NASA OAST AND ITS ROLE IN SPACE TECHNOLOGY DEVELOPMENT

by

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INTRODUCTION

I would like to welcome the participants to the "Space Technology Plasma Issues in 2001" conference here at JPL. I understand that you are all experts in this field and have contributed many years of effort to the subject of space plasmas. It is therefore with real excitement and pleasure that I open this conference and look forward to your ideas on how we should carry out in-space plasma experiments. In my remarks today, I would like to introduce you to several new programs, of which this conference is an integral part, that OAST has begun to support your efforts in space research and technology. First, however, I want to briefly discuss the four key issues that currently are consuming NASA's energies and should be of great concern to you, the participants in this conference. NASA is placing its emphasis in space on:

1. reconstituting the Shuttle capability

2. maintaining the Space Station momentum

3. resolving the current science mission backlog

4. rebuilding the technology base

First, of course, NASA is seeking to reconstitute the Shuttle launch capability. It is Dr. Fletcher's number one priority. The second one is maintaining the program momentum for the Space Station. All of us are concerned about what is happening with the Space Station program that the President has directed: When is it going to get started? Is it in trouble? Is there sufficient money for it? I would like to state here that I think that the problems raised by Congress with the Space Station are being disposed of nicely and that we will see a very strong program start this coming year. Thirdly, there is the tremendous impact to the science missions and payloads that the Shuttle problem has given rise to. NASA Headquarters is trying to determine how to work around the delays, how to reschedule the missions, and how to protect the payloads that have already been built and are sitting in storage.

Before turning to the fourth issue, that of rebuilding the technology base and the technology capability of the agency, I would like to speak briefly about the Office of Aeronautics and Space Technology (OAST). OAST has the responsibility for developing the advanced space technologies that will enable or enhance future national missions. We are working towards developing a space infrastructure, the cornerstone of which is the Space Station. Much of the technology activity in OAST and much of the funds are going towards technologies that would support this infrastructure. By infrastructure, I mean systems ranging from launch vehicles, propulsion systems, and structures for launch vehicles to advanced systems such as large, space-station types of structures, planetary missions, geoplatforms, lunar bases, and, in the distant future, long-duration manned missions to Mars.

As a planning guide, we in OAST use a mission chart that identifies driver missions (Figure 1). In developing this chart, driver missions are first identified. These are coordinated with as many people as possible to insure that our perspective of the future and the time frame are reasonable. Once everyone agrees that these missions are probably what will be happening 10, 15, or 20 years in the future, we can with some confidence begin to invest money in key technologies--money that is currently very scarce. The mission drivers are used to guide, to provide scope, and to give direction to OAST's research and technology activities. As shown in Figure 1, technologies that will enable the next-generation space-transportation systems are being worked on. Likewise, both next-generation spacecraft and large spacecraft systems technologies are being studied. These three categories are being used to provide a vertical cut to our program structure.

Now I would like to relate a sad story. Many of you here were doing space research in the 1960's. As shown in Figure 2, the funding in space research and technology in constant year dollars was well in excess of $900,000,000 a year from 1965 to 1967. That amount has eroded to a very flat level of about $200,000,000 a year--actually less--at present. The level has been about $175,000,000 a year for the last, almost 10 years. That investment has had to support the Space Transportation System (Shuttle) Program, the Space Station Program, and all the other activities that we're trying to do. That $200,000,000 doesn't really spread out very deeply. As demonstrated by the profile in Figure 2, the country is really suffering with respect to the amount of money going into research and technology for the space program.

Newspaper articles, the reports of blue-ribbon panels appointed by the President, and many other sources have all indicated that the country's space technology base is really deficient. NASA is living off the investments of the 1960's. The investment in advancing the state of technology to any great level has not been replenished. Technology no longer leads with solutions, it chases problems. Our expectations exceed what current technology can deliver. If the profile shown in Figure 2 is extrapolated to industry, it is not hard to understand why people are saying that the U.S. leadership in space is being challenged. NASA indeed recognized that its own expertise is on the decline--we are losing people and it is becoming more and more difficult to attract bright young graduates from the universities. We have a serious problem!

On that note I now want to introduce a new initiative that OAST has taken to the NASA Administrator. It is called the Civil Space Technology Initiative or CSTI--like SDI! It is OAST's response to the Administrator for a major augmentation within NASA for research and technology dollars. The actual dollar amounts are currently being reviewed by the Office of Management and Budget and will be released in the next six months. We are optimistic that the initiative will be successful and that it will provide the mechanism to reinvigorate the activities in research and technology for space. We intend to develop a focused thrust to remedy gaps in the technology base in order to enable high-priority programs. We plan to enable low-cost access to space and key NASA missions through developments in:

- launch-vehicle propulsion
- booster technology
- space-based propulsion
- launch-system autonomy

- aerobraking technology
- high capacity power
- spacecraft power
- automation and robotics
- large structures and control
- sensor device technology
- high data-rate systems

Ultimately these are the means to an end. This can be summarized in terms of the CSTI logic: restore agency technical strength; develop focused technology demonstrations; meet priority needs of NASA and National Security; rebuild the image, morale, and skills of the community; and make the program affordable. This last point, affordability, is very important and, as I will show, can be achieved. As illustrated by the National Commission on Space and its mandate to the nation and NASA to triple the investment in research and technology, many other groups have taken stands similar to ours.

As to affordability, OAST believes that the country can in fact invest very heavily in research and technology without having to make any commitments at this time to a major new program. This is an important point, since if each new program costs a billion dollars and there are 5 or 6 programs, then there is a 5- or 6-billion dollar a year commitment required. In contrast, the investment in research and technology can be on the order of 2- to 3-hundred-million dollars a year added to what we are currently spending. That is a very affordable investment without the necessity of commiting to the big, expensive programs of the past. It will permit us to make those kinds of big decisions farther in the future when the technology risk is much lower. This investment strategy will make this option viable. I think it is going to be a very exciting time for NASA beginning in FY88 with this infusion of money for research and technology.

The initial focus of the CSTI program will be in six areas:

1. Propulsion
   - Earth-to-orbit
   - Orbit transfer
   - Booster technology
2. Vehicle
   - Aeroassist flight experiment
3. Information systems
   - Science sensor technology
   - Data: High rate/capacity
4. Large structure and control
   - Control of flexible structures
   - Precision segmented reflectors
5. Power
   - High capacity
   - Spacecraft
6. Automation and robotics
   - Robotics
   - Autonomous systems

There are several areas in this list that are applicable to plasma interactions and, when we get approval, I am sure that the members of this group will be important participants in it.

I would now like to return to the subject of the conference--plasma interactions and in-space experiments. NASA has been conducting in-space experiments since 1960. Starting with 1960, we can construct an interesting profile of the type of experiments that have gone into orbit. In the earliest days, the experiments were basically associated with the programs and supported them--for example, the Gemini and Apollo programs. Since that time there has been a dip. More recently, with the Shuttle, there has been a tremendous resurgence of activity. The Shuttle is a facility that lends itself very nicely to doing things in space and in-space experimentation has grown accordingly. Now NASA is in a temporary stand-down. Even so, with the experience gathered since 1960 and on the Shuttle, we feel that we have demonstrated the feasibility of doing in-space experimentation on a routine basis. For the first time, the space environment has become an extension of ground-based activities. Now when it's necessary to go into space to do something, it is feasible, it is affordable, and it is becoming a significant new area for future opportunities.

As an example of in-space experiments applicable to future programs, consider the construction by astronauts of a truss assembly in the Shuttle bay in December of 1985. The truss is a baseline concept for the Space Station. It was this in-space experiment that was the final proof of the concept. Even more exciting experiments are planned in this area over the next 3 to 5 years--one is the further study of the control of large flexible structures in space. There are, in fact, three succeeding experiments, each becoming more and more complex. They start with a single beam and move on to two-body and then multi-body configurations. Similarly, OAST plans an aeroassist experiment for the Orbiter. A re-entry shield will be flown in and out of the Earth's upper atmosphere to evaluate maneuvering and aerobreaking concepts similar to those planned for future planetary missions.

The Space Station is being designed to be a facility. It will be a facility in the sense that it is intended to be actively used for research. That is, it is intended to satisfy the needs of the science community, and the technology community and to take advantage of commercial opportunities. The Space Station will act as a cornerstone, as a node, in the infrastructure of our space system. It will help us to get to the outer planets, perhaps establish a base on the moon, and will be a facility for performing numerous in-space operational activities.

Today we are at a crossroads. We have demonstrated the feasibility of doing things in space. There is an emerging, vocal user's community made up of many different interest groups and organizations. In turn, user needs are being reflected in the design of future space facilities which are being developed as national resources. They present unique opportunities to do things in space and answer many critical questions. In particular we find an exponentially expanding program driven by the convergence of:

USER NEEDS:

- Research in:
  - Materials
  - Fluids
  - Devices
  - Structures, Controls
- Demonstration
  - Proof of concept
  - Engineering demonstration
  - Flight qualification

SPACE FACILITIES:

- Shuttle
  - Payload Bay
  - Mid-deck
  - Cannisters
  - Hitchhikers
- Space Station
  - Internal payloads
  - Externally mounted
  - Technology Laboratory Module
  - Platform based

These two efforts--user needs and space facilities--are coming together in a coherent program.

For the last year I have trying to build a program for in-space experimentation within OAST that will be accepted as a real, viable element of the space program. There is no doubt that as new technologies are going to be needed as the space infrastructure grows, one of the best ways to advance technology and transfer that technology to applications is to either conduct the experiment in space and/or have a demonstration in space. This allows the user to gain confidence that the technology does in fact work and that he can baseline his space system design. As part of the planning for this effort, we have developed seven theme areas: energy systems, space structures, automation and robotics, fluid management, information systems, in-space operations, and, the subject of this conference, space environmental effects.

To begin the study, a major workshop was carried out in Williamsburg, Virginia in October, 1985. Each of these theme areas was addressed in detail by the 400 attendees. The attendees represented a cross-section of civil service, industry, university, and DoD space workers. The major conclusion of the conference was that there are significant desires to do experiments in space that advance the seven research and technology areas just listed. The seven themes were determined to be valid planning mechanisms. This year we are sponsoring mini-workshops or symposiums in many of the the theme areas. Fluids, large structures, materials, and, here, plasma interactions are currently being reviewed. Thus many activities orchestrated under a common program umbrella are starting to happen. We can aggregate all these and build a case for developing an in-space experiment program. Thus we are establishing OAST as the national focal point for in-space research and technology. We are coordinating the user community requirements and plans through workshops and symposia.

We have built a lot of interest over the last year in this program. One of the pitfalls we have encountered, however, is that we may be building interest too fast and with it, false expectations. Certainly, with the Shuttle problem and not knowing how much capacity will be available over the next 5 years in terms of Shuttle manifesting, it is very easy to become trapped. We have, however, taken positive steps to stimulate cooperative ventures through a new program--the Outreach Program. In October 1985, at the Williamsburg Conference, Dr. Ray Colladay, my boss, stated to the conferees at the meeting:

"I'm willing to put up money. I'm willing to challenge you...I want to challenge you, and I'm willing to put up $10 million a year of my money, and I want you to match it. I want you to not necessarily match the money, but match resources. I want you to come back to me and tell me what you want to do in space and I will make my money and my resources available to you. Together we can fly the type of experiments that you in industry or the academic community want to do in space."

The intent of Dr. Colladay's remarks is to build advocacy for in-space experiments and build a program that would lead to maximum utilization of the Space Station when it becomes an operational entity. As a first step in the Industry/University Experiments Program or "Outreach" (as separate from the CSTI), a CBD announcement was released on June 30, 1986 and an RFP was released on August 15, 1986. The objective is to provide incentives to industry to better utilize the technology development potential of space. The approach is to: 1) select experiments of mutual benefit to industry and NASA; 2) jointly develop, program, and fund appropriate experiments; and 3) provide unique facilities (Shuttle or Space Station). There are two classes of ventures: those for which the concept has been developed and, perhaps, for which hardware is ready to go. In this case, OAST will provide funds for integration and a free flight. In the second case, the concept may be excellent, but it may have not been developed very far. In that case, OAST will provide money, perhaps $100-$200 thousand per concept to allow further definition. In 1 to 2 years the concept will be recompeted to see if it should be taken to the hardware stage.

In terms of funding, in FY86, OAST has committed only about $32 million a year to flight experiments. It is currently projected that when the Space Station becomes operational, that $30 million will grow to $100 million. It may in fact grow to more but the baseline for my program is currently $100 million. This growth curve is shown in Figure 3 for the Outreach Program. With the combined efforts of universities and industries to match this level, the program should easily become a $200-million-a-year program by 1995. The potential for growth is even higher if the military in-space program is included. The nation could easily have a substantial half-billion dollar a year program in in-space technology. With this level of funding, there will be many opportunities to address such areas as plasma interactions. The potential is there!

This conference will be important in influencing our choices in this program. When we begin talking about Space-Station size facilities such as large deployable reflectors or even the Space Station itself, plasma interactions will play a key role in their performance. We have, for example, no real understanding of what effects plasma interactions will have on even such basic issues as contamination or safety. These issues will have to be addressed. The opportunity is here because NASA is going to have a Space Station and things have reached the point where such issues need to be addressed. There is no better group than those of you here today to identify the key plasma issues and to lay out a program that says "these issues have to be addressed over the next 10 years and these are the experiments that will answer those questions." The product of this conference is intended to support an investment of real dollars in a program in plasma interactions. The program may not be the size that you ask for but it will be the beginning of what we hope will be a long-term effort to answer at least some of the key questions in plasma interactions!

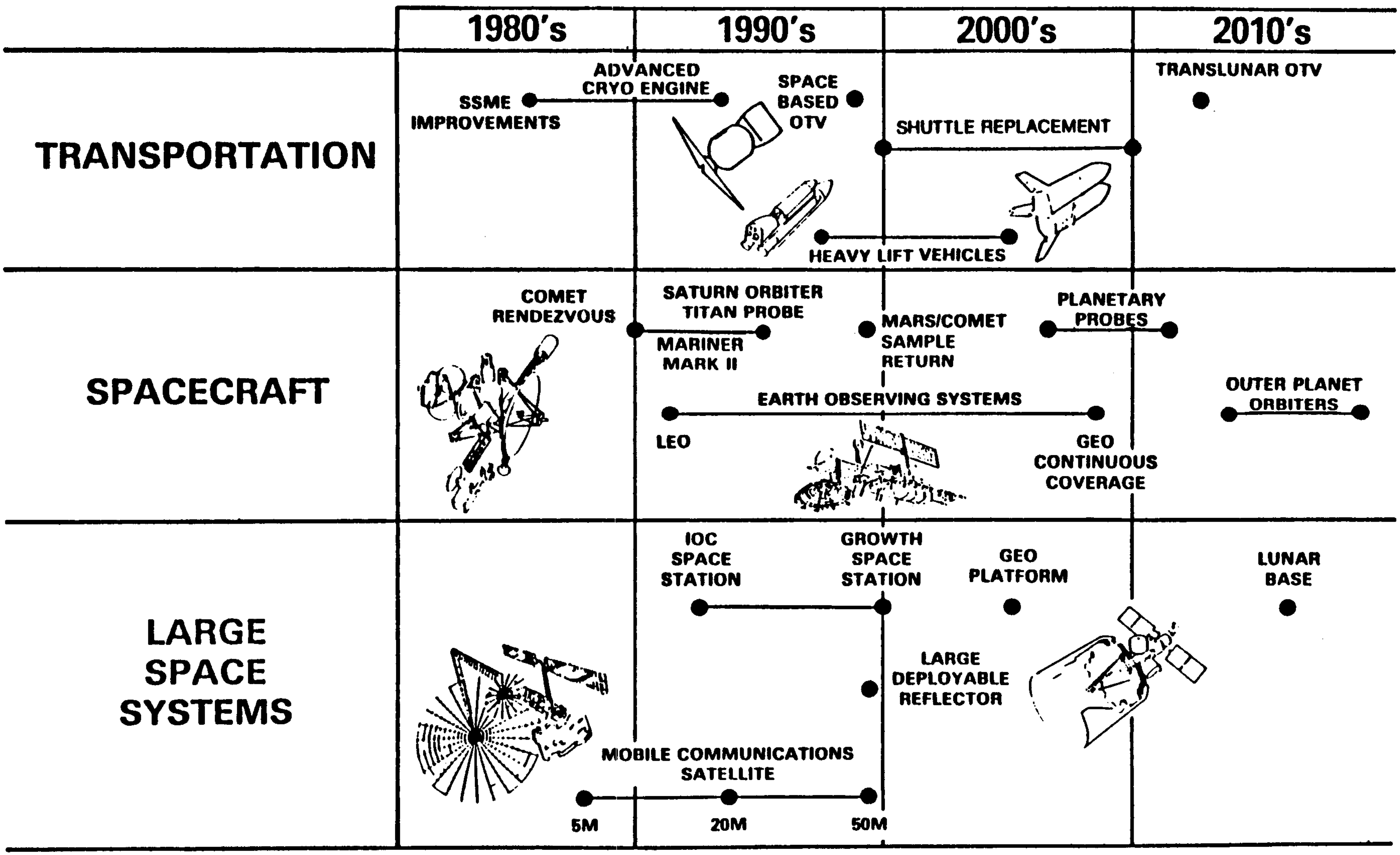

Fig. 1. Program Focus on Driver Missions

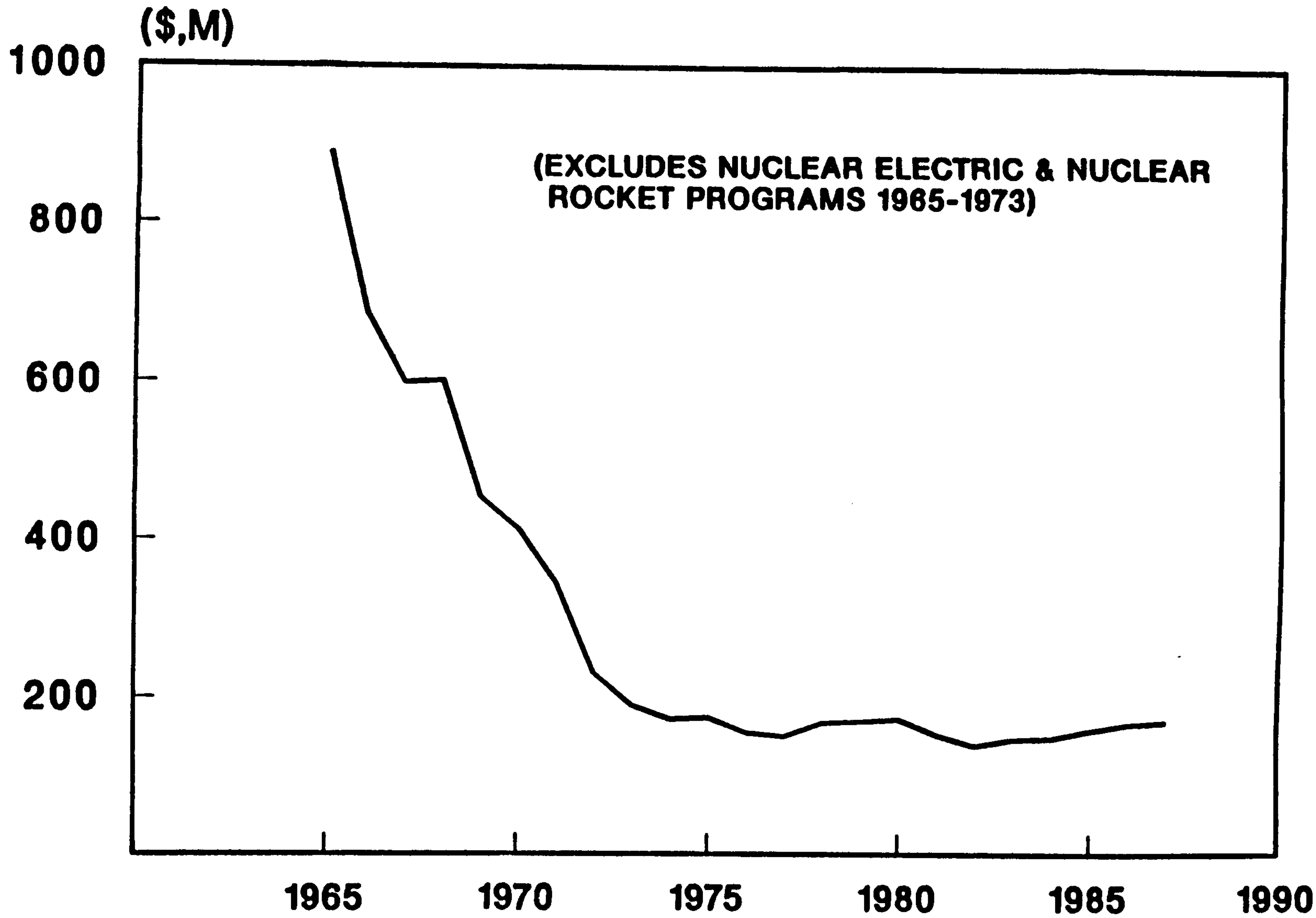

Fig. 2. Space Research and Technology Funding Trend (Constant FY 87 Dollars)

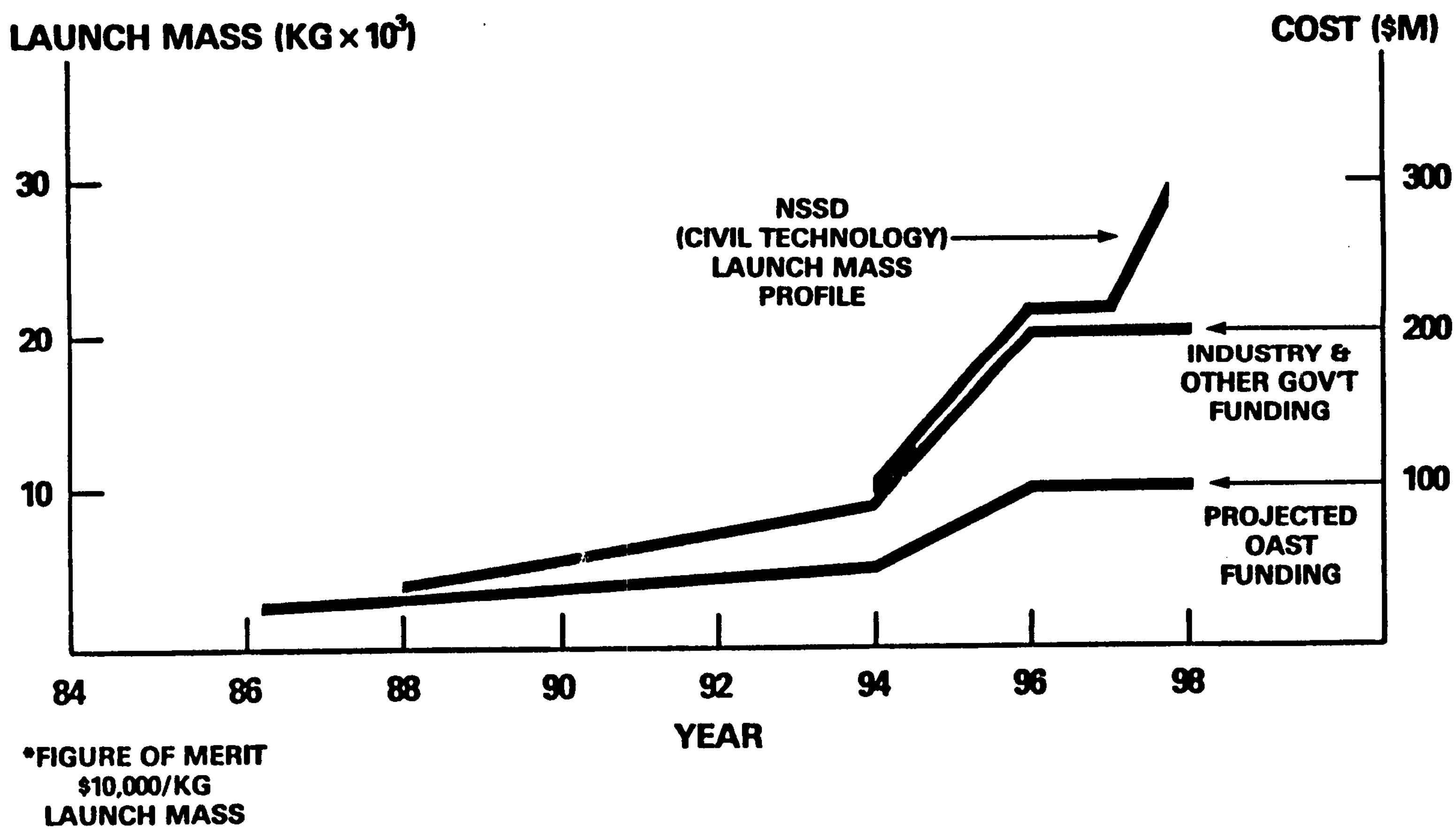

Fig. 3. In-Space Experiment Program Potentials