

FINAL REPORT

Contract No. NAS8-30739

AN APPROACH TO DEVELOPING THE MARKET
FOR SPACE SHUTTLE PAYLOADS
(BUSINESS/PUBLIC POLICY ISSUES AND INTERNATIONAL
MARKETING CONSIDERATIONS)

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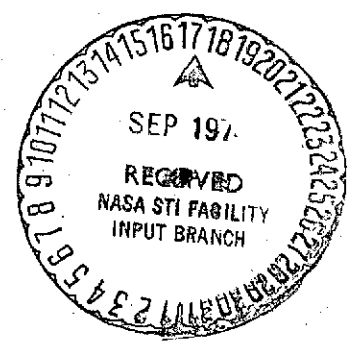
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CHAPTER I

EXECUTIVE SUMMARY

In this report ADL assesses the business and public policy issues that will be important for NASA to consider in the design of a program for stimulating uses and interesting potential users of the Space Transportation System in the U.S. private sector and in foreign countries, in preparation for operations of the STS in the early 1980s. We also characterize other salient factors that will need to be given special consideration in developing uses of STS in the international field.

A key finding of the study, which involved personal or mail contact with 45 leading U.S. organizations--primarily multinational manufacturing companies active in advanced technology fields--is that there is both a knowledge gap about precisely what STS can contribute to the profitable functioning of such enterprises in the 1980s and 1990s and a communications gap in making available such knowledge as exists. A key conclusion is that these gaps can probably be closed by well-thought-out, well-organized and energetic research and market development efforts and that closing them is crucial to securing widespread utilization of the STS by the private sector.

The study suggests that R&D uses of the STS, of a fairly basic kind, will probably have the greatest attraction for the U.S. private sector in the early 1980s but that the scale of such uses, in the light of the scale of the whole private sector industrial R&D budget at that time, may be somewhat less than presently-projected STS capacity committed to such uses. Transition to a condition of an excess of demand over capacity, by later in the 1980s, is seen as a possibility, however, considering potential uses of the STS for processing, sensing, telecommunications and navigation, and energy-production support. All of these estimates are presented with substantial qualifications since they can be verified, if at all, only by much more extended research on a number of fronts.

Realistic appreciation of the potential of the STS for achieving private sector objectives is also severely constrained at this time by the absence of a well-developed, explicit set of terms and conditions on which STS services will become available. To overcome this barrier the report

recommends development of an STS "Tariff Model" which will deal initially with at least the following subjects of crucial interest to prospective users:

- the expected organizational structure of the entity that will form the interface with the user community;
- the procedure for mission planning;
- the procedure for making and accepting offers to contract for services and resolution of competing demands;
- price formulas;
- explicit provisions that will govern the disposition of patentable inventions and utilized or generated knowhow;
- statements of basic policy in at least the following areas: safety requirements, environmental protection requirements, discrimination (or non-discrimination) among different classes of potential users, separation among military and non-military missions/payloads, utilization of telecommunications, required availability or dissemination of data acquired by on-board sensors, the extent to which the competitive status of private sector users will be considered, and the extent to which other Federal government policies affecting data generated on-board will be applied.

The report endorses the concept of the development of a "middleman organization" distinct from NASA itself to carry out the market development and, later, the marketing function. Ultimately, it is suggested, such an organization should become completely independent of NASA, generating its revenues from fees paid by users of STS and, in turn, purchasing facilities and services from NASA. The report spells out the evolutionary steps in the development of such an organization as follows:

- Contracting out, by NASA, of further market research, institutional development, and market development--to organizations similar to those employed in Phase I.
- Contracting out, by NASA, of responsibilities for actual sales of service to users--employing the concept of an exclusive agency, relying on one (possibly several) market development and marketing organizations. It is implied that, at this stage, the market will not be strong enough for the agent to operate without NASA financing.

- Creation, almost certainly by legislation, of an independent, regulated monopoly to market the commercial services of the STS, standing on its own financial feet, purchasing services from NASA.

It is not yet possible to estimate the time required for the complete evolution--it could be as long as 20 years and as short as 5. Much depends on findings in further market research, on the level of support for market development, and on demonstrated capabilities of STS to meet real commercial needs.

With respect to the foreign market a principal finding of the study--at this stage constrained from field research in foreign countries--is that an international marketing program will need to distinguish among the distinctive interests and capabilities, with respect to STS, of the highly-industrialized, service-oriented economies (the U.S., Western Europe, Japan and the Soviet Union), the rapidly industrializing and/or petroleum-based economies (e.g. Brazil, Iran, Saudi Arabia), and the agriculturally-based developing economies. The study also notes that a distinguishing characteristic of all foreign markets for STS will be the need for special efforts to develop and extend an atmosphere of trust and confidence in NASA on the part of foreign users, to resolve a large number of complex legal issues, and to establish a specialized management structure for the international market development effort.

The Phase II program recommended for dealing with the areas included in the ADL effort would involve the following elements:

- Further identification and analysis of the interests of foreign users, necessarily involving field interviews abroad;
- A careful study of the terms and conditions on which STS services will become available and their embodiment in an evolving STS Tariff Model;
- Detailed development of the structure and program of a new, independent marketing entity which would ultimately make STS services, supplied by NASA, available to the user community, including careful consideration of the transitional stages through which such a development must move, over a 5 to 20 year period;
- Continuing elaboration of presently fragmentary knowledge about both uses and users in the private sector, drawing on other studies and contractors as appropriate.

CHAPTER II

INTRODUCTION

The Space Transportation System (STS) is now being developed for operational use in the 1980s and beyond. It is designed to provide economical transportation to and from earth orbit and to allow more efficient space exploration and utilization for man's benefit. The major elements of this system can be reused after operations in earth orbit and will eventually replace many of the non-recoverable launch vehicles now used for placing payloads in space.

The key elements of the STS are the Space Shuttle Orbiter and its solid rocket booster motors being developed with industrial support by the U.S. National Aeronautics and Space Administration (NASA), the Spacelab manned laboratory being developed by NASA and the European Space Agency (ESA), and an Interim Upper Stage (IUS) for the Orbiter under development by the U.S. Department of Defense. A more advanced upper stage, the Space Tug, is also being developed by NASA to offer expanded capabilities and uses for the Space Transportation System after 1984. The Tug will provide greater system flexibility for operations in geosynchronous orbits, for orbital path changes and deep space operations with emphasis on space rendezvous and docking capability.

The complete system is designed not only to place a variety of payloads into various earth orbits and into trajectories throughout the solar system, but also to make possible the retrieval, refurbishment, repair and even refiring of spacecraft, thus reducing operational expenses significantly. It will provide a "shirtsleeve" working environment so that crew and passengers can spend up to one month in earth orbit, performing the role of a manned space station and allowing a variety of experimental and operational activities to be carried out under unique space conditions of close to zero gravity, zero vibration, zero contamination and absolute vacuum. The operational characteristics of STS launchings and reentries will be sufficiently less rigorous than those of present satellites as to permit orbital travel by a wide range of scientists, engineers, and others

not physically qualified as astronauts, thus expanding the range of skills available for space missions¹.

NASA is committed to making the STS available to non-NASA organizations on a cost-reimbursable basis. This includes other U.S. governmental agencies, U.S. private commercial enterprises and educational institutions as well as foreign governments and foreign private sector users.

Stimulating cost-reimbursable use of STS outside NASA and military programs presents some new problems, analogous to those which face any organization seeking to market an advanced new technological capability to potential users not well-acquainted with its characteristics and with little idea of how it might advance their own objectives. Accordingly, NASA has commissioned a series of limited, first phase studies of elements of those problems with the expectation that a second phase of such a study program --based on insights gained in the first--will follow.

The ADL effort reported in this document is one of four such studies being carried out more or less simultaneously by different contractors with a common theme but different emphases. The common theme is an effort to describe methodologies appropriate for NASA to use in identifying new uses and users of the STS in what will eventually be a marketing program. The different emphases are on potential uses and users in

- the Federal and state governments (other than the military services)²;
- the private industrial and commercial sectors of the U.S. industrial economy³;
- the educational community in the United States⁴;
- the international community, together with consideration of issues of business/public policy significant to private sector users both in the U.S. and abroad⁵.

¹ See Appendix B for a more extended description of the STS.

² The emphasis in the study carried out by Stanford Research Institute at Huntsville, Alabama, in the six-month period ending June 20, 1974.

³ The emphasis in the study carried out by Battelle Columbus Laboratories in the six-month period ending June 30, 1974.

⁴ The emphasis in the study being carried out by the University of Alabama at Huntsville for completion by September 1, 1974.

⁵ The emphases in the ADL study.

All of the studies have been deliberately constrained by low budgets (\$37,500, except for the University of Alabama which was funded at \$25,000) and short time schedules; they are considered by both the contractors and NASA as exploratory only.

Several other recent studies of aspects of the utilization of STS are relevant to NASA's marketing problem and strategy. These include a series of studies by the General Electric Company of "Beneficial Uses of Space" (BUS) and a series by Aerospace Corporation of "Business Risks and the Value of Operations in Space" (BRAVO). These, along with other selected published materials we have found useful as background in preparing this report, are cited in Appendix D.

CHAPTER III

OBJECTIVE, SCOPE AND RESEARCH APPROACH OF THIS STUDY

The initially-stated objectives of the ADL effort were to:

- Develop market-research and market development methodologies for stimulating STS uses by U.S. commercial and foreign users, and
- Define a Phase II program for in-depth market research, including the identification of public policy issues requiring early attention.

The following six tasks were envisioned:

- Review and expand data on prospective uses and users,
- Define conditions critical to commercial and industrial users,
- Differentiate the importance of such conditions as between domestic and foreign users,
- Evaluate and rank the conditions most likely to affect the marketability of the STS in the U.S. and abroad,
- Explore options for public policy, administrative practices, organizational forms, and operational arrangements for marketing the STS, and
- Define a Phase II program for in-depth market research; and identify public policy issues requiring early action.

After the commencement of the contract NASA requested that this initial phase of the work program be modified to the extent of not making direct contact with potential foreign user groups. Our evaluation of foreign user interests and requirements therefore is of necessity based on existing in-house ADL information and experience as well as information obtained from various "surrogates", such as executives of U.S. multinational corporations.

A further modification of the initially-stated objectives developed in the course of the work primarily as a consequence of the relative time-phasing of the Battelle and ADL studies. The Battelle study was contracted about three months in advance of the ADL study and completed two months earlier. The concentration of Battelle on developing a statement of detailed marketing methodology appropriate for a program aimed at stimulating private sector uses, especially in the U.S.A., and our broad concurrence

with Battelle on the utility and comprehensiveness of that methodology as reported in Battelle's mid-term briefing, suggested to us and the NASA COR that we should emphasize elements of the problem not present in the Battelle analysis--or in Battelle's terms of reference--especially the business and public policy issues which, it appears to us, may well be determinative to the success of an STS marketing program. Along with the effort to differentiate between the interests and responses characteristic of foreign as opposed to domestic users, this emphasis on business and public policy issues has come to dominate the ADL study--which accordingly gives relatively reduced attention to detailed marketing methodology per se.

Our approach, after literature search and analysis, centered on an interview program in the U.S. private sector among large, technologically-oriented manufacturing companies. To compensate for our inability to interview foreign companies directly, we biased our sample of U.S. companies by singling out those with substantial overseas operating experience and, within those companies, further seeking to talk with top-level executives whose personal experience encompassed overseas operations.

As a basis for such interviews we prepared the guidelines presented in Appendix A, backed up by a technical brief specially prepared for this purpose (Appendix B).

Because of limitations on an extensive interview program imposed by budget and time constraints, we arranged to sample a wider range of respondents through the cooperation of the Industrial Research Institute, Inc., the leading professional organization of Directors of Industrial Research. IRI kindly agreed to set up a special task force on the STS and, with our assistance, carried out a mail inquiry about knowledge and interest in STS capabilities among its key members.

Results of the interview program and the IRI inquiry are discussed in Chapters V and VI. Names of organizations with whom contact was made appear in Appendix C.

We also carried out a number of interviews, involving discussions of policies and policy issues likely to be significant to STS marketing, with knowledgeable senior staff at NASA Headquarters. On matters involving patents and inventions we acknowledge with thanks the cooperation of NASA

legal counsel with whom we discussed our views and who informally reviewed our conclusions.

Interviews and literature references were further supplemented by discussions with and commentary from a wide range of ADL professional staff, many of whom have substantial experience in international marketing, particularly of advanced technologies, and, in addition, a wide range of exposures to business and public policy issues of the kinds considered elsewhere in this report.

CHAPTER IV

STS CAPABILITIES AVAILABLE TO THE U.S. PRIVATE SECTOR AND FOREIGN USERS

A number of preliminary studies have already been undertaken to identify the nature of the opportunities which the characteristics of the STS system will afford to various user groups, including the U.S. Department of Defense and other government agencies, the U.S. private sector and potential foreign government and private sector users.

This section of the report provides a summary of the STS services which the existing state of knowledge and experience indicates will be available to the U.S. private sector and foreign users during the 1980-1991 period. A definition of such services and applications, as well as the existing set of terms and conditions on which access will be made available, is critical information for any consideration of such questions as:

- who the probable users will be;
- how much use will they make of it;
- when will they use it;
- under what conditions will they seek access to it; and
- how might the STS program best be marketed to those potential user groups.

For the most part, the service to be marketed is access to the space environment through the unique capabilities of this new form of transportation. The basic services of the STS will be:

- Use of the Spacelab during 7-30 day sorties to conduct experiments, process products, and carry out a number of related activities under conditions of close to zero gravity, zero vibration, zero contamination and within an absolute vacuum,
- Use of the shuttle to deliver a payload, or a payload with an upper stage, into orbit,
- Use of the shuttle to service (repair, refurbish or replenish) automated satellites already in space, and

- Use of the shuttle to retrieve spacecraft from orbit

In addition, access to the information collected in space by the various user groups will be of considerable value to a wide range of users in the United States and abroad who will have little or no understanding of the STS program per se. Thus, the STS marketing program must also consider how best to market such information to such potential users.

The uses which the unique characteristics of the STS appear to offer have been presented in some detail in a number of other reports. For the most part they fall into five general, but not mutually exclusive, categories:

- R & D
- Sensing
- Communications/Navigation
- Energy
- Space Processing

RESEARCH AND DEVELOPMENT

The STS opens up vast opportunities for research and development concerning the properties of earth substances in space, as well as the properties and utilization of space itself. Many of the results of this work will undoubtedly lead to specific applications for space processing, sensing, communications/navigation, and energy generation.

R&D activities which will be conducted as part of the STS program include attempts to extend applicable ground-based technology into the space environment where specific investigations require access to the unique characteristics of the space environment to supplement or verify ground-based data. Typically, these investigations are necessary steps in the development of new materials, new systems, and new concepts. The STS will open up new opportunities for fundamental physics and chemistry research that cannot be done on the ground.

In much the same way that emphasis has been given to R&D activities during many of the space efforts to date, such as during the Skylab program, so it can be anticipated that the early STS payloads will be

heavily oriented to R&D activities.

SENSING

Space shuttle sorties present many opportunities related to the observation of earth phenomena. This includes not only the observations which men will be able to make from space during sorties, but the ability to deliver and retrieve, repair and refurbish automated earth observation satellites from space.

Sensing applications fall into four broad categories:

- earth resources
- environmental quality
- weather and climate
- earth and ocean physics

Potential applications related to the earth's resources include studying the earth's mineral, forestry, agricultural and marine resources. International organizations, such as the FAO, governments and resource oriented firms will undoubtedly find this application of considerable interest.

The potential benefits to be derived from the application of space technology to pollution monitoring are generally well recognized. This includes air, water, and land pollution. The principal "users" of course would not be commercial enterprises but rather government organizations at the national, state and local level, foreign as well as domestic. NASA activities in these areas are advanced. Studies of weather and climate as well as earth and ocean physics are also likely to be undertaken primarily by government organizations for the ultimate benefit of a wide variety of user groups.

COMMUNICATIONS AND NAVIGATION

NASA's communications and navigation space program has to date relied on expendable launch vehicles to carry satellites into space. This method of transportation has required that satellite size and weight be compatible with the capabilities of launch vehicles. In some cases the vehicle could not support the desired spacecraft mission. Therefore, because a

large cost increment would have been necessary in order to use the next larger launch vehicle, occasional compromises in spacecraft capability that limited the payload to more moderate mission goals were at times necessary.

The availability of the STS will overcome these delivery problems and will enable automated communications and navigational satellites to be retrieved, repaired and refurbished. Such services will be of benefit to commercial users in the United States and abroad, as well as government users, especially in that design engineering reliability standards can be substantially relaxed as it becomes possible to repair such satellites in orbit. Major cost savings are foreseen.

ENERGY

The STS will enable man to explore new methods of overcoming the world's energy problems. It will make available a unique transport capability for the large payloads required if novel concepts for power generation methods located in space are to become a reality. Such methods could include solar energy conversion and nuclear fission and fusion in space.

SPACE PROCESSING

The characteristics of space which will be made accessible through the STS will enable some high technology products to be produced that could not be produced on earth or could not be produced as well on earth.

The range of processing applications theoretically possible in the space environment is suggested by the following twelve ideas generated by a recent GE study undertaken for NASA. It is likely, however, that a great deal of research must be undertaken in the years ahead to determine what space processing applications will prove to be financially as well as technically feasible.

Potential Application

- Imprinting circuitry on crystal wafers for surface acoustic wave electronics
- Particle manipulation by small forces

Basic Reasoning

- Elimination of vibration from imprinting system
- Elimination of gravity masking effect

Potential Application

- Vibration testing of small motors
- Single crystal and eutectic high temperature turbine buckets
- High purity tungsten x-ray targets
- Precise separation of radioisotopes
- Silicon crystal growth
- Epitaxial growth of magnetic bubble memory crystals
- Amorphous glasses and refractories
- Basic heat transfer data
- Separation of isoenzymes
- Utilization of biorhythms

Basic Reasoning

Improvement of present 4CPS limit, isolation from sonic and magnetic fields

Certain superalloys not amenable to casting; present crystals small and contain dislocations; eutectics contain dislocation, etc.

Contamination of melt by crucible

High specificity separation techniques

Convection during crystal growth

Convection, loss of supersaturation

Crystallization due to inclusions, convection

Convection during measurements

Denaturation of Isoenzymes by separation under G loading

Terrestrial influences

THE STATE OF KNOWLEDGE ABOUT APPLICATIONS, GENERALLY

Despite the indications of utility reviewed above, our overall impression of the state of knowledge about precisely what uses of STS will prove to be most attractive, particularly from the point of view of the private sector, is that too little is yet known to validate any firm conclusions about the potential commercial significance of such uses. Closing this knowledge gap through extensive research and experimentation is unquestionably one of NASA's primary tasks, if the STS is to be perceived by the private sector as significant to its own interests. Against this background of a knowledge gap we discuss prospects for private sector utilization in the next chapter.

CHAPTER V

PROSPECTS FOR PRIVATE SECTOR UTILIZATION

In this chapter we summarize our views as to the scope (and uncertainties) of the private sector market for STS services in the 1980s to the extent that such views can be derived from the limited samplings of the market that we have thus far been able to make. Unfortunately, the dominant conclusion to be drawn from our interviews of senior executives of U.S. corporations is that private U.S. industry is not yet prepared to comment with any specificity on its probable utilization of STS services. This conclusion is verified by the nature of the response to the mail inquiry along the same lines made for us by the Industrial Research Institute whose member companies do the bulk of the industrially-supported R&D in the United States.

As noted in Chapter III, IRI's Shuttle Survey Task Force submitted a version of our interview guidelines (see Appendix A) to 41 of its member companies, inviting written comments and/or indication of willingness to meet with ADL for a day's discussion on the issues under review. Only 13 replied and of these only three indicated real interest in pursuing the subject. This response (7% interest) is significant because it is unusual for IRI members to be unresponsive on matters of concern to them, as we found when we collaborated with IRI a year ago on a study of "Barriers to Innovation in Industry: Opportunities for Public Policy Changes", undertaken for the National Science Foundation.

We are persuaded, as noted, to conclude that U.S. companies find it difficult to take an interest in a venture they consider so remote from their needs and so far in advance of them. Individual responses emphasize this point:

- "Frankly, the urgency of this puzzles me a bit."
- "Please keep us informed as plans develop...in case the STS program does fit with our future plans."
- "Priorities on the available time of our corporate development and technical staff preclude our working on the opportunities represented by the commercial utilization of the space shuttle at this time."
- "We find it hard to think so far in the future when we have so many concerns over the next few years."

Statements such as these indicate that there is need for a strong and well-directed promotional effort on behalf of STS if industry is to be stimulated into taking early enough interest to utilize the lead time between now and the early 1980s to prepare for commercial utilization.

However, despite limited present understanding and interest exhibited by the private sector, there are a number of areas in which it is possible to characterize the extent to which this potential user group is likely to seek access to the various services to be offered by the STS. Our conclusions in more detail, and the reasoning which leads us to them, follow.

RESEARCH AND DEVELOPMENT

Interaction with industry in the interview program substantiates the view that the R&D support capability of STS will be the aspect of greatest interest to industry, at least during the initial years. It also suggests, however, that R&D users of the STS in the 1980s will be operating in a buyers' market.

To provide some gauge of what this market may be we present, in Table V-1, an estimate of R&D expenditures during 1975 in the five industrial sectors most likely to find STS relevant to their needs. It is within an overall budget such as this that STS R&D (mostly basic for a while) is likely to have to find its place.

TABLE V-1
ESTIMATED R&D EXPENDITURES BY SELECTED
U.S. INDUSTRIES, 1975

<u>Industry</u>	<u>Estimated Company-Funded R&D, 1975</u>	
	<u>Total R&D</u>	<u>Basic Research</u>
	(millions of dollars)	
Drugs and Medicine	750	140
Electronics	2,500	80
Fabricated Metals	200	20
Industrial Chemicals	1,025	125
Non-Ferrous Metals	<u>233</u>	<u>40</u>
	4,708	405

Sources: Report on "Materials and Man's Needs", National Academy of Sciences, 1974; Arthur D. Little estimates.

Assuming a continuation of 1972-1975 trends in growth of R&D expenditures (about 5% per annum), the total R&D expenditures of the five "most-likely-to-be-interested" industry sectors listed in Table V-1 will approximate \$6,000 million in 1980, of which some \$500 million might be devoted to basic research.

Though none of our industry respondents would venture even a guess as to what percentage of annual total R&D or basic research expenditures his firm might devote to STS uses in the early 1980s, most speculated that it would be no more than one percent, and that the objective would more likely be basic research than applied research or development. Even among the largest companies, we encountered such remarks as "Oh, I might be willing to authorize \$250,000 if my top physicist was burning with desire to undertake some speculative R&D project in a space lab," or "We would have little interest in any tests or experiments in which the cost is measured in a couple of million dollars for rather limited results."

These very rough estimates suggest that all the most likely U.S. private sector R&D users, taken together, may not spend more than \$5

million per year on STS related activities in the early 1980s. Considering that, as a rule of thumb, those most interested or knowledgeable estimated that the "rental costs" of access to the space lab itself would be only a quarter of their total cost of performing STS-based basic research, the annual revenue of STS "rental of space" from U.S. private sector R&D users may possibly not even exceed \$1-2 million per year in the early 1980s, i.e., one-tenth to one-fifth of prospective charges for a single Spacelab sortie.

We were not able to make any such "guesstimates" for potential foreign commercial users, lacking data that can only be developed through first-hand investigation abroad. However, we tend to believe that all demand from such foreign users combined would not exceed the total U.S. patronage of STS for commercially-oriented basic research.

In short, we believe that in the early 1980s the one-per-year commercially-dedicated Space Shuttle sortie may well be underutilized if reliance is placed on R&D alone. We therefore reemphasize the need to begin serious investigation and promotion of potential R&D utilization of STS by industry at the earliest possible time in order to help create a market.

PROCESSING

Not only do leading R&D directors of major corporations find it difficult to project whether, where, what for, or how much they might use the STS for basic research purposes, but they, their engineering colleagues and company executives, seem to find it premature to speculate about processing in STS facilities. Most seem to think that this won't become practical until the late 1980s, and only after extensive proof-of-principle efforts undertaken on the ground and in pilot STS operations.

All are agreed on the obvious, i.e., that any material or product processed in space would have to have an inherent value of thousands of dollars per pound. Primary metals producers, being in the dollar-per-pound business, simply cannot visualize how space processing can benefit their business. They grant that some exotic alloy, manufacturable only under space conditions, might command a thousand-dollar-per-pound price, but since this is not their primary business, they currently seem to pay little attention to such possibilities.

Even on the assumption that again, say, one percent of total R&D (including applied research and engineering development) might be applied to establishing proof-of-principle or prototype processing facilities aboard the space shuttle, the annual expenditure of all most likely industries combined would probably not exceed \$60 million, even by the late 1980s. Again, assuming that only about one-quarter of this amount would go towards "rental" of Spacelab facilities, the revenue from STS facilities for processing would probably not exceed \$15 million per year from U.S. users. Assuming, once again, a similar amount from potential foreign commercial users, one might predict \$30 million per year in the late 1980s, or the equivalent of charges for three space-shuttle sorties per year. This would represent a substantial augmentation of demand over that visualized above for fairly basic R&D alone.

In summary, with only one commercially-dedicated space shuttle per year--as now planned--during the 1980s, there could be a transition to a seller's market in the late 1980s, when processing uses, including applied research and engineering, might create an excess of demand over available capacity. This does not take into account space available for commercial users on other shuttle sorties primarily dedicated to NASA or other agency (DOD-excepted) uses. If such extra "piggy-back" capacity were to be available throughout the 1980s the seller's market might not develop as early as we have just suggested.

SENSING

Commercial users concerned with earth resources, e.g., mining and mineral companies, agriculture and timber producers, have a potential interest in data obtainable through sensing from close-in, earth-orbiting sensors. They have already been getting valuable data from ERTS One and Two and from Skylab. They expect the development of improved sensing technology by the time the space shuttle is operative, e.g., by making possible the use of photography rather than indirect sensing.

However, the data derived from satellite sensing is considered not so unique and definitive as to warrant concerns by any one corporation about exclusivity of ownership. Putting it differently, particularly as far as mineral exploration is concerned, the data based on surface observations gives only indirect clues as to minerals at appreciable depths. There

remains, therefore, substantial uncertainty and a great deal depends on the judgments and supporting on-the-ground data that has to be provided by each individual company. Thus, the sensing data available to everyone still lends itself to a considerable range of interpretations.

Consequently, industry's need in this area of potential STS utilization is not for exclusivity or proprietary information. Fortunately, this is in line with political judgment, embodied in the Administration's explicit practice of sharing ERTS-type information with all users. It may therefore be advantageous to consider whether a private or public sector service organization should be created which would operate the most advanced equipment aboard the space shuttle and on the ground, and sell the data output to all comers. A principal requirement of such a service organization would be accurate and rapid processing and distribution of data, some of it seasonal (e.g., in relation to agriculture). Careful scheduling of data requirements and space shuttle sortie flights would be imperative.

In any event it does seem likely that demands for sensed data, involving the presence of a manned or man-monitored sensor, might provide some share of a market for STS use fairly early in the 1980s.

TELECOMMUNICATIONS

INTELSAT/COMSAT operations now provide satellite communication services. Additional private and national systems are under consideration. In light of the extensive and complex experience of COMSAT gained in creating an international consortium, we would expect the STS telecommunication uses to provide additional technical capabilities (such as in situ repair of even geosynchronous satellites, or additional free-flying, near-earth orbit satellites for special communication purposes). Depending on cost factors not yet elaborated, we can visualize some of the major computer-business data-oriented, multinational firms, based here or abroad, to be interested in considering the creation of their own satellite network in order to have the complete in-house systems capability of delivering point-to-point business-communications performance on a global scale.

Both sensing and telecommunications are so intimately bound up with issues of international politics and related U.S. positions that any quantitative estimate of potential commercial uses of STS in these two cate-

gories--both as to volume and timing--depends primarily on Administration policy rather than on commercial market demand or opportunities. We therefore have not attempted such estimates under the scope of this assignment. Nonetheless we believe they are worthy of careful investigation and will probably provide some share of commercial demand for STS capabilities in the 1980s. We have noted above the possible indirect interest in STS which telecommunications companies are likely to have as a result of its promise as a contributor to relaxed standards of equipment reliability in communications and navigation satellites.

ENERGY

The space shuttle is an essential component of a space transportation system if satellite power-producing plants are ever to come into being. An example of such satellite power plants is the Solar Satellite Power Station concept¹. Use of the shuttle for such a venture will depend, in large measure, on priorities for federal funding of R&D and other incentives to press ahead with that concept--or with alternative energy-from-space concepts, such as placing nuclear fission (breeder) plants in earth orbit.

In another context, the possibility of producing thin-wafer solar cells on a space-platform production line has been suggested, because of unique advantages of weightlessness and control of purity. Such an activity would enhance the potential of terrestrial generation of electric power from solar energy. Proof-of-principle and cost analyses are still lacking to make this candidate for energy-related space-processing more than a gleam in the eye.

¹ See Feasibility Study of a Satellite Solar Power Station, NASA CR-2357, Arthur D. Little, Inc., February 1974, NTIS, Springfield, Va. 22151.

CHAPTER VI

TERMS AND CONDITIONS LIKELY TO BE OF IMPORTANCE TO POTENTIAL U.S. PRIVATE SECTOR USERS

ADL interviews with senior executives of major U.S. corporations, as well as the assistance provided by the Industrial Research Institute and their corporate members, also explored the terms and conditions under which the U.S. private sector might be interested in taking advantage of STS services. As already suggested in Chapter V, it became clear that most senior U.S. corporate officials have great difficulty in assessing their interest in utilization of the STS during the 1980-1991 period, because they:

- are traditionally absorbed with short-term concerns,
- don't perceive, or have a difficult time grasping, the relevance of the services which the STS may provide during the 1980-1991 period to their corporate interests, and
- have more questions than answers about the terms and conditions under which they might find access to STS services advantageous.

This is not surprising. What it emphasizes, however, is that STS capabilities will only be effectively marketed to the private sector if the STS is perceived by senior executives to offer services likely to enhance corporate profitability. To do so the service must:

- be recognized as important to the furtherance of corporate objectives;
- be competitively priced in relationship to alternative uses of capital;
- fall within the realm of acceptable risk.

In spite of these difficulties ADL's interaction to date with the U.S. private sector did elicit a number of tentative comments suggestive of the major issues of concern to U.S. industry in the years ahead as they evaluate their interest in the STS services. These major issues include:

- assurance of access to STS services
- the pricing of STS services
- the allocation of risks
- the confidentiality of information
- patent, knowhow and anti-trust policies
- who will sell STS services

ASSURANCE OF ACCESS TO STS SERVICES

The STS will make available to the private sector access to a range of services, the terms and conditions of each varying in accordance with the interests of the selling entity and the needs of each class of user. For any corporation interested in STS services, however, it is clear that a considerable lead time and substantial expenditures will be required during which the corporation must have a high degree of assurance that the STS will in fact be made available to him, for the uses he needs and within a price range which can be calculated in advance. The long-term commitment which the U.S. Government in general and NASA in particular appears to have made in support of the STS program during the 1980-1981 period, as well as NASA's expressed intent to provide the private sector with access to STS services, are thus of great importance and should go far to providing the kind of assurance needed. Whether, in addition, some explicit long-range contractual assurance of availability will be required remains an open question.

In addition, the potential private sector users will need clarification and assurance as to exactly what services will be made available. For example, in addition to carrying payloads, will the private sector have, as one respondent queried, "access to the dedicated payload computer, data acquisition systems, data links--additional fuel cells, power converters and thermal radiators"? Will their flight personnel have access to NASA training facilities?

Potential users will also want to know how, in spite of Presidential statements that access will be available on a "non-discriminatory" basis, by whom, and in accordance with what criteria, will disputes concerning access be adjudicated.

THE PRICING OF STS SERVICES

A principal constraint on access will certainly be the estimated price of \$10 million per flight, coupled with the substantial sums which a private sector user will have to spend before and after each flight. As noted in Chapter V the "rental costs" of access to the space lab itself may be only a quarter of a user's total costs associated with the effort. Thus, the costs associated with STS use are likely to impose a serious constraint on the extent to which individual U.S. corporations are likely to seek access to the STS, at least during its early years of availability. As a

result, it may prove advantageous for groups of companies to work together to share the costs and risks as well as the benefits of STS utilization. Such a trend would necessitate a careful evaluation of U.S. antitrust law and of what changes in the law will be required if private sector joint ventures are to take advantage of the STS.

Although we have assumed for analytical purposes that the cost per flight would approximate \$10 million and that access would be on a "non-discriminatory" basis, this would not necessarily foreclose the possibility of STS services being priced differently for different classes of users as a means of stimulating one use over another. Such a policy would of course affect the marketability of the STS to the various classes of potential users. Alternative ways of stimulating one form of use over another without developing complex pricing formulas would be through the provision of special tax advantages or government subsidies to various classes of users.

STS marketability to the private sector might also be enhanced if users were permitted to pay a lower initial fee for the service but obligated to pay NASA a royalty as a percentage of the sales of all products developed as a result of the STS services performed.

Presidential statements, as well as the NASA-ESA agreement, clearly state that ESA members at least will have access to STS services on the same basis as potential U.S. users. Although we do not perceive this policy as a marketing constraint, it should at least be noted that some interviewees within the U.S. private sector feel strongly that U.S. industry should be in a favored position relative to their competitors abroad with regard to access and price, since it will have been their tax dollars that made most of the STS possible.

INSURANCE AGAINST RISKS INVOLVED IN USING THE STS

Although NASA has had considerable experience in dealing with the unique risks associated with space flights, the existence of such substantial and often incalculable risks could pose a major constraint on the interest of private sector users. The potential private sector user will not take advantage of the STS unless it can calculate, and at reasonable cost insure, its payload and personnel as well as its total investment in the

business from loss caused by NASA, by other users or by unforeseen occurrences. For example, were an unexpected contingency to abort a flight, would NASA guarantee to re-fly the payload at no additional cost to the user? What liabilities to injured third parties will a user be exposed to? The experience of COMSAT as well as of those involved in nuclear power plant development may suggest how these potential constraints to the marketability of STS services can best be overcome to a degree acceptable to potential private sector users.

CONFIDENTIALITY OF INFORMATION

The extent to which confidentiality will be important to commercial sector clients as a precondition to use appears to vary substantially. For example, mineral resource sensing from space, according to industry officials, provides only general clues of enormous uncertainty as to the minerals below the earth's surface. Since the same sensing data will be valuable only if it is interpreted correctly by specialists on earth, reluctance to give knowledge to competitors that a company is seeking such information is not likely to create a major constraint on the marketability of this STS service. On the other hand, knowledge that a competitor plans to undertake a major new manufacturing process in space could be extremely valuable information. A potential STS user for the latter purpose could consider assurances of privacy of great importance.

PATENT, KNOWHOW AND ANTITRUST POLICIES

To the extent that a corporation invests its own money it usually wants exclusive use of any data or products that result, except possibly for rights which NASA might want for governmental purposes. This was the fairly consistent view of those potential private sector users contacted during the course of this initial investigation. Anything less than this is likely to impose a constraint on the marketability of STS services to a number of potential private sector users.

As has already been mentioned, the high cost associated with use of the STS is likely to stimulate interest in joint corporate endeavors in space which may present antitrust problems and act as a marketing constraint. At least in the area of sensing, one approach which might avoid these antitrust problems would be the creation of independent service corporations

which would utilize the STS and sell the information to all interested parties. Policies and procedures could undoubtedly be devised to stimulate the creation of such new service organizations.

THE SELLER OF STS SERVICES

Experience, as well as recent interviews, suggest that U.S. corporations would rather deal with a private or semi-private seller of STS services than with a government entity. This is due to the belief that government entities are more bureaucratic, don't really understand the needs of business, are susceptible to political pressures, and are often primarily concerned with "feathering their own nests".

Although NASA will undoubtedly be responsible for carrying out each STS sortie, and could develop marketing capabilities, we believe that STS services could more effectively be marketed to the private sector by a more independent business-oriented entity. An independent COMSAT-type of structure, which was financially self-supporting through user's fees, was suggested by some respondents as a prototype organizational arrangement to be considered.

CONCLUSIONS

U.S. corporations which theoretically might benefit from the unique services which will be offered by the STS will treat the STS in the same manner as any other business opportunity, the critical issue being whether the investment in such services is likely to increase profitability more than alternative utilizations of corporate resources. The terms and conditions upon which STS services will be offered to corporations will, of course, be of critical importance in determining the marketability of the STS to this class of potential user.

The interviews conducted with various U.S. corporate officials clearly showed that they had a very difficult time formulating views on the terms and conditions under which they might seek to buy STS services because of a lack of understanding of how such services really relate to their own corporate interests.

The foregoing should not at all suggest that the private sector cannot in the immediate future help in the NASA process of developing a realistic

package of opportunities, terms and conditions, but rather that a continuing interaction process must take place between NASA and this potential user group before such a package can be forthcoming.

It is clear, however, as a result of this initial study, that the interaction process should focus on questions relating to access to and pricing of STS services, insurance against risks, questions of confidentiality, patent protection and antitrust, and issues relating to who the seller of STS services to this class of user should be.

CHAPTER VII

THE FOREIGN MARKET FOR THE STS

During the 1980s it is likely that the world will be made up of the following three major groups of economies, distinguished by the amount of capital and technological capabilities available to each to pay for and take advantage of the STS.

- Highly industrialized, service-oriented economies

The United States, Western Europe, Japan and the Soviet Union will fall into this category. Without question the private and public sectors of these economies will constitute the major targets for STS services. In terms of demand characteristics, these economies will be quite similar to the United States. The question presented to NASA therefore in its consideration of how best to market STS services to potential users in these countries will not be so much what STS services are relevant to these economies as how such services should be marketed within them. The marketing of such services to the Soviet Union will, of course, pose unique issues.

- Rapidly industrializing and petroleum-based economies

Brazil is the best example of an economy which, in the 1980s, will have developed such a substantial industrial base and level of technological sophistication that it will be able to pay for and benefit from many of the results of the STS program, but to a more limited degree than will be the case of the more highly industrialized economies. It is unlikely that such countries will be prepared to utilize the STS for R&D purposes. They are likely to be particularly interested in STS sensing and communications capabilities.

Petroleum-based economies, such as Saudi Arabia and Iran, will undoubtedly utilize their extraordinary foreign exchange earnings over the next decade to develop their industrial capabilities. Although they certainly will have accumulated sufficient capital to pay for STS services they are unlikely to have developed the technological capabilities to enable them to participate directly in the STS program or benefit from many of the results. Again, STS sensing and communications activities are most likely to be of greatest relevance to this group of countries.

• Agriculturally-based developing economies

The vast majority of the world's economies will not during the 1980s be in a position to pay for STS space, nor will they have developed the technological skills to enable them to take advantage of many of the benefits derived from the STS program. At the same time, these economies would certainly benefit from some of the information and technology developed during the course of the program. These nations, which already represent more than two-thirds of the world's population, have increasingly come to feel that the United States, and the other industrially advanced nations, have not been prepared to share their money or technological advances with them. Economic, humanitarian and political factors warrant those responsible for the marketing of the STS to give consideration to how this group of nations might interface with the STS program.

A foreign marketing program for STS must begin by clearly distinguishing among these three major economic groups and developing approaches appropriate and specialized for each. It will of course be true that many of the considerations which will affect the marketing of STS services in the United States will be important in foreign marketing as well. There are, however, other, complicating factors arising from nationalistic attitudes as well as differing legal and political systems of potential foreign users. These factors, like the basic economic differences earlier referred to, must also be analyzed with care if the STS is to be marketed effectively abroad with a minimum of political problems and a maximization of benefits.

Initially at least, potential foreign user governments and enterprises will test the U.S. Government's good will and intentions as well as seek clarification on a number of issues. For example:

- Will the U.S. be truly non-discriminatory vis-a-vis foreign corporate and governmental users with regard to access to the STS, the pricing of STS services, and the sharing of information developed by the STS?
- How much will foreign users have to reveal to American authorities to justify STS utilization?
- How will the confidentiality of proprietary data provided and developed be maintained?

- How will differences in patent and licensing laws be reconciled?
- Will foreign corporations be permitted to undertake joint STS activities legal in their country but illegal in the U.S.? Will joint U.S.-foreign corporate efforts, legal abroad but illegal in the U.S., be permitted?
- Under what conditions will foreigners have access to NASA and U.S. corporate technology and knowhow?
- Under what conditions will the U.S. Government permit itself to be sued? In which jurisdiction? What will the process entail? What will be the ultimate tribunal?

These questions fall into three broad areas of concern which must be taken into account in the formulation of an STS marketing strategy to potential foreign user groups:

- The development of trust between NASA and potential foreign users
- The resolution of international legal questions
- The structuring of STS international marketing mechanisms

THE DEVELOPMENT OF TRUST BETWEEN NASA AND POTENTIAL FOREIGN USERS

Foreign corporations are, in general, not used to dealing with U.S. Government agencies such as NASA. This inexperience, coupled with fundamental nationalistic feelings, is likely at times to cause foreign executives to view U.S. intentions with some mistrust. Some will assume that, regardless of official declarations of non-discrimination among users, U.S. officials will be under pressure from American corporations, Congress, and possibly the military services to favor American users because American companies and the military do not support the subsidized export of aerospace and other industrial knowhow paid for by U.S. tax dollars.

The existence of this sentiment may cause foreign companies stalled in negotiations with NASA to accuse NASA of deliberately favoring American competitors. They will find support for their mistrust in the attitude of many American executives who oppose what the executives see as a "giveaway program". Such sentiments were expressed a number of times during the course of recent ADL interviews. For example:

"I am strongly of the opinion that the U.S. should not give away, on equal monetary terms, space to foreign companies for experiments or manufacturing activities in the STS program. They should pay more."

"It seems pretty clear that there will be many conflicts of interest between U.S. and ESRO based industrial firms as well as between ESRO and NASA. Early recognition of these conflicts of interest should be given by NASA and a policy of avoiding giveaways will be necessary to secure continued political and budgetary support for the space shuttle program. Of course, there are international cooperation advantages at least in the political sphere. But we must be quite sensitive to the conflict between these and the commercial interests of U.S. industry and the nation as a whole."

Department of Justice antitrust lawyers may, in the eyes of foreigners, be under similar corporate or Congressional pressure to discriminate against foreign users. Many European executives already feel that American antitrust laws are administered prejudicially against them when they try to acquire American companies. Thus they may believe that European joint ventures for space R&D which are legal in Europe may be blocked by the Justice Department, especially since American companies would argue that otherwise they would be at a disadvantage.

Maintenance of the confidentiality of foreign proprietary data may be questioned since NASA will be seen to have close ties to U.S. industry particularly in view of the transfer of personnel back and forth between NASA and the private sector. While NASA has an excellent record with regard to the proper handling of proprietary information, the large and diverse commercial efforts likely to arise from the availability of the STS, against a background of U.S.-European rivalry, may make the maintenance of confidentiality an area of increasing European concern.

Many Europeans feel that Americans are arrogant about space and advanced technology generally. It has been said that Americans are involved in a "patron rather than partner" syndrome. Under such circumstances, even well-intended American advice may be a source of friction and conflict.

Although the views expressed above have focused primarily on European attitudes and U.S.-European rivalries, they are undoubtedly representative of the problems which NASA will face with regard to the Japanese, the Soviets and other potential foreign government and private sector users. For example, many U.S. executives feel strongly that Japanese industry has benefited to an inordinate extent from U.S. research and development efforts, which have been sold to the Japanese for a fraction of their value. They note the Japanese Government's close working relationships with and extensive support for Japanese industry, as well as Japan's more relaxed anti-

trust laws, and conclude that U.S. industry is at a considerable competitive disadvantage. They would anticipate that a Japanese Government organization, such as MITI, will actively participate in the STS program and then provide the resulting information and knowhow to all interested Japanese industries and institutions. STS policies which would appear to perpetuate this situation would continue to grate on many U.S. executives and create questions on the part of potential Japanese STS users. Although these problems are not new to NASA, the STS marketing program, both organizationally and substantively, must be able to deal effectively with them.

THE RESOLUTION OF INTERNATIONAL LEGAL QUESTIONS

Many patent, licensing, antitrust, jurisdictional, and other international legal issues will have to be resolved during the course of STS development and operation. As an indication of the extraordinary complexity of these issues, some of the key questions which will have to be resolved in the patent field are:

- If NASA adopts uniform patent provisions for domestic and foreign users, any of them might ipso facto be discriminatory to foreign users because of variations between various national patent laws-- e.g., U.S. patent law has no mandatory licensing provision for failure to use, while most foreign patent laws do.
- Whose patent laws will apply to inventions made in space or reduced to practice in space? This is a particularly troublesome legal question. The shuttle service is U.S. owned, the space laboratories being built by ESA may be U.S. owned or owned by various foreign governments or corporations (to whom ESA may sell them), the inventor may not be from the same country which owns the particular lab in which the invention occurs, and the invention itself might be made over Rhodesia or over Japan.
- Are there special problems in relation to the U.S. reserving a license for government use (leaving the user entitled to commercial use) in those countries where the government engages in commercial activities or is the commercial entrepreneur, e.g., the U.S.S.R.?
- What enforcement procedures are needed to deal with infringements if a patent has been granted for an invention which is only useful

in space (thus not covered by any national government's patent)? For example, if a German company makes a perfect crystal in space and has the process patented in Germany, and a U.S. company infringes on the patent in a subsequent spacecraft, a question is raised as to the territorial limits of the restraint on the infringement and whose business it is to enforce whatever rights may be involved. Where an invention is patented in ten countries the problems are compounded.

Serious consideration should be given in Phase II to dealing in at least a preliminary way with these legal complexities and potential problems.

THE STRUCTURING OF STS INTERNATIONAL MARKETING MECHANISMS

The structure for marketing STS services to potential foreign users must be integrated into the total STS organization plan and coordinated with the marketing of STS services to domestic government and private sector users.

There are at least four possible basic structures conceivable for international STS marketing:

- A unitary structure--one international unit for the total effort
- A multilateral structure--separate units for each of the major market areas (e.g. NASA, ESA, etc.)
- A multinational structure--one national unit for each country
- A United States structure--one U.S. unit handling the worldwide effort.

There are difficulties inherent in a marketing program run by many semi-autonomous bodies. Just as differences over system interface problems have had to be resolved (e.g., over Spacelab/Orbiter weight goals), conflicting interests will have to be dealt with during the development, production, and marketing phases of the STS.

From a theoretical point of view, a true unitary structure with multinational jurisdiction, direction, financing, and staffing up and down the line might seem best because it would minimize parochial interests. However, creating a truly international working team, as opposed to a facade, may be extremely difficult. National governments may tend to assert their own interests in the joint decision-making process. Intense national competition for top posts may be divisive. The current bilateral NASA-ESA

relationship itself could be an obstacle to the creation of a unitary effort. Some analysts say that "Europeans can't agree on anything except to keep Americans out". Thus ESA and European governments may oppose direct links between Americans and European users without some European public control and participation in the relationships. European companies may wish to draw on their governments or ESA for support.

A multilateral U.S.-European structure might appeal to Europeans who wish to maintain autonomy from the U.S. They may hope that a European-wide organization could obtain better access, financial, patent, antitrust, and other terms than a merely national organization could. However, ESA or other European-wide organizations are often under pressure from European national interests. Sometimes European-wide institutions are paralyzed and give way to direct government-to-government behind-the-scenes negotiations. Factors other than sound business principles may thus influence some aspects of the STS marketing and utilization program. One U.S. Government official experienced in joint U.S.-European efforts has stated:

"...The joint decision-making process is diluted by shared authority and shared responsibility at all levels. I consider this aspect to be a key problem confronting all types of multinational programs and it is almost impossible to solve. In short, between partners there can be no boss. There can only be negotiated decision. Thus, future managers need to recognize that international consortia, when joint decision-making is the objective, necessitate 'compromise'. Compromise leaves the door ajar to all sorts of national external pressures and prejudices..."

A structure with one unit for each country, on the other hand, risks severe fragmentation and parochialism. Each nation has its own tradition of business-government relations which might become institutionalized with each government formally and continually representing the interests of its nationals in conflicts with NASA. A U.S. marketing entity might thus be severely restricted in activities seeking direct access to foreign customers.

To exclude the U.S. from foreign marketing would tend to force complicated multilayered interactions, limiting direct marketer-user contact and thereby tending to restrict utilization. A United States structure, with one U.S. unit handling all marketing worldwide, would offer the benefit of maximizing direct contact and interaction between the U.S. marketer and potential foreign users. Although they may not be experienced in dealing with U.S. government agencies, potential foreign corporate users are likely

to be large multinational firms with experience in worldwide business relations. Except to bring in European governments or ESA on an ad hoc basis when conflict with U.S. interests arises, European corporations may prefer direct links to the U.S. marketing organization in the hope of facilitating the planning and reducing the cost of utilization. It is even possible that the participation of a European government may be perceived as undesirable by European companies which wish to maintain the confidentiality of proprietary information even with respect to their own governments.

Since the economic interests and prestige of ESA members are deeply involved in the Spacelab development effort, the governments are likely to want to maintain the involvement of European public institutions in the marketing and utilization of STS services. One way of minimizing complexities under these circumstances would be careful design of the formal mechanisms for adjusting differences that may arise between the U.S. marketing entity and potential European users, especially in those matters in which European public institutions might wish to intervene. For example, resort to an international arbitration authority perceived as truly impartial could reduce the likelihood of direct governmental intervention.

Political problems may also arise with other countries. Communist bloc nations may wish to participate. Some Third World countries may also wish to send technicians into space to satisfy demands of national prestige even though the effort could not be justified on economic grounds.

Developing countries may also feel that the benefits of STS utilization should be shared worldwide. Some mechanism for disseminating non-proprietary information, a form of technology transfer, may be justified on political as well as economic and humanitarian grounds. Possibilities to be considered would include resort to the participation of existing international organizations in the STS program, the strengthening of NASA's own international programs, the participation of Third World countries as a group, or the establishment of an organization, which might be tied to the National Academy of Engineering, which would be responsible for interfacing with the STS program and channeling such non-proprietary results through the U.S. Aid Program or through the United Nations.

Not every barrier to a truly international unitary effort arises from high-level competition for control and jurisdiction. More commonplace

operating problems such as staffing can also contribute difficulty. Staffing can be a problem for several reasons:

- Incentives may be insufficient for governments and corporations to assign outstanding personnel to an international STS marketing effort. Unlike work in the engineering, production, and scientific activities of STS, participation in STS "support organizations" such as marketing, may not be considered a step forward along a career path.
- Getting talented individuals to live abroad may be difficult and expensive.
- Many individuals will remain loyal to their own nation's interests, government policies, or company desires.
- Development of an open, regular personal relationship between American and foreign staff members will be handicapped, as in other multinational organizations by nationalism, transoceanic distances, language and culture problems and the relatively high costs entailed in any international activity.

In any event, the precise structure of the STS marketing activity, whether it takes unitary form, or one of the suggested alternates, will have substantial effects on the success of the marketing effort. Attention to questions of structure thus becomes a requisite of a Phase II marketing program.

CONCLUSIONS

It will require detailed market research, including in-depth interviews, to go much further than the impressionistic conclusions recorded above toward assessing foreign markets for STS and dealing with their unique problems. Broadly speaking, foreign markets will have most of the characteristics and difficulties for stimulating interest that are present in the U.S. market, with an overlay of the additional complexities reviewed in this chapter. Nonetheless, as European participation in the Spacelab program attests, at least the industrialized country governments are interested in the STS and it seems highly predictable that the private sectors of these countries will, in due course, also become involved. The interests of the Soviet Bloc countries and the Third World are less easy to foresee, but a marketing effort for STS will nevertheless need to take their potential

into account. For the reasons given above, development of trust, development of solutions for international legal problems whose solutions may require long lead times, and attention to issues of internal structure of the marketing mechanism will have special significance for the foreign marketing effort.

CHAPTER VIII

THE NEED FOR AN STS TARIFF MODEL

A fundamental obstacle to the development of a realistic STS marketing program to reach potential users has been the absence of an explicit statement of the principal terms and conditions on which access to the STS will be made available. It has become possible over the last year or two to state with growing precision the technical characteristics of the Orbiter, Spacelab and even the Tug, and to lay out--in a series of progressively more definite mission and payload "models"--an increasingly clear picture of what operations will be like in the early 1980s. It is not yet possible, however, for a potential user, seriously interested in beginning an analysis of the costs and benefits of the STS to his 1980 programs, to get an equally satisfactory answer to key questions, such as those described in Chapters VI and VII, about conditions which will surround access.

What is needed soon we choose to call a "Tariff Model"¹, thus relating it to the Mission and Payload Models already in evolution. While it is understandable why such an STS Tariff Model is not yet available, its early construction should be a primary task of the Phase II market development program.

The availability of an STS Tariff Model, with characteristics indicated below, will make it possible for market researchers in Phase II to give potential users a much clearer idea of the total package of rights and obligations that will condition access to the capabilities of the STS and, in turn, to receive a more realistic response about the probability of utilization by prospective users. Discussion of the terms, conditions and underlying policies to be embodied in an evolving Tariff Model will also permit NASA to evaluate more realistically the trade-offs which necessarily must be made between user interests and NASA/Government interests. Thus, as is already apparent in the case of the Mission and Payload Models, the Tariff

¹ The term is used here in its generic sense, as in the transportation industry, to include the entire package of rights and liabilities offered to the users, going beyond the mere price schedules, as in "tariff... explanation, information, a list of things, particularly of fees to be paid, from arafa, to inform" (Webster's New Twentieth Century Dictionary of the English Language, Second Edition 1967).

Model itself will become a tool for policy and institutional development within NASA, bringing into continually clearer focus the realities of the future program and the steps to be taken to accomplish it.

Before outlining suggested substantive content for the STS Tariff Model, it will be useful to indicate what some of its more general characteristics should be:

- It should be comprehensive. An effort should be made to develop as complete a statement of the conditions likely to be imposed on utilization as is possible in the present state of policy and organizational development within NASA.
- It necessarily must have a tentative and open-ended quality. What is envisioned is a series of evolutionary statements, to be revised at intervals as in the case of the Mission and Payload Models, each successive instrument incorporating the learning developed since the last but remaining open for further change as progress and policies become more clearly defined.
- It should be based on, and related to, existing policy and known experience, both in the automated satellite programs and in relevant NASA experience with making government-owned facilities available to the private sector, as in the wind tunnel case. We believe, however, on the basis of our preliminary work, that some new issues of policy will need to be dealt with.
- It should be related to, based on, and specialized for the characteristics of the several quite different markets in which STS services will be offered--to other agencies of the U.S. Government, to foreign governments, to the private sector at home and abroad, and to the differing functional components of these markets--R&D, processing, sensing, telecommunications, energy, education, and possibly others.
- It should be written with simplicity and clarity.

Given the foregoing general characteristics, the STS Tariff Model should deal initially with at least the following subjects:

- the expected organizational structure of the entity that will form the interface with the user community;
- the procedure for mission planning;
- the procedure for making and accepting offers to contract for services and resolution of competing demands;

- price formulas;
- explicit provisions that will govern the disposition of patentable inventions and utilized or generated knowhow;
- statements of basic policy in at least the following areas: safety requirements, environmental protection requirements, discrimination (or non-discrimination) among different classes of potential users, separation among military and non-military missions/payloads, utilization of telecommunications, required availability or dissemination of data acquired by on-board sensors, the extent to which the competitive status of private sector users will be considered, and the extent to which other Federal government policies affecting data generated on-board will be applied.

The construction of even a first draft Tariff Model covering the foregoing areas would be a task requiring resources well beyond those available in this Phase I study. However, we comment briefly below on each of these aspects as some indication of the nature of the present state of policy development within NASA with respect to them (as it appears to us on the basis of necessarily cursory exploration) and to point out some initial directions for Phase II work in Tariff Model development.

ORGANIZATIONAL STRUCTURE

It seems likely that, in a year or two, some form of specialized marketing organization for selling STS services will begin emerging within NASA. Whether the model should be that used in making wind tunnel service available, or the "middleman" organization envisaged in the recent Battelle study, or some other more radical concept such as a new Federally-chartered corporation along COMSAT lines is, of course, not yet clear. The Tariff Model should at least present a range of organizational possibilities, discuss their implications for the customer, and go as far toward describing the functions of the emerging organization as is possible in each successive version of the model.

PROCEDURE FOR MISSION PLANNING

An important part of the STS Tariff Model will be a clear and detailed explanation of how a prospective user's requirements are to be fitted into the Mission and Payload Models. Since, at least in the early stages, long

lead times will be required for both parties to the ultimate transaction, readiness to commit funds and key personnel in user organizations will be enhanced substantially by the existence of a spelled-out, step-by-step procedure leading from the initial, exploratory inquiry to final acceptance of an on-board experiment or operation. An early prototype for the first steps in such a procedure which has come to our attention is the series of "Announcements of Opportunity" to participate in the definition of instrumentation for Spacelab missions, currently being issued by the Office of the NASA Associate Administrator for Space Science. These contain such critical items as a description of the concept of an Instrument Definition Team, how such a team--drawn from the user community--will be selected, organized, financed, related to NASA's own technical staff, scheduled; what proposals to participate should contain, how they will be evaluated and on what criteria; eligibility of foreign proposers and the involvement of their governments and/or ESRO/ESA; and how technical data the offeror does not want disclosed is to be handled. Such matters, and many more of a similar nature, should be covered in the STS Tariff Model.

PROCEDURES FOR CONTRACTING FOR SERVICE

Similar to the need for a description of procedure for mission planning is the need in the Tariff Model for a step-by-step description of the procedure that will lead from an indication of interest in a contract to purchase STS service to the fully executed contract itself. NASA's long experience in the wind tunnel field may have substantial relevance here and should be carefully investigated during Phase II.

PRICE FORMULAS

As emphasized in Chapter VI, pricing will naturally be a critical part of the Tariff Model and will have far-reaching effects on both the scale and timing of customer interest and on NASA's own budget and program. We understand that first steps toward developing policies on pricing and a system of cost accounting to permit rational policy-making with respect to pricing have already been taken. Among policy decisions which will be critical in the pricing area are those with respect to cost-pricing versus value-pricing, and the use of pricing to achieve policy objectives other

than cost recovery itself--such as widespread utilization, differential pricing among classes of users or classes of uses. The important point, however, is that early development of such policies and a translation of these into explicit price schedules will more significantly affect decisions of prospective users than any other aspect of the Tariff Model. NASA may also have to face the question of whether it can or will guarantee the stability of the announced price schedule for some period of time into the future as an inducement to commitments to long-range planning and expenditures by potential users.

THE DISPOSITION OF PATENTABLE INVENTIONS AND UTILIZED OR GENERATED KNOWHOW

The Tariff Model must also contain a clear statement of applicable NASA policy affecting patentable inventions and knowhow used in or generated by STS activity. NASA's extensive policy framework in these areas already appears to provide ample precedent for STS policy in most respects. The most likely arrangement with users of the STS would be an analogue to the policy that NASA applies in current activities where NASA facilities such as wind tunnels are used by commercial organizations, foreign governments and academic scientists, reimbursing NASA for cost.

The applicable contract clause provides:

"The experimenter shall disclose to NASA any inventions which he may conceive or first actually reduce to practice in the use of NASA facilities, equipment or materials. Rights to those inventions made by the experimenter while performing work for NASA will be determined by the Administrator under 42 U.S.C. 2456. As to all other such inventions made by the experimenter, the government reserves a paid-up license to practice such inventions for governmental purposes unless it is shown to the Administrator's satisfaction that, in view of the circumstances and equities, the government is entitled to greater rights or is not justified in acquiring a license of this scope."

NASA's authority to be as flexible on property rights as this clause indicates flows from an explicit provision in legislation which sets forth both the agency's rights to take title to all inventions made in the performance of a contract with NASA and the Administrator's authority to waive such rights as long as the waiver is subject to a royalty-free license for government purposes. (Section 305 of the National Aeronautics and Space Act of 1958).

Section 305 requires NASA to take title only when the invention is made under a contract (i.e. where the other party is being paid by NASA); thus NASA is under no obligation to use the title-taking (or the waiver) procedure in the case of users of the space shuttle who reimburse NASA for the cost of the shuttle service. In recent policies applied to launches for COMSAT and Western Union (Westar), there are policy analogues for space shuttle users to be able to retain all property rights. In these cases the companies reimburse NASA for launching costs, but retain all property rights, including any proprietary data which they might have to provide NASA for technical launch purposes but which NASA keeps in confidence.

A typology of NASA policy options for reimbursable cost users of STS is presented in Table VIII-1. An expanded and more definitive statement will need to be a part of the Tariff Model.

SAFETY REQUIREMENTS

Little controversy should arise over NASA's reserved right to determine the level of safety to be built into on-board experiments or operations. At the same time, users will want to have foreknowledge of the safety procedures and standards, as well as policies relative to the allocation of risks. A safety section will therefore need to be incorporated in the Tariff Model. As in the case of the invention and knowhow section, this section should emerge relatively easily from the body of current practice on access to NASA facilities by the private sector or other government agencies.

ENVIRONMENTAL PROTECTION REGULATIONS

This may be a new area for consideration in developing the Tariff Model although analogues may exist in NASA practice with respect to automated satellite operations. What is envisaged is a NASA responsibility to ensure that on-board experiments or operations are carried out in such a way as to minimize environmental pollution of orbital space. As in the case of safety it will be important that users be familiarized in advance with the policies, procedures and standards that will be applied in order that unnecessary expenditures of time and funds be avoided by the user.

TABLE VIII-1

TYPOLGY OF NASA POLICY OPTIONS FOR REIMBURSABLE COST USERS

<u>Policy Options</u>	<u>Implications</u>	<u>Rationale</u>
"Hands off" policy	No U.S. property rights acquired and all proprietary data submitted for launch or safety purposes protected by NASA.	Users considered paying passengers on a transport service.
Data-sharing after reasonable time limit	U.S. gets and reports operational and descriptive data but protects proprietary data.	U.S. obligated to tell public what has been accomplished, but need not disclose proprietary data to competitors. User gets first crack at reporting results (except for earth observation data which must be available as soon as practicable).
Royalties paid to U.S. on commercially viable inventions in space or on the ground or both	Royalties	To help NASA recoup original R&D costs of space shuttle (as opposed to reimbursable costs of shuttle service).
Royalty-free U.S. license required on patented inventions for use in space only	Self-explanatory	Users are not paying any of the past R&D costs of space shuttle, thus U.S. is entitled to license.
Royalty-free U.S. license required on patented inventions for use in space and on the ground	Self-explanatory	Users are not paying any of the past R&D costs of space shuttle, thus U.S. is entitled to license.

TABLE VIII-1 (Continued)

<u>Policy Options</u>	<u>Implications</u>	<u>Rationale</u>
Compulsory licensing if patent-holder doesn't utilize invention after reasonable time period	User would not need to disclose proprietary background data if it provided sufficient operational and descriptive data to permit manufacture	Most foreign patent laws do have such a provision for non-use.
Compulsory licensing with reasonable royalty for public health and safety uses	Same as above	To compel use.
Compulsory licensing with reasonable royalty for all inventions	Same as above.	To assure wide usage.
Compulsory licensing with reasonable royalty for all inventions; also, proprietary data required	Self-explanatory	Proprietary data might be needed in some cases in order to practice the invention.
Foreground and background data required by NASA	NASA publishes data	In the case where no invention is made, proprietary data may be needed to make the device.
U.S. takes title with or without waiver provision	Self-explanatory	This is an unlikely NASA option-- it has almost been ruled out, but it should be noted that there is a precedent for it, namely AT&T's Telstar.

DISCRIMINATION AMONG CLASSES OF USERS AND USES

Existing policy on access to satellite launching capabilities of NASA, as between U.S. entities and foreign countries and international organizations, is one of non-discrimination, as indicated by the President's policy statement of October 9, 1972. This statement specifically provides that, "for reimbursable launch services from U.S. launch sites, foreign users will be charged on the same basis as comparable non-U.S. Government domestic users." Present NASA thinking appears to be that STS services will be governed by an extension of this principle, although preference, in the event of scheduling conflicts or payload limitations (but apparently without discrimination in price) is to go to experiments or applications proposed by ESA and foreign governments participating in the Spacelab program. As noted in Chapter VI, some U.S. prospective users may question the wisdom of this policy, in the light of the scale of the U.S. investment in R&D and development of the STS. Also, as noted later in this Chapter, other public policies in the U.S., such as those designed to provide preference to small businesses, may need to be considered as the STS develops.

SEPARATION AMONG MILITARY AND NON-MILITARY MISSIONS/PAYLOADS

It could be of concern to certain classes of prospective users that their uses would be commingled with military-oriented or classified activities aboard an STS flight (primarily because of the likely heightened level of security procedures and rigidities associated with such activities). The Tariff Model could easily set this issue to rest by providing for what appears already to be intended--complete separation of military and non-military payloads and missions.

UTILIZATION OF TELECOMMUNICATIONS CAPABILITIES

The Tariff Model will need to extend to the STS the policies already worked out for utilization of automated satellites with telecommunications capabilities, such as conformity with international agreements as to use of the radio-frequency spectrum, direct broadcast to earth receivers, and the like. We have not encountered in our preliminary analysis any unique problems of the STS not also present in the unmanned satellite programs.

DATA ACQUIRED BY ON-BOARD SENSORS

Policies have already been developed by NASA concerning the required public dissemination of data acquired by on-board sensors such as those of ERTS. Such policies, which will presumably be extended to the STS, will necessarily limit utilization of the STS for acquisition of data for strictly proprietary use by mining, drilling, or fishing enterprises or for monitoring the movements or locations of a competitor's vehicles or facilities. These policies will tend to minimize possible political tensions that might otherwise be generated by the use of STS by, for example, multinational corporations for proprietary data acquisition. A careful evaluation of this issue is called for, as is an explicit set of regulations to achieve desired ends.

POLICY ON COMPETITION

It is conceivable that NASA will be required, by law or executive policy, to give weight (or price concessions), in making STS services available in the event of shortfalls in capacity or schedule conflicts, to small business enterprises, or to discriminate against certain classes of prospective users, for overriding reasons of policy or to stimulate competition. This is perhaps unlikely until the STS becomes perceived as a more significant factor affecting business competition than it is likely to be for some years. It is not too early, however, to explore the possible shape of such policies and to be prepared to reflect them in the Tariff Model if they are deemed likely to emerge within the next decade.

OTHER FEDERAL GOVERNMENT POLICIES AFFECTING DATA GENERATED ON-BOARD

Analogous to the foregoing policy area is the already-established requirement that users of NASA launch capabilities, even on a reimbursable basis, must grant a license to the United States Government for governmental use in all inventions made and knowhow acquired in the field of health and safety. The probability is high that this requirement will be extended to the STS. If so, its precise formulation should become a part of the STS Tariff Model.

CHAPTER IX

MAJOR ISSUES FOR FURTHER CONSIDERATION

In the foregoing chapters we have discussed a range of topics that bear on

- the long-range objective of NASA in maximizing the use of the STS-- the Space Shuttle, the Spacelab, and the Space Tug, and
- the near-term objective of formulating a plan for pursuing the long-range objective.

We have borne in mind that the Space Shuttle is basically a transportation system; that its unique feature is to provide regular access to a new environment--space; and that NASA's objective in maximizing the use of the STS is to "sell space", since the STS is the most economical way, presently foreseen, to work in this environment within the next decade.

The purpose of this chapter is to highlight major issues for further consideration by NASA as it shapes up Phase II of the Shuttle New User Analysis Program.

THE NEED FOR A MARKET DEVELOPMENT PROGRAM

For many reasons an active market development program is essential to stimulate utilization of STS, particularly in the early years:

- Even a decade hence many potential users will not be aware of the potential benefits of STS to them despite widespread publicity. Companies are swamped with incoming data on new possibilities and many of these ideas are ignored without serious consideration.
- Corporations which attempt to analyze the potential of STS seriously may have incomplete data and fail to evaluate opportunities correctly.
- Many executives will have initial difficulty in visualizing specific commercial applications.
- Potential users may clearly envision the possible benefits of STS, but may be deterred by the risk of being a pioneer. When executives are considering substantial investment to prepare for space activity and millions more for the actual use of STS, who will risk being first? When risks and costs are perceived as high, the advantage

of a head start on competitors, possibly of only a few months, may seem too small. In the face of such possibilities, NASA may wish to stimulate initial usage in certain activities. Despite a "first come, first served" non-discriminatory policy, could or should NASA promise exclusive utilization of STS for a certain activity during a period of time to companies taking high risks in a pioneering effort, especially if the effort would require a series of sorties?

- A passive marketing strategy--"let users come to us"--generally fails when even the most exciting consumer or industrial products are introduced. Successful corporations have learned the value of an active marketing program in creating user awareness and acceptance. They have abandoned the philosophy typical earlier in this century that if you invent a better mousetrap, the world will beat a path to your door. Even more than new mundane products, a revolutionary service such as STS requires an active marketing approach.

Analysis by us in Phase I, and concurrent work by other contributors, verifies the view that potential users--domestic and foreign, private industry or public sector--are insufficiently informed to give serious attention early enough to their possible uses of the shuttle. Early enough, that is to say, to interact productively with NASA or an intermediate organization so that both the seller of and the customer for STS services can use the 5 to 6 years lead time remaining to work out technical, organizational, procedural, legal, fiscal, regulatory, and other operational problems, in both the private and public sectors at home as well as overseas.

Market development efforts are therefore of high priority now. Since NASA is not widely known as an organization selling services (though its wind tunnel program and satellite launchings have established successful precedents), the help of contractors in the marketing effort can be useful. Involvement of third parties can help overcome the reluctance that some of the industry has in becoming directly involved with government. Qualified contractors can also render assistance, through application of market development technique and background knowledge of industry sectors most likely to be interested in STS. NASA does not now appear to have a requisite number of staff with such experience and would probably find it difficult, expensive, and time-consuming to find them, although this is not out of the

question. It may not be prudent to do so, however, in light of the consideration that should be given to establishing a "middleman organization", one function of which would be to take on the market development task.

Personal direct contact with potential users is an essential element in the market development effort, together with reaching wider groups through seminars, professional and management meetings and conventions, and the distribution and display of appropriate audio-visual material.

In such a market development effort, stress should be placed not only on conveying the technical opportunities that would benefit potential STS users, but also the business/public policy considerations that would govern such uses. Early elaboration of an STS Tariff Model (the general characteristics of which are outlined in Chapter VIII) would go a long way toward answering the questions that we have encountered in our discussions with potential customers. The lack of answers to such questions at the present time reinforces industry's hesitance to take a serious interest in planning its activities to take advantage of the STS program in the 1980s.

In summary, to overcome present barriers to widespread industrial involvement we urge a well-thought-out and intensive effort to convey meaningful technical and tariff information to prospective users, using personal contacts as much as possible. This will also facilitate evaluation of the responsiveness of the market and lead to improvements in the approach as experience is gained.

We assume that the approach to market development will be based on the well-proven principle that the seller must think in terms of customer needs and objectives and not primarily of its own.

THE NEED FOR AN STS TARIFF MODEL

We reiterate the importance of developing an STS Tariff Model along the lines suggested in Chapter VIII. NASA and its contractors should prepare a first draft--taking note of user requirements, and refine it through iteration as responses from prospective customers are obtained in the concurrent market development effort.

THE NEED FOR A MIDDLEMAN ORGANIZATION

A basic task in succeeding phases of the new user/uses development (marketing) program in which NASA clearly should engage beginning very soon

will be design and development of the organization(s) to carry it out over the long term. Reasoning presented convincingly in the June 30 report of Battelle Columbus (cited in Appendix D) points to the desirability of the development of a "middleman" organization distinct from NASA itself to carry out the market development and, later, the actual marketing function. Ultimately such an organization should be completely independent of NASA, securing its revenues from fees paid by users of STS and, in turn, purchasing facilities and services from NASA.

Such a relationship implies creating, in effect, a monopoly for the "middleman" organization. A monopoly made possible by public investment and protected by exclusivity granted by the public power must, in the American system, be a regulated monopoly. The COMSAT model, for exercising the monopoly of space telecommunications granted by the U.S. Federal Government, under regulation established in a very specific statute, comes to mind. Between the present situation in which NASA must continue for a while to act as market researcher, market developer, as well as operator of STS--and the establishment of a COMSAT-like middleman status, lie a succession of transitional stages. Defining these is properly a function of a Phase II research program but there appear to be at least the following evolutionary steps:

- Contracting out, by NASA, of further market research, institutional development, and market development--to organizations similar to those employed in Phase I.
- Contracting out, by NASA, of responsibilities for actual sales of service to users--employing the concept of an exclusive agency, relying on one (possibly several) market development and marketing organizations. It is implied that, at this stage, the market will not be strong enough for the agent to operate without NASA financing.
- Creation, almost certainly by legislation, of an independent, regulated monopoly to market the commercial services of the STS, standing on its own financial feet, purchasing services from NASA.

It is not yet possible to estimate the time required for the complete evolution--it could be as long as 20 years and as short as 5. Much depends on findings in further market research, on the level of support for market development, and on demonstrated capabilities of STS to meet real commercial needs. One thing is certain, it is not too soon to move forward.

CHAPTER X

A PHASE II STUDY PROGRAM

In this chapter we present the elements which we believe should be included in a Phase II study program, responsive to

- our findings in the Phase I program reported in the preceding chapters;
- informal discussions with NASA/MSFC

FURTHER IDENTIFICATION AND ANALYSIS OF FOREIGN USERS

Our work in Phase I put emphasis on considering the interests of potential foreign users and their special requirements as these may affect NASA policies for stimulating, and providing access for, such users. As noted previously, we were enjoined, subsequent to starting work, from making direct contacts with potential foreign users during this Phase I effort, and modified our work program accordingly. The contents of Chapter VII of this report on the foreign market for the STS are, therefore, necessarily based largely on existing in-house knowledge of public and private sector objectives, attitudes, business conditions, and technological readiness in other countries. None of these could be checked or elaborated through direct research with foreign users, though we gained some useful impressions through "surrogates," such as executives of U.S. multinational corporations.

In light of the above, we believe it essential that continuing work in Phase II of this program encompass--among other aspects discussed below--a reasonably comprehensive effort of field research in selected foreign countries--both in their public and private sectors--in order to assess firsthand the issues discussed in Chapters VI-IX and to be able to draw succinct differentiation, if any, between U.S. and foreign users.

We are given to understand by NASA that the European Space Agency may be ready to have such a U.S.-initiated market research effort begun in some depth in Phase II of this program (i.e., essentially during 1975), and that ESA may possibly wish to participate in it with its own resources.

We would welcome such a collaborative effort in Europe, subject to NASA concurrence. Similarly, we would welcome collaboration from appropriate organizations in Japan, Canada, and Australia, and in the Third World (though appropriate organizations are less likely to be found there, except at the national level in a few countries and possibly through multinational bodies, such as the OAS, the Andean Pact countries, and multinational Development Banks--IBRD, Inter-American, Asian, African).

If such collaboration were either not forthcoming--or not considered desirable by NASA--we are, of course, prepared to undertake the work independently, provided that no active opposition is encountered in any of the countries (which is unlikely, though lack of interest may well be a stumbling block in the less-developed countries).

In short, we recommend a reasonably comprehensive overseas market-research effort to clarify the issues raised in this report.

DEVELOPMENT OF AN STS TARIFF MODEL

In Chapter VIII we discuss the need for an STS Tariff Model, and we recommend that such a tariff model should deal with at least the following subjects (on each of which we have commented only briefly in Chapter VIII):

- the expected organizational structure of the entity that will form the interface with the user community;
- the procedure for mission planning;
- the procedure for making and accepting offers to contract for services and resolution of competing demands;
- a price schedule;
- explicit provisions that will govern the disposition of patentable inventions and utilized or generated knowhow;
- statements of basic policy in at least the following areas: safety requirements, environmental protection requirements, discrimination (or non-discrimination) among different classes of potential users, separation among military and non-military missions/payloads, utilization for telecommunications, required availability or dissemination of data acquired by on-board sensors, the extent to which the competitive status of private sector users will be considered, and the extent to which other federal government policies affecting data generated on-board will be applied.

These subjects are listed in order of priority as we judge it from our Phase I work.

DEFINITION OF AN INDEPENDENT MARKETING ENTITY

Serious consideration should be given very soon to the development of a new entity that will form the interface between NASA and the user community, the middleman organization described in Chapter IX.

Not only should full consideration be given in Phase II work to the organizational structure of such an entity, but also to its operational priorities. High amongst these should be an intensive promotional--educational in the best sense of the word--effort to alert potential users of the STS to anticipated opportunities in using the STS that would benefit them and their customers and communities. The apathy of U.S. industry at large in this respect--mirrored, we suspect, in some instances at least abroad--is striking. Considering the long lead times necessary to match commercial needs for STS services (not yet understood or considered by most potential users) with the Mission and Payload Models already under active development by NASA, we believe it essential that industry be brought up to speed lest it find itself so out-of-step with NASA plans later as to find those plans disadvantageous to its own interests.

We therefore recommend that the Phase II work lead to a comprehensive definition of what is required of NASA and/or the suggested interface organization, particularly with respect to means for developing the market, that is promoting, STS uses.

In undertaking this work in Phase II, and extending it to the other items listed in the Tariff Model discussed in Chapter VIII, the contractor should expect to draw heavily on concurrent work, presumably to be undertaken by other contractors, that would elaborate in Phase II efforts on the methodologies that have been developed in Phase I to determine potential uses and users of the STS in both the public and private sectors.

SUMMARY

In Phase II, we would propose:

- Expansion of the ADL Phase I effort to assess needs and requirements of foreign users through direct field research in selected countries overseas

- Development of the major items of the proposed Tariff Model described in Chapter VIII of this report in order to provide NASA and/or a quasi-independent interface organization with the necessary tools/aids for user community development, and to assist in making test calls on prospective users using these tools/aids.
- Detailed development of the structure and programs of a new, independent marketing entity which would ultimately make STS services, supplied by NASA, available to the user community, including a careful consideration of the transitional stages through which such a development must move, over a 5-20 year period.
- Continuing elaboration of presently fragmentary knowledge about both uses and users in the private sector, drawing on other studies and contractors as appropriate.

APPENDIX A

A GUIDELINE FOR INTERVIEWS WITH SELECTED U.S.
MULTINATIONAL FIRMS CONCERNING STS USER REQUIREMENTS

INTRODUCTORY NOTE

The following guidelines were developed by ADL early in this project for use in stimulating comment on business policy and public policy issues by respondents selected from top-level management of U.S. multinational companies experienced in planning entry into advanced technologies. They proved to be useful for this purpose and are included here as of possible value in further explorations of this kind as well as an indication of the agenda covered in the ADL interview program.

How will these constraints be enforced?

- pricing structure, i.e., recovery of costs of flight only?
- national security/international policy matters, e.g., in sensing mode who may look at whom, for what, and how will data be treated?
- privacy of each user conducting his work from potential "prying" competitors (in same vehicle or on same data space/ground transmission system)?
- allocation of scarce resource (STS space) in accordance with national objectives?
 - e.g., • preference for certain uses and therefore users? Who will determine and control?
 - evidence of commercialization potential and user's commitment to follow through?
- who will pick route, orbit, length of flight?

4. What are "existing" constraints to access?

- e.g., • patent rights to inventions made while using STS? User retains full rights; NASA has rights for government use; NASA owns rights; NASA requires user to license at reasonable royalty, etc., or what combination of these alternatives?
- ownership rights on patents and know-how acquired. What does user feel he wants or can reasonably expect?
 - e.g., • territorial rights - U.S. STS like U.S. flag "ship at sea," or does "law of space" supervene?
 - free to allocate right to others?
 - political interventions by whom, e.g., in sensing and communication uses?
- antitrust law effects on joint R&D or any of the other use categories
- regulatory policies and law
 - e.g., • environmental; consumer safety; public interest, etc.

D. Comments on Ability of Prospective Users to Address Above Business/
Public Policy Issues

1. Are these issues unique in their experience and therefore their responses "off the cuff"?
2. Should these issues be considered in the broader context of industry access to government-owned facilities at large (e.g., in other agencies)?
3. Do these issues raise serious questions of public policy that might affect U.S. industrial/commercial competitiveness overseas (or at home)? What are these questions and their parameters, and why?

E. Can Prospective Users Rank Severity of Issues in (3) Above - As of Now, and As Likely to Be in the 1980s?

F. Can Prospective Users Describe Alternative Models (Packages) of Desired Access Conditions and Give Pros and Cons for Each?

Summary

This is first opportunity (not last) for prospective users to take initiative to make themselves heard in government on those business/public policy issues that they believe would critically affect their interest or ability to become actual users of STS. It would be useful for them therefore to cover the full spectrum of their concerns as regards public policy issues and rank them, if possible, by priority.

It may take long lead times to change public policies. That is why ADL is making this early attempt (six years in advance of first flight) to help guide NASA consideration of policy options designed to encourage commercial uses of STS. Differentiation between perceptions of potential foreign users and domestic users would be very desirable if possible.

APPENDIX B

TECHNICAL BRIEF

SPACE TRANSPORTATION SYSTEM (STS)

INTRODUCTORY NOTE

The technical brief reproduced in this appendix was developed by ADL for use as background preceding interviews with respondents selected from top-level management of U.S. multinational companies. We were surprised to find, early in this project, that there did not appear to be available in the official NASA literature at that time a succinct, up-to-date and explicit description of STS and its capabilities suitable for this purpose. We accordingly prepared the material in this appendix, which has since been reviewed by the COR for this project. It is reproduced here as having possible value as the beginning of an expanded description useful in a Phase II market research program.

TECHNICAL BRIEF

SPACE TRANSPORTATION SYSTEM (STS)

INTRODUCTION

A new international space transportation system is now being developed for operational use in the 1980's and beyond. It is designed to provide economical transportation to and from Earth orbit and to allow more efficient space exploration and utilization for man's benefit. The major elements of this system can be reused after operations in Earth orbit and will eventually replace practically all of the rocket launch vehicles now used for placing payloads into space. These elements include the Space Shuttle Orbiter and its solid rocket booster motors being developed with industrial support by the U.S. National Aeronautics and Space Administration; the Spacelab manned laboratory being developed by NASA and the European Space Research Organization (ESRO)*; and an Interim Upper Stage (IUS) for the Orbiter under development by the U.S. Department of Defense. A more advanced upper stage called the Space Tug is also being developed by NASA which will offer expanded capabilities and uses for the Space Transportation System or STS after 1984. This will allow greater system flexibility for operations in geosynchronous orbits, for orbital path changes and deep space operations with emphasis on space rendezvous and docking capability.

The complete system is designed to not only place a variety of payloads into various Earth orbits and into trajectories throughout the solar system, but it also will allow the retrieval, refurbishment, repair and even re-firing of spacecraft, thus reducing operational expenses. It can also provide a "shirtsleeve" working environment so the crew and passengers can spend up to one month in Earth orbit, performing the role of a manned space station and allowing a variety of experimental and operational activities to be performed in the unique environment found there. Due to the relaxed physical standards and requirements for passengers, scientific investigators, technicians, educators, journalists, and others may perform useful tasks in space.

BACKGROUND

The concept for combining rocket and aircraft technology and allowing spacecraft to be returned to Earth from space was well established by early rocketry and aeronautical pioneers such as Goddard, Oberth, Tsiolkovsky, and others. German rocket developments during World War II included flight testing of winged V-2's and preliminary design of a manned recoverable version of this historic rocket was prepared. A German scientist, Dr. Eugen

* Soon to change its name to European Space Agency (ESA).

Sänger, also performed detailed studies for a long range bomber which was, in essence, an orbital rocket craft using its winged area to allow a gliding return to earth with its crew by skipping across upper levels of the atmosphere.

Popular articles in the mid 1950's, such as in the Collier's series on space travel, emphasized the idea of reusable Earth-to-orbit space transportation systems. And rocket aircraft developed during this post-war period helped to evolve the concept. Many aerospace plane studies were likewise performed and the Dynasoar program was established by the U.S. Department of Defense, although this program for a reusable manned spacecraft was later cancelled.

With national commitments made for manned space activities in the 1960's, priorities were given to ballistic type, non-recoverable launch vehicles to meet Earth orbiting and Lunar landing schedules. This culminated in the modification of military rockets such as the Redstone, Atlas, and Titan for launching Mercury and Gemini spacecraft into orbit and the development of larger rockets to boost much heavier payloads into space. The huge Saturn 5 rocket system developed by NASA provided the thrust required to place astronauts on the moon and the means to allow their safe return during the Apollo program. This space vehicle was also used to launch a large, fully operational space station, the Skylab, into Earth orbit where it remains after several lengthy visits by astronauts launched by Saturn 1B rockets. To date all launching rockets for the above programs and for unmanned missions, including satellite and space probe launches, have been expendable and quite costly.

As the Apollo program reached fruition, development of the next generation of space launch vehicles, with emphasis on the reusable concept, was initiated. After a number of evaluations, trade-offs, and feasibility studies, the current space shuttle configuration evolved which will be developed in the 1970's and made fully operational, along with other STS elements, in the 1980's and beyond.

DESCRIPTION

Space Shuttle Vehicle (SSV) The complete vehicle includes the Orbiter, the External Tank (ET), and the two Solid Rocket Boosters (SRB's). The Orbiter is a piloted, rocket powered vehicle which accommodates the crew, passengers and payloads. It is designed to be reused some 100 times and is about the size of a DC-9 passenger aircraft. The External Tank provides liquid propellants for the Space Shuttle Main Engines (SSME) that power the Orbiter and is expendable after propellant depletion. The booster engines are ignited at launch together with the Orbiter main engines. Together they provide some 6.25 million pounds of thrust. When the booster engine firings are completed, the motor cases are jettisoned, recovered by parachutes, and then refurbished for reuse. A two-week ground turnaround will be required for the Orbiter from landing to liftoff.

Spacelab This major Space Shuttle payload consists of standardized manned laboratory modules and unmanned, unpressurized instrument platforms (pallets) that will allow the Orbiter to conduct extended research and other activities during "sortie" missions lasting from 7 to 30 days in Earth orbit. Thus, the combination of the Orbiter and Spacelab provides a reusable space station capability, as the 32,000 pound Spacelab has an operational lifetime of fifty missions. Nine European countries, members of ESRO, are sharing the development costs of Spacelab with initial operations planned in the early 1980's.

Space Tug For payload delivery to and return from very high orbits, or to allow trajectories to the planets or beyond, additional propulsion stages are required for the Space Shuttle. To accommodate early operations, the U.S. Department of Defense has tentatively agreed to develop an Interim Upper Stage (IUS) with a deployment capability of 5,000 pounds, but lacking a payload retrieval capability. This agency plans to use the Space Shuttle as a part of its defense activities. Later, a more advanced upper stage will be developed and used to place about 4 tons of payload into Geosynchronous Orbit (GS) at some 19,323 nautical miles altitude. This space tug, in a round-trip mode, will also be able to deliver to and retrieve from GSO some 2,750 pounds of payload.

MISSIONS AND OPERATIONS

Current mission and payload planning documents indicate 782 Space Shuttle flights will be required through 1991 with about one-third (31%) of these required for the U.S. Department of Defense. Also, almost one-third (29%) of the total flights will originate from the Western Test Range (WTR) at Vandenberg Air Force Base, California, primarily for high inclination (polar) orbits. Apollo program facilities located at the Eastern Test Range (ETR) for NASA's Kennedy Space Center (KSC) will be modified to accommodate the Space Shuttle Vehicle and its payloads for launch into more eastern (equatorial) orbits. Multiple payloads are expected during Space Shuttle flights although DOD payloads will not be combined with non-DOD payloads. Additional missions and applications can also be expected as further studies and contacts are made with other potential users of this new transportation system.

PAYLOAD CHARACTERISTICS

The following listing provides the Space Shuttle capabilities and selected payload parameters of interest to researchers, experimenters, and commercial users of the STS:

- Crew and passenger load - crew of 4 plus 6 passengers
- Payload weights - 65,000 pounds to 100 nautical mile orbit
- 32,000 pounds return from 100 nautical mile orbit

- Payload size (max.): 60 feet length
15 feet diameter
- Loading: 3 g's maximum (launch and re-entry)
- Pointing: \pm 0.5 degrees
- Stability: \pm 0.1 degree per second
- Deployment/Retrieval: Long reach manipulator arms (remotely controlled by crew)
- Payload Environmental Criteria
 - Pressure: Payload Bay Unpressurized
 - Temperature Range -
 - Prelaunch: +40° to +120°F
 - Launch: +40° to +150°F
 - Entry/Landing: -100 to +200°F
 - Heat Rejection Provision: 21,500 BTU/hr.
- Power Available
 - Baseline: 50 KWH
 - During orbit: 3.0 KW average
6.0 KW peak
 - During Orbiter Operations: 1.0 KW average
1.5 KW peak

PAYLOAD APPLICATIONS

The current NASA payload analysis outlines possible future payloads as a baseline which can be used for reference and planning purposes. With almost a thousand payloads identified and represented during the initial eleven-year period of Space Shuttle operations (1980-1991), NASA documents indicate about one-third of these will be sortie payloads, requiring Spacelab. Low Earth Orbit payloads will comprise about two-thirds of the total sent into space.

Listed below are codes for the automated (free flying) and sortie (attached to Orbiter) payload programs currently identified to meet the projected mission objectives of STS.

- ASTRONOMY (AST)
- COMMUNICATION AND NAVIGATION (C/N)
- EARTH OBSERVATIONS (EO)
- EARTH AND OCEAN PHYSICS (EOP)

- LIFE SCIENCE (LS)
- LUNAR EXPLORATION (LUN)
- PLANETARY EXPLORATION (PL)
- PHYSICS (PHY)
- SPACE PROCESSING (SP)
- SPACE TECHNOLOGY (ST)

ECONOMIC DATA

The currently planned Space Transportation System assumes a continuing and constant NASA level budget of \$3.3 billion yearly. Other items of economic interest are listed below. These figures were used in the "October 1973 NASA Payload Model" document and are based on 1972 dollars.

- Estimated R&D costs for the Space Shuttle - \$5.4 billion
- Estimated R&D costs for Spacelab - \$300-400 million
- Estimated comparative savings for STS over Expendable Systems - \$14 billion during 1980 to 1991
- Estimated cost per Space Shuttle flight - \$9.8 million
- Estimated additional cost per Space Tug mode - \$.85 million

NEW APPLICATIONS

Efforts are currently underway to stimulate new awareness and interest in the STS and its potential applications. An Advanced Payload Analysis (APA) is being directed toward the development of methodologies required for identifying new STS users. Emphasis is being placed on domestic and foreign government agencies, industrial communities and educational communities. Also, studies are being made to develop a policy and basis for STS user flight charges.

Sampling techniques are being applied to validate the approaches now being considered for new STS applications. Also, many new ideas for meeting national and international goals in such critical fields as energy and natural resource development; environmental protection; communication and educational improvements; and advanced materials development can be investigated and applied with the aid of this new technological tool.

APPENDIX C

COMPANIES AND ORGANIZATIONS INCLUDED IN
ADL INTERVIEW PROGRAM AND/OR SPACE SHUTTLE SURVEY
BY THE INDUSTRIAL RESEARCH INSTITUTE, INC.

INTRODUCTORY NOTE

As reported in Chapter III ADL staff interviewed a selected list of members of top-level staff of multinational corporations known to be experienced in adopting advanced technologies in order to obtain a perception of business and public policy issues likely to be considered important in decisions to invest in utilizing the STS when it becomes available in the 1980's. This was supplemented, as noted, by a survey performed, at ADL's suggestion, by the Industrial Research Institute, Inc., the leading professional organization of U.S. corporate Directors of Research. This appendix lists the companies and other organizations with whom contact was made.

COMPANIES AND ORGANIZATIONS INCLUDED IN
ADL INTERVIEW PROGRAM AND/OR SPACE SHUTTLE SURVEY
BY THE INDUSTRIAL RESEARCH INSTITUTE, INC.

A M F Incorporated
Abbott Laboratories
Allegheny Ludlum Industries, Inc.
Aluminum Company of America
The Bendix Corporation
Burlington Industries, Inc.
The Cabot Corporation
Campbell Institute for Food Research
The Carborundum Company
Chevron Research Company
Communications Satellite Corporation
Corning Glass Works
Crown Zellerbach Corporation
Debevoise, Plimpton & Page (Corporate Counsel)
The Dow Chemical Company
E. I. Du Pont de Nemours and Company, Incorporated
Eastman Kodak Company
Esso Research and Engineering Company
Ford Motor Company
General Electric Co. (Corporate Headquarters)
General Electric Company, Space Technology Center
General Foods Corporation
General Mills, Inc.
The B. F. Goodrich Company
Gould Inc.
International Business Machines Corporation
Kennecott Copper Corporation
Kimberly-Clark Corporation
Eli Lilly and Company
Mallinckrodt Chemical Works
Owens-Illinois, Inc.
Polaroid Corporation

The Procter & Gamble Company
RCA Corporation
Ralston Purina Company
Sperry Rand Corporation
E. R. Squibb & Sons, Inc.
Sterling Drug, Inc.
J. P. Stevens & Co., Inc.
Texas Instruments Incorporated
Union Carbide Corporation
UNIROYAL, Inc.
Universal Oil Products Company
Whirlpool Corporation
Xerox Corporation

APPENDIX D

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APPENDIX E

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