by high front-end R&D costs and the long-term nature of most such projects, yielding risk-adjusted rates-of-return well below industry averages. Government support is needed to help reduce front-end risks for the innovative companies initiating new commercial lines to help offset the time value of money penalty for these lengthy projects, to help provide more positive incentives for commercial success, and to help ensure availability of supporting space facilities and services in the latter part of

of the 1980's. We recommend strong support of NASA's new industrial operating policies, and we recommend revisions to the current tax laws to add success incentives and offset the time value of money for long-term investments.

The Space Industrialization Corporation should be founded only if NASA is unable to attract or support the level of participation required to effect a consistent and timely expansion of space industrialization. The Corporation should not fund its own R&D effort; its financial support to private firms should be limited to the space verification and demonstration phases of their R&D programs; long-term loans with low interest rates should be considered; a major function of planning, integrating and brokering should be provided; and proper screening methods should be employed to minimize support of poorly defined endeavors.

We are convinced that American industry, in cooperation with the United States Government, will take advantage of this opportunity to fulfill the potential of this vast new resource, space.

We hope these comments will prove helpful to the Subcommittee.



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