NA ONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICE OF ADMINISTRATOR

December 29, 1971

Honorable Caspar W. Weinberger
Deputy Director
Office of Management and Budget
Executive Office of the President
Washington, D.C. 20503

Dear Cap:

The purpose of this letter is to report the results of recent studies of several space shuttle options, and to recommend a course of action to be taken in the FY 1973 budget.

SUMMARY

We have concluded that the full capability 15 x 60' - 65,000# payload shuttle still represents a "best buy", and in ordinary times should be developed. However, in recognition of the extremely severe near-term budgetary problems, we are recommending a somewhat smaller vehicle--one with a 14 x 45' - 45,000# payload capability, at a somewhat reduced overall cost.

This is the smallest vehicle that we can still consider to be useful for manned flight as well as a variety of unmanned payloads. However, it will not accommodate many DOD payloads and some planetary payloads.

Also, it will not accommodate a space tug together with a payload, and will therefore not provide an effective capability to return payloads or propulsive stages from high "synchronous" orbits, where most applications payloads are placed.

BACKGROUND

Early in 1971, after completion of feasibility studies, NASA focused on a shuttle configuration that would replace all of the existing launch vehicles (except the very small Scout, and the very large Saturn V); would provide for a continuation of manned space flight; and would have the lowest possible cost per flight. This configuration had a 15 x 60' -65,000# payload bay; a very large orbiter; and a huge fly-back booster. It would cost $10 billion to develop, and $4.1 million per flight.

We then set out to optimize the configuration for the best balance between development cost and operating cost, while retaining the full 15 x 60' - 65,000# capability that is required to accommodate all NASA and DOD payloads. The result: a much smaller orbiter with external jettisonable tanks; and a ballistic reusable booster. The development cost was cut nearly in half, to $5.5 billion, while the cost per flight increased to $7.7 million. Although the cost per pound of payload in orbit increased from $63 to $118, we felt this to be worth the huge savings in development cost.

During the course of our studies as well as at the request of the "Flax Committee" we also looked at smaller payload compartments. More recently in a meeting with Don Rice, we were asked to examine shuttle costs with an even smaller performance capability. Specifically, we were asked 2 1/2 weeks ago to look at a 10 x 30' - 30,000# payload capability, with the added guideline that the development cost should be less than $4 billion, and the cost per flight less than $5 million. (We have not been able to meet these cost objectives). We have now compared costs and payload capabilities of five different shuttle options, and have reached certain conclusions.

Federation of Rocky Mountain States, Inc.

Suite 203/1390 Logan St./Denver, Colorado 80203/Phone: (303) 825-7284

November 29, 1971

The President
The White House
Washington, D. C. 20500

Dear Mr. President:

By letter of September 27, 1971, on behalf of the representatives of the states of Oregon, Idaho, Montana, New Mexico, Wyoming, Utah and Kansas, I wrote to you concerning the space shuttle program. Mr. Peter Flanigan of your office replied by a letter dated October 28, 1971.

Representatives from the above-named states, and, on this occasion, representatives of the State of Colorado, had the pleasure of meeting with Dr. James Fletcher, Administrator of NASA, here in Denver, Colorado today. Dr. Fletcher was most helpful to us in explaining the present status of the space shuttle program, both in terms of funding as well as with regard to the various configuration alternatives which are under consideration. I was requested by the representatives of the states present to write to you and express our sincere appreciation that Dr. Fletcher would meet with us and discuss with us in a very frank manner the whole matter.

We want to renew our expression of support for a NASA space shuttle program which will be a cost-effective one in the long term and which will help retain our nation's leadership in space while making possible significant contributions to the constructive utilization of space technology and the considerable national resource of technical manpower which our country has developed. We sincerely hope that your decisions and those of Congress will assure us all that full consideration has been given to all available information and data. We are prepared to make whatever contribution we can to sound decisions on this critical program.

Sincerely,

Jack M. Campbell

Jack M. Campbell
President

JMC/sb

cc: Mr. Peter Flanigan
DR. James Fletcher

NATIONAL AERONAUTICS AND SPACE COUNCIL
EXECUTIVE OFFICE OF THE PRESIDENT, WASHINGTON 20502

Jon — Fri PM

Attached is a reasonably good summary of the aerospace situation which you might find useful.

Tom W. can make lunch Thurs when NASA will have something to say about the shuttle studies they now have underway. If you need some help sooner let me know & I'm sure we can get assistance from George Low.

Bill

AE … ONOMY

Its R …

and …

AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC.

aerospace
AIA
research center

AEROSPACE and the U.S. ECONOMY

Its Role, Contributions and Critical Problems

AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC.

AEROSPACE and the U.S. ECONOMY

Its Role, Contributions and Critical Problems

A Publication of

AEROSPACE RESEARCH CENTER
AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC.
1725 DE SALES STREET, N.W., WASHINGTON, D.C. 20036

NOVEMBER 1971

Contents

		Page
1	INTRODUCTION	7
2	THE AEROSPACE ECONOMIC PROFILE	9
	Industry Definition and Products	9
	Industry Location	10
	Sales	10
	Employment	13
	Payroll	13
	Productivity	13
	Fixed Capital Investment	13
	Balance of Trade	15
	The Research and Development Component	15
	Financial Characteristics	16
3	THE ROLE OF AEROSPACE IN THE NATIONAL ECONOMY	18
	The National Perspective	18
	National Implications of Aerospace Decline	20
4	CRITICAL ECONOMIC PROBLEMS OF THE AEROSPACE INDUSTRY	22
	Aerospace Problems in the General Economic Setting	23
	Aerospace Concentration	23
	Decline in Traditional Markets	24
	Other Market Opportunities	24
	The Problems of Regional Dependence	24
	The Problems of Labor Specialization	25
	The Problems of Intra-industry Transfer of Assets	25
	Effects of Inflation	25
	Long R&D and Production Phases	26
	Heavy Dependence on a Few Principal Buyers	26
	A Small Number of High Unit Value Product Items	27
	A High Working Capital/Total Capital Ratio	27
	Particular Aerospace Problems	28
	Research and Development Problems	28
	R&D Trends	29
	R&D/Export Relationships	29
	R&D Risks	30
	R&D's Critical Role	30

Page

Aerospace Contractual Problems: The Cost/Risk/Profit Environment . . . 31
Shift of Risks . . . 31
Disallowed Costs . . . 31
Contract Types . . . 32
Proliferation of Regulations . . . 32
Conclusion . . . 32
The Financial Problem . . . 32
5 **SUMMARY AND PERSPECTIVE** . . . 34
Aerospace and the National Economy . . . 34
Critical Industry Problems . . . 35
The National Interest . . . 36
Corrective Action . . . 36

Graphs

1: Geographic Distribution Of Major Aerospace Activity . . . 10
2: Aerospace Sales . . . 11
3: Profit Sales Ratio, All Manufacturing And Aerospace . . . 11
4: Aerospace Annual Average Employment . . . 12
5: R&D Employment Of Scientists And Engineers . . . 14
6: Value Added By Various Industries . . . 14
7: Exports Less Imports For Major U. S. Industrial Sectors . . . 15
8: Percentage Rates Of Change In Aerospace Financial Characteristics . . . 16
9: Payroll and Materials Costs As A Percentage Of Value Of Shipments . . . 28

Page

APPENDIX A: ECONOMIC PROFILE OF THE AEROSPACE INDUSTRY 38

Concentration 39

The Geographic Distribution of Aerospace Activity 40

NASA Contract Awards 41

Distribution of Prime DoD Contract Awards to Major Aerospace Firms by Region and Type of Product 41

Commercial Transport Production 41

The Linkages Between Aerospace and Other Economic Sectors 41

Employment 43

Income 44

Productivity 44

Fixed Capital Assets 47

Sales 47

Backlog 51

Sales in Relation to GNP, Manufacturing, and Durable Goods 51

Aerospace Balance of Trade 51

Research and Development Expenditures by Aerospace Firms 53

Trends in the Financial Characteristics of the Aerospace Industry 53

Financial Comparisons Between Aerospace and All Manufacturing 54

Financial Ratio Analysis 54

Graphs

10: Value Added Per Production Worker, Aerospace vs Manufacturing 45

11: Production Workers' Average Annual Income 46

12: Aerospace Industry's Annual Sales And Costs Levels 48

13: Sales Percentages, By Customer 49

14: Sales Percentages, By Product 50

15: Aerospace Sales As Percentages Of GNP, All Manufacturing, And Durable Goods 52

16: Aerospace Industry's Net Sales/Net Worth 55

Page

APPENDIX B: AEROSPACE PROFILE TABLES 57

1: State Employment Trends 57

2: The Aircraft And Parts Industry
As A Supplier Of Intermediate Products 58

3: The Aircraft And Parts Industry
As A Generator Of Economic Activity 59

4: Trends In Aerospace Employment 60

5: Trend of Scientists And Engineers 60

6: Profile Data For SIC Codes 372 And 1925 Combined 61

7: Profile Of All Manufacturing 61

8: Profile Calculations For Aerospace And All Manufacturing 62

9: Comparison Between Aerospace And All Manufacturing 63

10: Aerospace Sales Percentages By Customer And By Product 63

11: Changes In Aerospace Backlog 64

12: Changes In The Relative Share Of Aerospace Sales
As A Part of GNP, Total Manufacturing, And Durable Goods 64

13: Trends In Aerospace Exports And Imports 65

14: Rates Of Change In Aerospace Financial Characteristics 65

15: Aerospace Financial Items As A Percent Of The Same Items
For All Manufacturing Corporations 66

16: Financial Ratio Trends 67

17: Federal Expenditures For Research And Development 68

18: Funding For R&D Performance By Selected Industries 68

Introduction

1

The United States aerospace industry is today the focus of much attention by those concerned with the economic health of the nation. In this respect the industry is following a classic economic pattern. In the past, historically important U.S. industries such as railroads, shipbuilding, textiles and power have all emerged in different periods as healthy economic entities of crucial importance in world and U.S. commerce. While each contributed significantly to the well-being of the nation, each in time developed its own problems: depleted or displaced markets, specialized labor, and unwanted political and social side effects. Following this pattern, the U.S. aerospace industry is today undergoing crucial changes producing effects felt throughout the U.S. economy and has entered into its own period of major readjustment to changing conditions, priorities, and markets.

The point of this analogy is simply that in considering the relation of the U.S. aerospace industry to the total economy, it is clear that its problems constitute an economic and historic phenomenon of the first magnitude—not an ephemeral annoyance whose effects will subside as soon as the current economic uncertainties are clarified. The current situation and the outlook for the immediate future appear bleak, and if unchecked, this trend will result in a severe loss to the nation's output. In both tangible and intangible ways, the industry's problems have broad implications at both the federal and local levels. The proper perspective, therefore, is essential for those whose acts and decisions will affect the future role of this economic force in national affairs, determining whether the industry continues to contribute to its fullest capacity to the economic well-being or declines to the point where its potential cannot be realized.

This essential perspective is not easy to achieve. There are a host of misunderstandings and a lack of knowledge about the industry and its operations. Key to a better understanding is an objective perspective on the industry whose uniqueness among U.S. industries is established by these characteristics:

- Its product line is largely determined by Government needs and requirements which, during the past generation, have changed drastically and continually, and which appear likely to continue to change in unforeseen ways in response to developments in international and domestic relations.
- In virtually all its products, revolutionary advances in performance and capability are required, constantly forcing industry to work at the frontier of the technological "state-of-the-art" and to draw from virtually all of the scientific disciplines.
- It embodies a larger share of the nation's expenditures on R&D and technological advance than any other industry group, giving it an unmatched importance to long-term growth in productivity and national economic vigor.
- The scale of single programs that often run into billions of dollars each and with complexities requiring sophisticated systems management skills, is unparalleled in other industrial sectors.
- Major programs in many instances take more than ten years from concept to completion.
- With the exception of commercial aircraft, there is no present commercial or consumer marketplace for the preponderant share of its products.

In view of the present and potential role of this unique industry in economic growth, social progress, and national security, there exists in many policy circles concern over the current loss and potential long-term economic effects of aerospace decline. For several reasons, many informed persons believe that the economic viability of the nation, both domestically and internationally, depends in no small measure on a financially healthy and prosperous aerospace industry. At the same time, others are reacting to the current problems of the aerospace industry as if the national economic scene would be little affected by its demise.

The premise of this study is that the economic role of this industry at this point in U.S. history warrants most careful consideration. Its purpose, accordingly, is to provide some perspective on the industry for those whose actions and decisions will affect it. Such an objective understanding of the economic environment of the aerospace industry is particularly important now, when the general economic conditions of the country, downturns in market demand and shifting national priorities and political attitudes have depressed sales, profits, and other industry economic indicators. These trends, largely external to the industry itself, have contributed to the general public's misunderstanding of the economics of the industry and its relationship to the rest of the industrial economy of the U.S.

This study, therefore, examines the structure and problems of the aerospace industry in sufficient detail to relate an historically and economically objective point of view essential to rational policy-making in the years immediately ahead. It is basically diagnostic rather than prescriptive.

The complex inter-relationships of the material in this study are such that it was felt that inclusion of an Executive Summary for the busy reader would not adequately convey the perspective necessary for a full understanding. To assist the reader, however, the policy implications of the study will be found in the five chapters with the bulk of supporting details in the appendices.

This essential perspective is not easy to achieve. There are a host of misunderstandings and a lack of knowledge about the industry and its operations. Key to a better understanding is an objective perspective on the industry whose uniqueness among U.S. industries is established by these characteristics:

- Its product line is largely determined by Government needs and requirements which, during the past generation, have changed drastically and continually, and which appear likely to continue to change in unforeseen ways in response to developments in international and domestic relations.
- In virtually all its products, revolutionary advances in performance and capability are required, constantly forcing industry to work at the frontier of the technological "state-of-the-art" and to draw from virtually all of the scientific disciplines.
- It embodies a larger share of the nation's expenditures on R&D and technological advance than any other industry group, giving it an unmatched importance to long-term growth in productivity and national economic vigor.
- The scale of single programs that often run into billions of dollars each and with complexities requiring sophisticated systems management skills, is unparalleled in other industrial sectors.
- Major programs in many instances take more than ten years from concept to completion.
- With the exception of commercial aircraft, there is no present commercial or consumer marketplace for the preponderant share of its products.

In view of the present and potential role of this unique industry in economic growth, social progress, and national security, there exists in many policy circles concern over the current loss and potential long-term economic effects of aerospace decline. For several reasons, many informed persons believe that the economic viability of the nation, both domestically and internationally, depends in no small measure on a financially healthy and prosperous aerospace industry. At the same time, others are reacting to the current problems of the aerospace industry as if the national economic scene would be little affected by its demise.

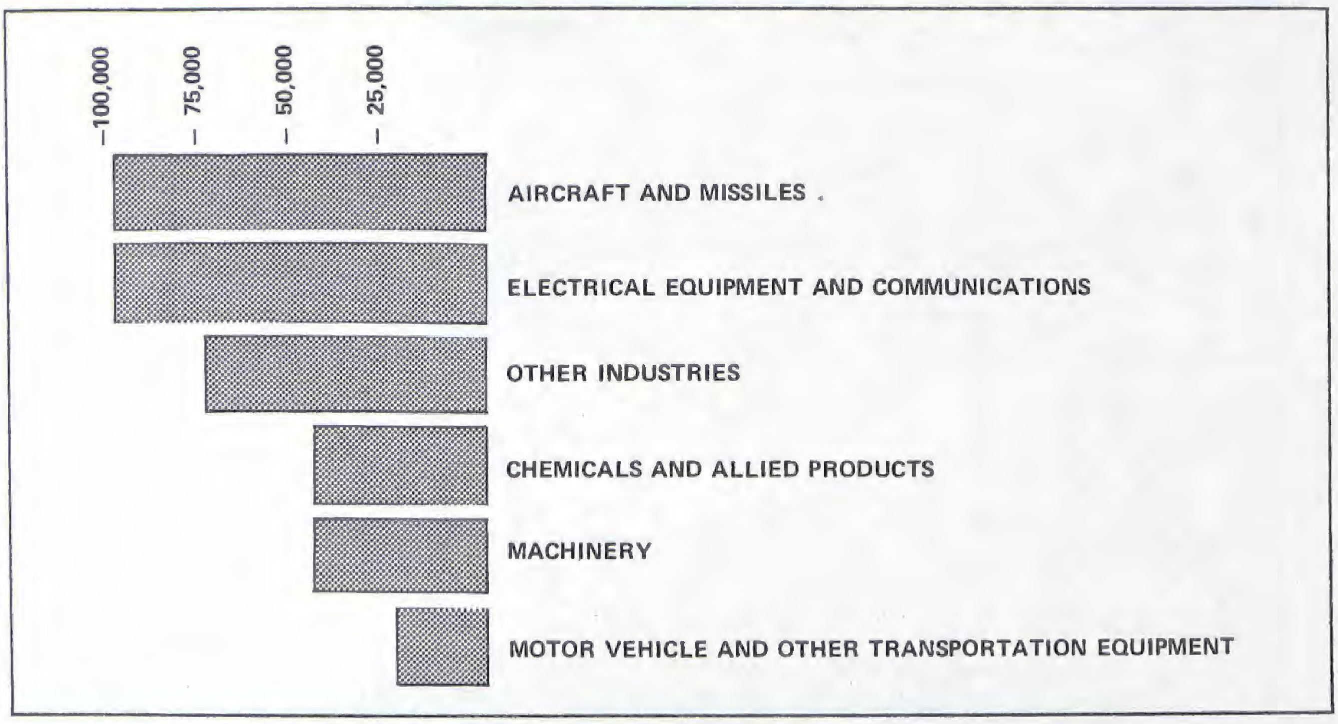
The premise of this study is that the economic role of this industry at this point in U.S. history warrants most careful consideration. Its purpose, accordingly, is to provide some perspective on the industry for those whose actions and decisions will affect it. Such an objective understanding of the economic environment of the aerospace industry is particularly important now, when the general economic conditions of the country, downturns in market demand and shifting national priorities and political attitudes have depressed sales, profits, and other industry economic indicators. These trends, largely external to the industry itself, have contributed to the general public's misunderstanding of the economics of the industry and its relationship to the rest of the industrial economy of the U.S.

This study, therefore, examines the structure and problems of the aerospace industry in sufficient detail to relate an historically and economically objective point of view essential to rational policy-making in the years immediately ahead. It is basically diagnostic rather than prescriptive.

The complex inter-relationships of the material in this study are such that it was felt that inclusion of an Executive Summary for the busy reader would not adequately convey the perspective necessary for a full understanding. To assist the reader, however, the policy implications of the study will be found in the five chapters with the bulk of supporting details in the appendices.

GRAPH 5

R & D EMPLOYMENT* OF SCIENTISTS AND ENGINEERS, 1968

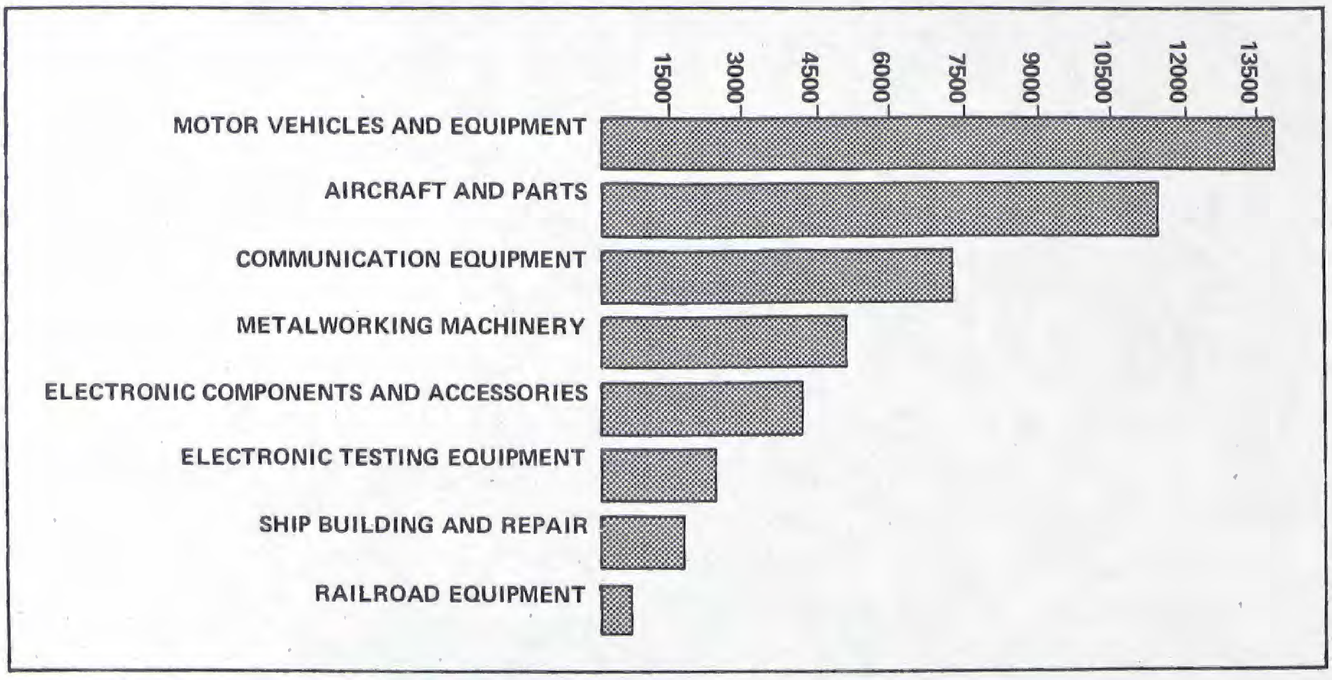


Source: National Science Foundation Annual Report, R & D in Industry.
*Full-time equivalents representing all those who were employed during the year. The actual number of scientists and engineers in aerospace, for example, was 235,000.

GRAPH 6

VALUE ADDED BY VARIOUS INDUSTRIES

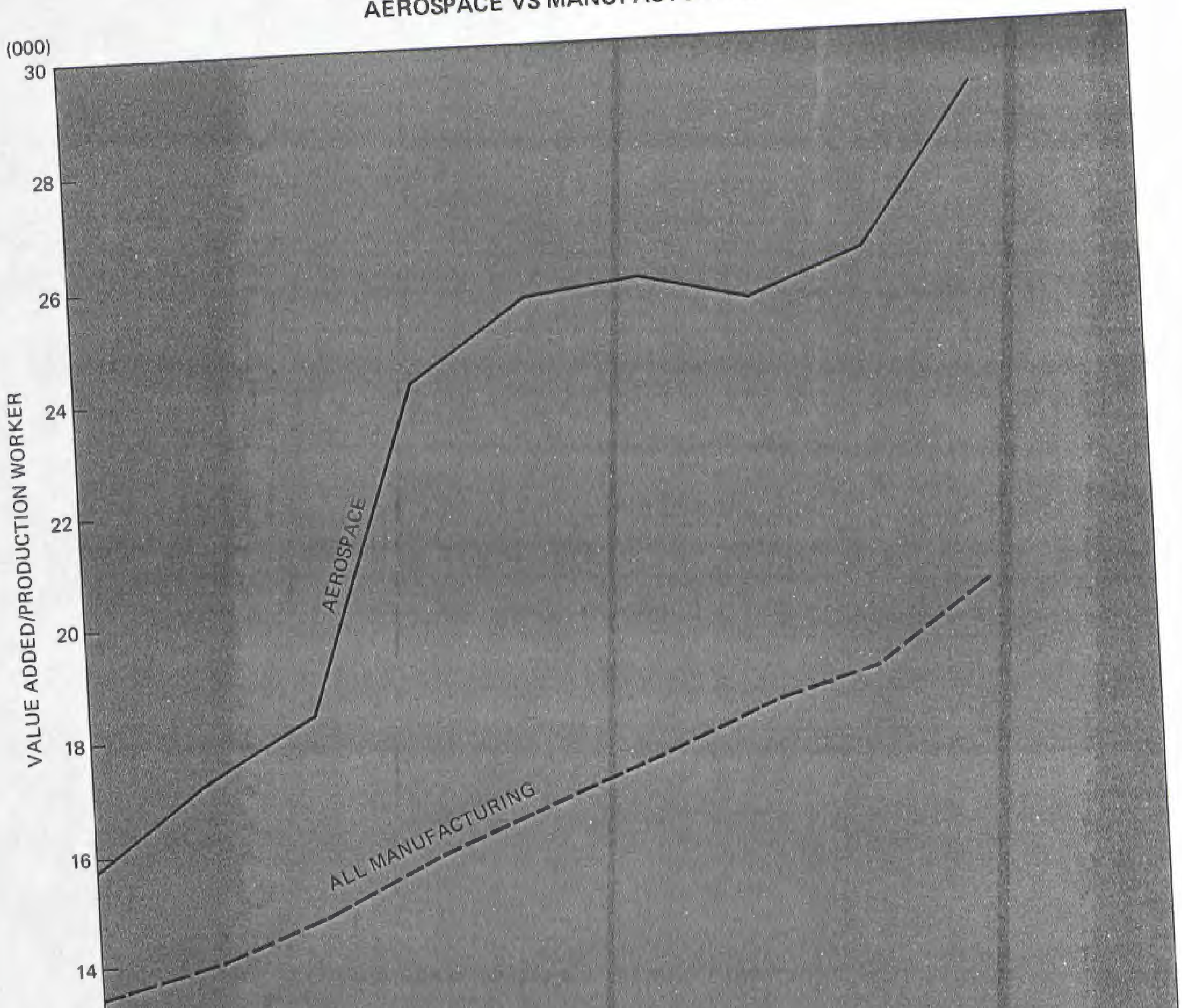
($ Millions)



Source: Based on data from the Dept. of Commerce, Census of Manufacturers, 1967.

GRAPH 10

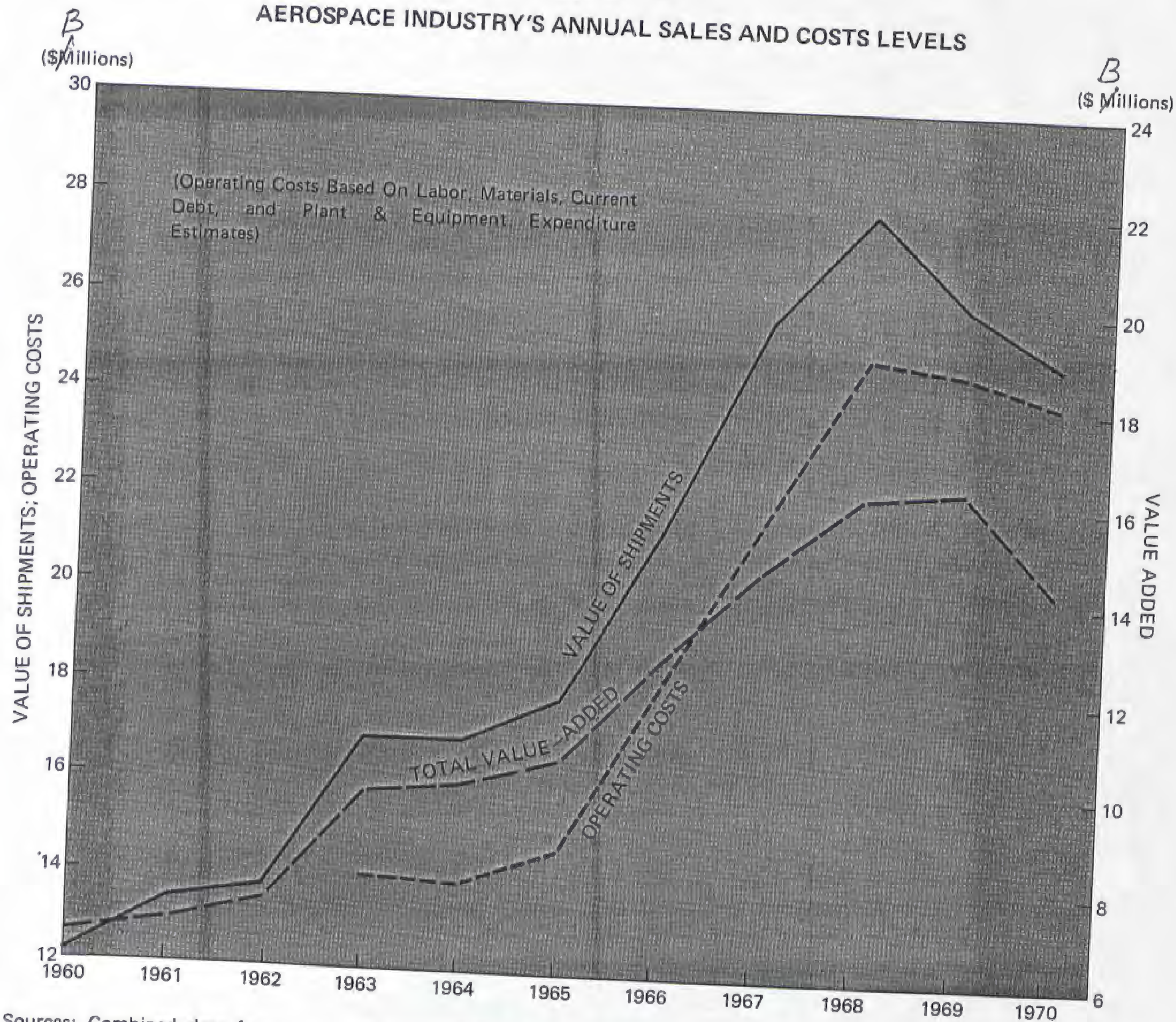
VALUE ADDED PER PRODUCTION WORKER
AEROSPACE VS MANUFACTURING



Source: Department of Commerce, B.D.C., *Industry Profiles, 1958-68;* November 1970.

GRAPH 12

AEROSPACE INDUSTRY'S ANNUAL SALES AND COSTS LEVELS



Sources: Combined data from *Industry Profiles 1958-68*, Department of Commerce; and *Aerospace Facts and Figures*, AIA, Washington, D.C.

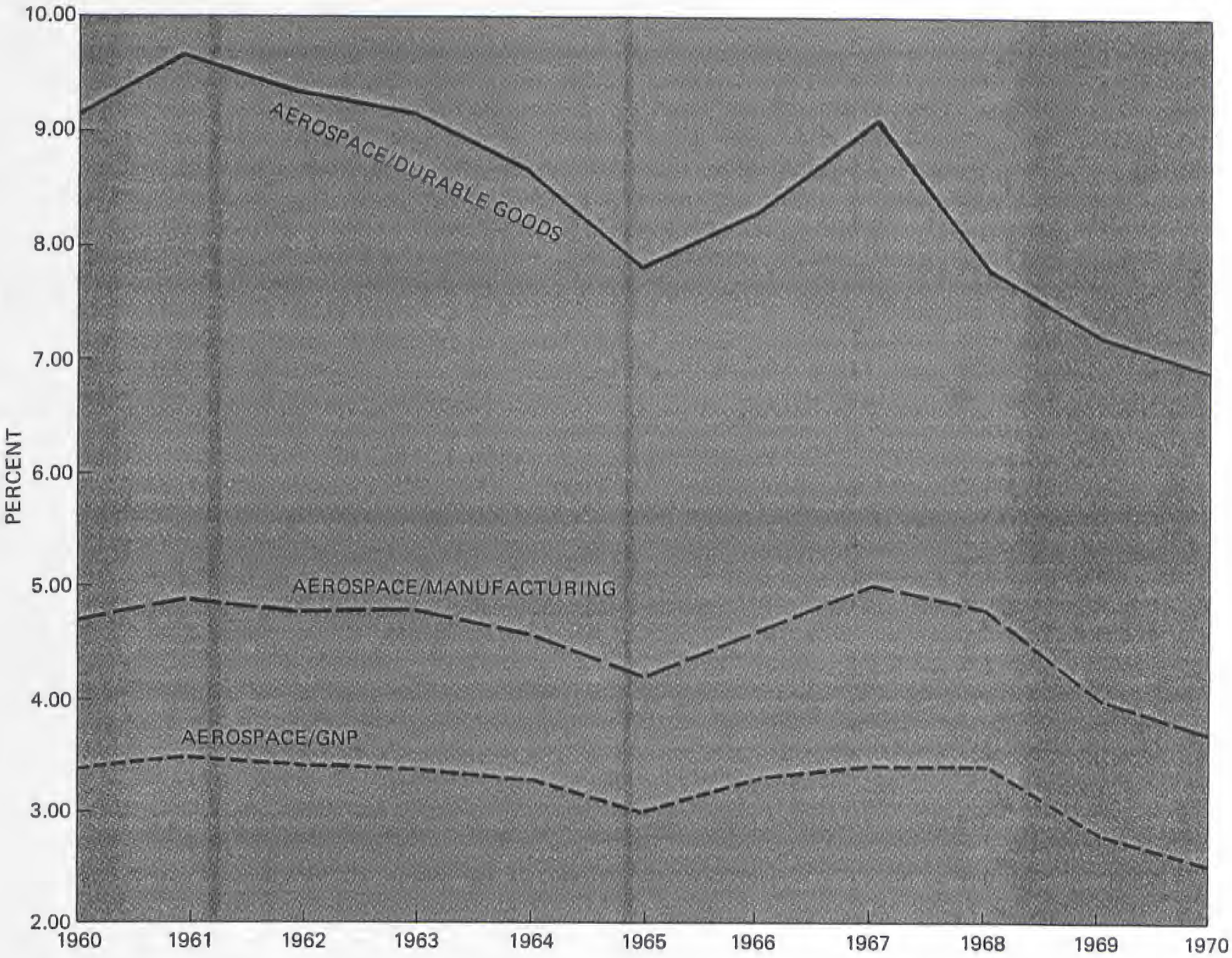
comparisons measure the relative total activity generated by industries in the economy.

In 1968, the four aerospace sectors, taken at the 4 digit SIC level, were all among the top 21 manufacturing sectors in sales. Motor vehicles (1st), radio and TV communication equipment (6th), metal stampings (9th), and electronic components (19th) were the only related industries among the top-ranked sectors, which included aircraft (5th), aircraft engines and parts (12th), guided missiles (13th), and aircraft equipment (21st).

When the four aerospace sectors are grouped, they rank second in sales to motor vehicles and parts among manufacturing industries. Aerospace sales contributed 3.6 percent of all sales by manufacturers in 1970, down from a high of 5 percent in 1967. Aerospace industry sales plummeted steeply (14 percent) from 1968 to the end of 1970. And with a

GRAPH 15

AEROSPACE SALES AS PERCENTAGES OF GNP, ALL MANUFACTURING, AND DURABLE GOODS



Source: Based on data from Aerospace Facts & Figures, AIA, Washington, D.C.

through the extensive research and development conducted by the industry, in comparison to all other domestic and international industries. Perhaps most exemplary is the fact that the U.S. aerospace industry has built about 80 percent of the Free World's transport aircraft.

A number of distinct trends is indicated in U.S. aerospace exports and imports. Obviously, aerospace exports are a very significant part ($3.47 billion or about 8 percent) of total U.S. exports in 1970 and are estimated at an all-time high of $5 billion for 1971.[11] Aerospace exports are also a significant part (12 to 20 percent) of aerospace sales. Although U.S. civilian aerospace exports, as a share of total aerospace exports, accounted for only 45 percent in 1963, they increased steadily to 74 percent by 1970. Aircraft and parts comprise the largest part of civilian exports.

Military aerospace exports, which accounted for

[11] *The Economy at Mid-Year*, U.S. Department of Commerce, Washington, D.C., 1971.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

OFFICE OF THE ADMINISTRATOR

10/5/71

TO: Jonathan C. Rose
Spl. Asst. to the President

From: H. Dale Grubb

Enclosed is the letter which we discussed.

Enclosure

ND SPACE ADMINISTRATION
, D.C. 20546

r 4, 1971

1971, regarding our
pace shuttle, we described
ered. These included
of what we are now
in which the capabil-
g more nearly existing
ogressively enhanced
by the introduction of new technology and subsystems to result some years after initial flight operations in a Mark II shuttle of full planned capabilities. As a part of this plan, we are also studying the use of a reusable fly-back booster with F-1 engines, and the possible alternate of a reusable ballistic booster.

To explore fully all of the alternatives, we now plan to extend the current Phase B study contracts with the present contractor teams through April 1972. Under this schedule, we believe we will be in a position to make final decisions on the development approach to be followed and to undertake the necessary procurement actions to begin actual vehicle development no later than the Summer of calendar year 1972.

In view of the planning schedule we have now adopted, we have deferred the selection of sites for shuttle developmental and operational flights until the overall systems characteristics are defined. Under the present schedule, this means that final site selections will not be made until the Spring of 1972.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICE OF THE ADMINISTRATOR

October 4, 1971

Honorable George P. Miller
Chairman
Committee on Science and
Astronautics
House of Representatives
Washington, D. C. 20515

Dear Mr. Chairman:

In our letter to you of September 14, 1971, regarding our planning for the development of the space shuttle, we described the alternate approaches being considered. These included looking carefully at the possibility of what we are now referring to as a Mark I/Mark II plan in which the capabilities of a Mark I shuttle system using more nearly existing technology and subsystems would be progressively enhanced by the introduction of new technology and subsystems to result some years after initial flight operations in a Mark II shuttle of full planned capabilities. As a part of this plan, we are also studying the use of a reusable fly-back booster with F-1 engines, and the possible alternate of a reusable ballistic booster.

To explore fully all of the alternatives, we now plan to extend the current Phase B study contracts with the present contractor teams through April 1972. Under this schedule, we believe we will be in a position to make final decisions on the development approach to be followed and to undertake the necessary procurement actions to begin actual vehicle development no later than the Summer of calendar year 1972.

In view of the planning schedule we have now adopted, we have deferred the selection of sites for shuttle developmental and operational flights until the overall systems characteristics are defined. Under the present schedule, this means that final site selections will not be made until the Spring of 1972.

I would be pleased to discuss these matters with you in greater detail if you wish.

Sincerely,

James C. Fletcher
Administrator

MADISON COUNTY REPUBLICAN PARTY
2210 Governors Drive West, Huntsville, Alabama 35805
(205) 539-1301

J. ELBERT PETERS, CHAIRMAN
1701 Jeannette Circle NW
Huntsville, Alabama 35805
(205) 859-3186

December 17, 1971

Mr. H. R. Haldeman
Assistant to the President
The White House
Washington, D.C. 20500

Dear Mr. Haldeman:

This country's space program has frequently been the object of criticism from those who feel the money for this program is not being expended in the best interests of the most people. This criticism has come especially from people who feel the money should be used to solve some of the problems here on Earth.

We who are closer to the space effort, as is the case here in Huntsville, are aware of many of the immediate benefits deriving from this activity, as well as the long-range and "spin-off" benefits. But perhaps we are too close to the space program to understand why there is not more support for it - from all levels of government and from the average man on the street.

The enclosed article by Dr. Ernst Stuhlinger, Associate Director for Science at the Marshall Space Flight Center, Huntsville, was written several months ago. However, it still is very timely and does an excellent job of answering the question, "Why Explore Space?" I hope you will take a few minutes from your busy schedule to read it.

Your active support of a higher budget for NASA in fiscal year 1973 is solicited.

Comments from you on your reaction ~~to~~ the enclosed article will be appreciated.

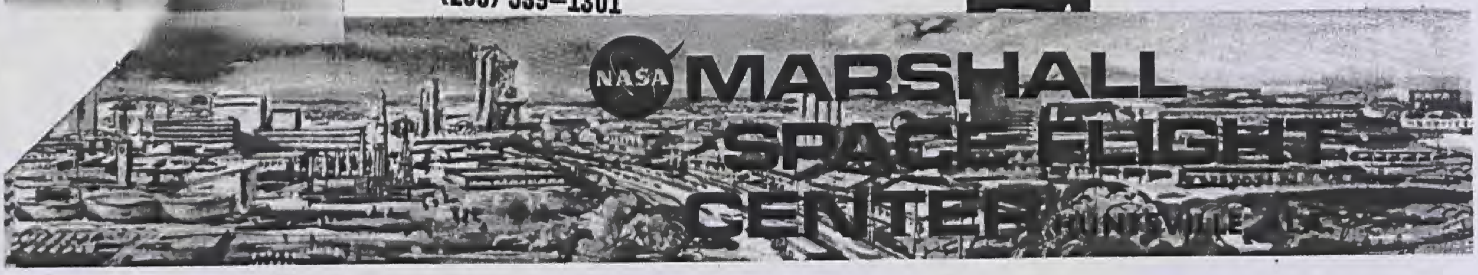
Sincerely yours,

J. Elbert Peters

J. Elbert Peters

Enclosure

..., Alabama 35805
(205) 539-1301



WHY EXPLORE SPACE?

Some of the reasons for exploring space, when there are numerous social problems on earth, were described recently by Dr. Ernst Stuhlinger, Associate Director of Science at the Marshall Space Flight Center, Huntsville.

His beliefs were expressed in his reply to a letter from Sister Mary Jucunda, O.P., a nun who works among starving native children of Zambia, Africa. Dr. Stuhlinger is known internationally for his contributions to electric and nuclear propulsion and his concepts for a manned journey to Mars.

Touched by Sister Mary's concern and sincerity, Dr. Stuhlinger answered her letter as follows:

Your letter was one of many which are reaching me every day, but it has touched me more deeply than all the others because it came so much from the depths of a searching mind and a compassionate heart.

I will try to answer your question as best as I possibly can.

First, however, I would like to say what great admiration I have for you, and for all your many brave sisters, because you are dedicating your lives to the noblest cause of man: help for his fellowmen who are in need.

You asked in your letter how I can suggest the expenditure of billions of dollars for a voyage to Mars, at a time when many children on this earth are starving to death.

I know that you do not expect an answer such as "Oh, I did not know that there are children dying from hunger, but from now on I will desist from any kind of space research until mankind has solved that problem!"

In fact, I have known of famined children long before I knew that a voyage to the planet Mars is technically feasible; however, I believe, like many of my friends, that traveling to the moon and eventually to Mars and to other planets is a venture which we should undertake now and I even believe that this project, in the long run, will contribute more to the solution of these grave problems we are facing here on earth than many other potential projects of help which are debated and discussed year after year, and which are so extremely slow in yielding tangible results.

Before trying to describe in more detail how our space program is contributing to the solution of our earthly problems, I would like to relate briefly a supposedly true story which may help support the argument.

About 400 years ago, there lived a count in a small town in Germany. He was one of the benign counts and he gave a large part of his income to the poor in his town. This was much appreciated because poverty was abundant during medieval times, and there were epidemics of the plague which ravaged the country frequently.

One day, the count met a strange man. He had a workbench and little laboratory in his house, and he labored hard during the daytime so that he could afford a few hours every evening to work in his laboratory.

He ground small lenses from pieces of glass; he mounted the lenses in tubes; and he used these gadgets to look at very small objects. The count was particularly fascinated by the tiny creatures that could be observed with the strong magnification and which he had never seen before.

He invited the man to move with his laboratory to the castle, to become a member of the count's household, and to devote henceforth all his time to the development and perfection of his optical gadgets as a special employee of the count.

The townspeople, however, became angry when they realized that the count was wasting his money, as they thought, on a stunt without purpose. "We are suffering from this plague," they said, "while he is paying that man for a useless hobby!"

But the count remained firm. "I give you as much as I can afford," he said, "but I also support this man and his work, because I know that someday something will come out of it!"

Indeed, something very good came out of this work, and also out of similar work done by others at other places:

the microscope. It is well known that the microscope has contributed more than any other invention to the progress of medicine, and that the elimination of the plague and many other contagious diseases from most parts of the world is largely a result of studies which the microscope made possible.

The count, by retaining some of his spending money for research and discovery, contributed far more to the relief of human suffering than he could have contributed by giving all he could possibly spare to his plague-ridden community.

The situation which we are facing today is similar in many respects. The President of the United States is spending about $200 billion in his yearly budget. This money goes to health, education, welfare, urban renewal, highways, transportation, foreign aid, defense, conservation, science, agriculture and many installations inside and outside the country.

About 1.6 per cent of this national budget was allocated to space exploration this year. The space program includes Project Apollo, and many other smaller projects in space physics, space astronomy, space biology, planetary projects, earth resources projects, and space engineering.

To make this expenditure for the space program possible, the average American taxpayer with $10,000 income per year is paying about 30 tax dollars for space.

The rest of his income, $9,970, remains for his subsistence, his recreation, his savings, his taxes and all his other expenditures.

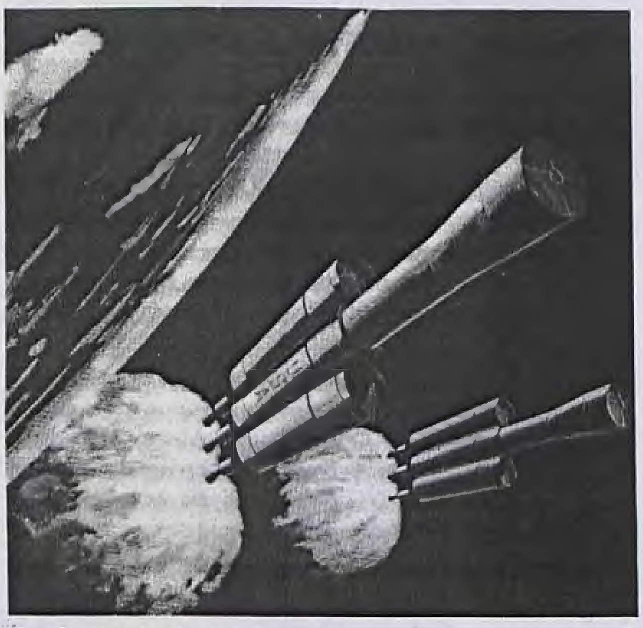
You will probably ask now: "Why don't you take 5 or 3 or 1 dollar out of the 30 space dollars which the average American taxpayer is paying and send these dollars to the hungry children?"

To answer this question, I have to explain briefly how the economy of this country works. The situation is very similar in other countries.

The government consists of a number of departments (Interior; Justice; Health, Education and Welfare; Transportation; Defense; and others), and of bureaus (National Science Foundation; National Aeronautics and Space Administration; and others).

All of them prepare their yearly budgets according to their assigned missions, and each of them must defend its budget against extremely severe screening by congressional committees, and against heavy pressure for economy from the Bureau of the Budget and the President. When the funds are finally appropriated by Congress, they can be spent only for the line items specified and approved in the budget.

The budget of the National Aeronautics and Space Administration, naturally, can contain only items directly related to aeronautics and space. If this budget were not approved by Congress, the funds proposed for it would not be available for something else; they would



simply not be levied from the taxpayer, unless one of the other budgets had obtained approval for a specific increase which would then absorb the funds not spent for space.

You may realize from this brief discourse that support for hungry children, or rather a support in addition to what the United States is already contributing to this very worthy cause in the form of foreign aid, can be obtained only if the appropriate department submits a budget line item for this purpose and if this line item is then approved by Congress.

You may ask now whether I personally would be in favor of such a move by our government. My answer is an emphatic yes. Indeed, I would not mind it at all if my annual taxes were increased by a number of dollars for the purpose of feeding hungry children wherever they may live.

I know that all of my friends feel the same way; however, we could not bring such a program to life merely by desisting from making plans for voyages to Mars. On the contrary, I even believe that by working for the space program I can make some contribution to the relief and eventual solution of such grave problems as poverty and hunger on earth.

Basic to the hunger problem are two functions: the production of food and the distribution of food. Food production by agriculture, cattle ranching, ocean fishing and other large scale operations is efficient in some parts of the world, but drastically deficient in many others.

For example, large areas of land could be utilized far better if efficient methods of watershed control, fertilizer use, weather forecasting, fertility assessment, plantation programming, field selection, planting habits, timing of cultivation, crop survey and harvest planning were applied.

The best tool for the improvement of all these functions, undoubtedly, is the artificial earth satellite. Circling the globe at a high altitude, it can screen wide areas of land within a short time; it can observe and measure a large variety of factors indicating the status and conditions of crops, soil, droughts, rainfall, snow cover, etc., and it can radio this information to ground stations for appropriate use.

It has been estimated that even a modest system of earth satellites equipped with earth resources sensors, working within a program for worldwide agricultural improvement, will increase the yearly crops by an equivalent of many billions of dollars.

The distribution of the food to the needy is a completely different problem. The question is not so much one of shipping volume; it is one of international cooperation.

The ruler of a small nation may feel very uneasy about the prospects of having large quantities of food shipped into his country by a large nation, simply because he fears that along with the food there may also be an import of influence and foreign power.

Efficient relief from hunger, I am afraid, will not come before the boundaries between nations have become less divisive than they are today.

I do not believe that space flight will accomplish this miracle overnight; however, the space program is certainly among the most promising and powerful agents working in this direction.

Let me only remind you of the recent near-tragedy of Apollo 13. When the time of the crucial reentry of the astronauts approached, the Soviet Union discontinued all Russian radio transmissions in the frequency bands used by the Apollo Project in order to avoid any possible interference, and Russian ships stationed themselves in the Pacific and the Atlantic oceans in case an emergency rescue would become necessary.

Had the astronaut capsule touched down near a Russian ship, the Russians would undoubtedly have expended as much care and effort in their rescue as if Russian cosmonauts had returned from a space trip.

If Russian space travelers should ever be in a similar emergency situation, Americans would do the same, without any doubt.

Higher food production through survey and assessment from orbit, and better food distribution through improved international relations, are only two examples of how profoundly the space program will impact life on earth.

I would like to quote two other examples: stimulation of technological development and generation of scientific knowledge.

The requirements for high precision and for extreme reliability which must be imposed upon the components of a moon-traveling spacecraft are entirely unprecedented in the history of engineering.

The development of systems which meet these severe requirements has provided us a unique opportunity to find new materials and methods, to invent better technical systems, to improve manufacturing procedures, to lengthen the lifetimes of instruments and even to discover new laws of nature.

All this newly acquired technical knowledge is also available for applications to earth-bound technologies. Every year, about a thousand technical innovations generated in the space program find their ways into our earthly technology where they lead to better kitchen appliances and farm equipment, better sewing machines and radios, better ships and airplanes, better weather forecasting and storm warning, better communications, better medical instruments, better utensils and tools for everyday life.

Presumably, you will ask now why we must develop first a life support system for our moon-traveling astronauts, before we can build a remote-reading sensor system for heart patients.

The answer is simply: significant progress in the solution of technical problems is frequently made not by a direct approach, but by first setting a goal of high challenge which offers a strong motivation for innovative work, which fires the imagination and spurs men to expend their best efforts, and which acts as a catalyst by including chains of other reactions.

Space flight, without any doubt, is playing exactly this role. The voyage to Mars will certainly not be a direct source of food for the hungry; however, it will lead to so many new technologies and capabilities that the spinoffs from this project alone will be worth many times the cost of its implementation.

Besides the need for new technologies, there is a continuing great need for new basic knowledge in the sciences if we wish to improve the conditions of human life on earth.

We need more knowledge in physics and chemistry, in biology and physiology, and very particularly in medicine to cope with all these problems which threaten man's life: hunger, disease, contamination of food and water, pollution of the environment.

We need more young men and women who choose science as a career, and we need better support for those scientists who have the talent and the determination to engage in fruitful research work.

Challenging research objectives must be available, and sufficient support for research projects must be provided. Again, the space program with its wonderful opportunities to engage in truly magnificent research studies of the moon and planets, of physics and astronomy, of biology and medicine, is an almost ideal catalyst which induces the reaction between the motivation for scientific work, opportunities to observe exciting phenomena of nature, and material support needed to carry out the research effort.

Among all the activities which are directed, controlled and funded by the American government, the space program is certainly the most visible, and probably the most debated activity, although it consumes only 1.6 per cent of the total national budget and less than one-third of 1 per cent of the gross national product.

As a stimulant and catalyst for the development of new technologies, and for research in the basic sciences, it is unparalleled by any other activity. In this respect, we may even say that the space program is taking over a function which for three or four thousand years has been the sad prerogative of wars.

How much human suffering can be avoided if nations, instead of competing with their bomb-dropping fleets of airplanes and rockets, compete with their moon-traveling space ships! This competition is full of promise for brilliant victories, but it leaves no room for the bitter fate of the vanquished which breeds nothing but revenge and new wars.

Although our space program seems to lead us away from our earth and out toward the moon, the sun, the planets and the stars, I believe that none of these celestial objects will find as much attention and study by space scientists as our earth.

It will become a better earth, not only because of all the new technological and scientific knowledge which we will apply to the betterment of life, but also because we are developing a far deeper appreciation of our earth, of life, and of man.

The photograph which I enclose with this letter shows a view of our earth as seen from Apollo 8 when it orbited the moon at Christmas, 1968.

Of all the many wonderful results of the space program so far, this picture may be the most important one.

It opened our eyes to the fact that our earth is a beautiful and most precious island in an unlimited void, and that there is no other place for us to live but the thin surface layer of our planet, bordered by the bleak nothingness of space.

Never before did so many people recognize how limited our earth really is, and how perilous it would be to tamper with its ecological balance.

Ever since this picture was first published, voices have become louder and louder, warning of the grave problems that confront man in our times: pollution, hunger, poverty, urban living, food production, water control, overpopulation.

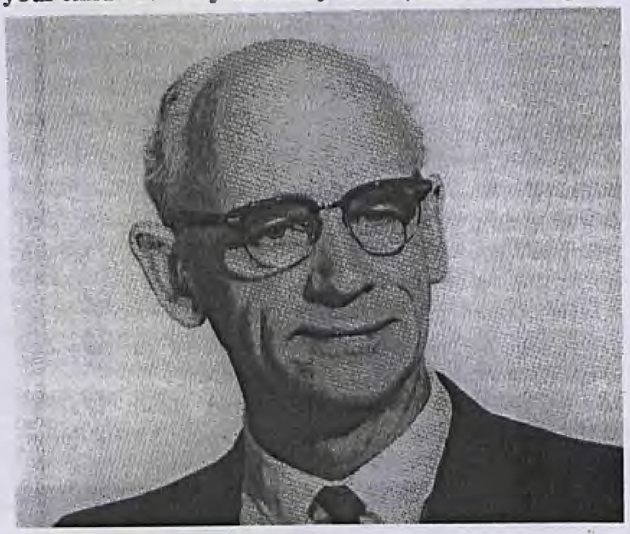
It is certainly not by accident that we begin to see the tremendous tasks waiting for us at a time when the young space age has provided us the first good look at our own planet.

Very fortunately, though, the space age not only holds out a mirror in which we can see ourselves; it also provides us with the technologies, the challenge, the motivation, and even with the optimism to attack these tasks with confidence.

What we learn in our space program, I believe, is fully supporting what Albert Schweitzer had in mind when he said:

"I am looking at the future with concern, but with good hope."

My very best wishes will always be with you and with your children. Very Sincerely Yours, Ernst Stuhlinger.



DR. ERNST STUHLINGER

Born in Germany in 1913, Dr. Stuhlinger received a Ph.D. in physics from the University of Tuebingen in 1936.

He was a member of the German rocket development team at Peenemunde, and came to the United States in 1946, working for the U.S. Army at Fort Bliss, Texas. He moved to Huntsville in 1950, continuing his work for the Army at Redstone Arsenal until the Marshall Center was formed in 1960.

Dr. Stuhlinger has received numerous awards and widespread recognition for research in propulsion. He received the Exceptional Civilian Service Award for his part in the launching of Explorer I, America's first earth satellite.