SPACE STATION
OPERATIONS TASK FORCE

PANEL 3 REPORT

USER DEVELOPMENT
AND
INTEGRATION

DECEMBER, 1987

FORWARD

This report contains the results of the User Development
and Integration Panel's deliberations for the Space Station
Operations Task Force. This report forms the basis for
some of the recommendations summarized in the SSOTF Summary
Report dated December 1987 and describes in greater detail
the User Development and Integration major function of the
Space Station Operations Concept. To obtain a full appre-
ciation of the contents of this report the reader is
advised to read first the Summary Report which describes
the User Development and Integration function in context
with the other major functions as part of the overall
developed end-to-end operations concept. It should be
noted that the subsections of this report were developed
and written by subgroups of the panel. As such, the reader
may note differences in style and continuity between
subsections. Due to time and resource limitation, no
effort was made to provide for stylized editing. Also, the
terminology used in this report to describe the User
Development and Integration major function may differ
slightly from that used in the Summary Report in order to
impart a finer grain of knowledge to the reader. However,
the official Space Station Operations Concept Lexicon is

contained in the Summary Report, and terms introduced in
this book, that are not used and defined in the Summary
Report or are used in substitute of a term or part of a
term in the Summary Report, are listed on page vii with an
explanation and further definition if appropriate. Should
the definition of a term in this book be interpreted by the
reader to conflict with the corresponding definition in
the Summary Report, the definition in the Summary Report
will take precedence.

Lastly, where recommendations in this report differ from
those in the Summary Report, the Summary Recommendations
take precedent. (Recommendations of all panels were
reviewed and debated by the Task and in some instances were
changed.)

Any questions or clarifications needed concerning details
or recommendations contained in this report should be
addressed to the Panel Chairman, Mr. George Anikis, (202)
453-2570.

George Anikis   2/4/88
George Anikis   Date

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The following is a listing of all participants in the Space Station Operations Task Force (SSOTF). It has been extracted from the SSOTF Summary Report.
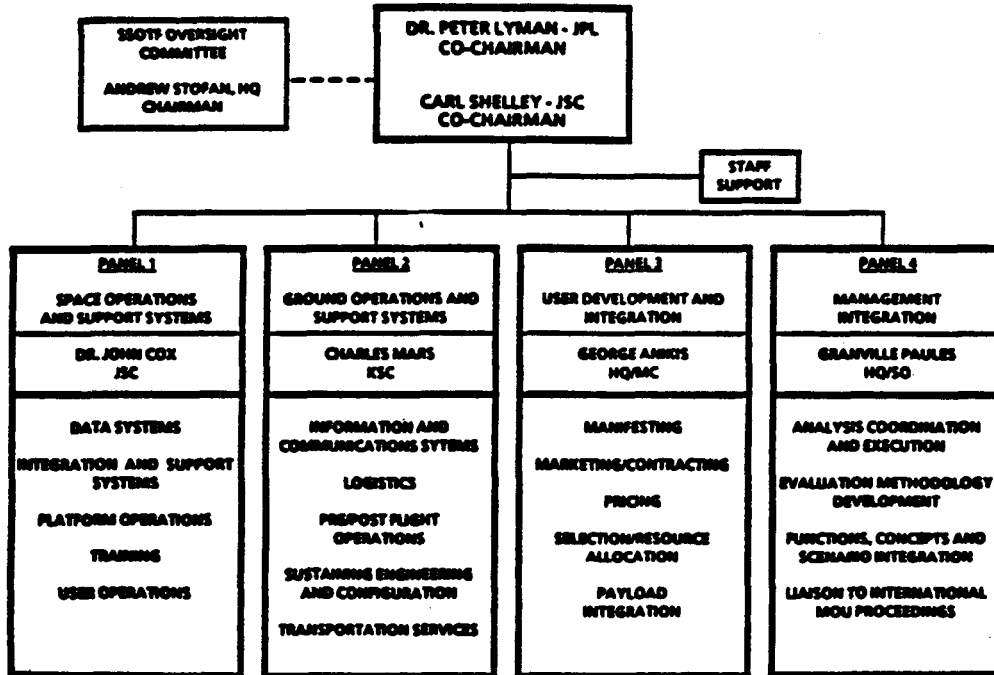
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  - **British Navy Submarine Operations**

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AEROJET TECH SYSTEMS CO.	EAGLE ENGINEERING
AIR PRODUCTS & CHEMICALS INC.	ESSEX CORPORATION
ALCOA TECHNICAL CENTER	EXXON RESEARCH & ENGINEERING COMPANY
ALLIS CHALMERS CORPORATION	FAIRCHILD REPUBLIC CO.
AMERICAN CYANAMID	FLEXWATT CORP.
ARMCO, INC.	FORD AEROSPACE & COMMUNICATIONS
ASARCO, INC.	CORPORATION
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BELL COMMUNICATIONS RESEARCH	GRUMMAN
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LTV-VOUGHT CO.	STAR TECHNOLOGY AND SCIENCE
MARTIN MARIETTA	SUNDSTRAND MISSILE & SPACE POWERS
MECHANICAL TECHNOLOGY, INC.	SYSTEMS
McDONNELL DOUGLAS	TELEDYNE BROWN ENGINEERING
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PRIME WELDING SYSTEMS	UNITED TECHNOLOGIES POWER SYSTEMS (UTC)
P.R. MILLER ASSOCIATES	VITRO CORPORATION
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REMOTE MANIPULATOR SYSTEMS DIVISION	WHIRLPOOL CORPORATION
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SCHERING-PLOUGH CORPORATION	
SPACE COMMUNICATIONS CO.	
SPAR AEROSPACE	
SPERRY FLIGHT SYSTEMS	

Bold means Briefed Task Force

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1.0 EXECUTIVE SUMMARY

1.1 INTRODUCTION

On September 30, 1986, the Associate Administrator for the Office of Space Station, Mr. Andrew J. Stofan, said that because of the complexity and challenge of developing and operating a Space Station, "NASA must behave differently than ever before . . . and must change its way of doing business."

The User Development and Integration Panel has followed these guidelines while developing a concept for the user communities' interrelationship with the mature operations phase of the Space Station.

The User

The user community provides the requirements that justify the Space Station and is recognized as the most important element of the Space Station Program. To assure that the users' requirements are fully considered throughout the evolutionary design and mature operations of the Space Station, the concept allows the users to fully participate in the operations decision making process at all management levels. The process essentially guarantees the users a substantial voice in the planning, preparing, and meeting of their requirements. Experience from past programs has emphasized that developing and keeping a strong user constituency is essential, and it demands the implementation of an operations concept that welcomes the users and allows their interests to be accommodated.

User Community

The User Community can encompass the following communities:

NASA
Other government agencies -- DoD, NOAA, State Dept., etc.
Non U.S Government -- Domestic
International partners
Non U.S. (international) participants (not partners)

User Classes/Groups/Categories[1]

User communities can sponsor or collaborate on research,
development and applications activities in one or more user
classes, groups, or categories. These activities can include,
but are not necessarily limited to:

Science
Technology
Commercial Cooperative
Commercial-reimbursable
Space Station Engineering Development[2]

User-Friendly Accommodations

Two major user-related objectives for the successful operation
of the Space Station are to accommodate the users, and to do
that in a "user friendly" manner. "Accommodation" encompasses
all of the physical, functional, procedural and programmatic

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[1] In this report, there is no specific difference intended
by the use of the terms community, constituency, group,
category, or class.

[2] Space Station Engineering users are those whose payloads
are concerned with product improvement or new development
directly associated with the Space Station capability.
These users are not included in the discussions or provi-
sions within this report.

aspects of the users' involvement: "User friendly" emphasizes the requirement that all features of user accommodations are easy to access and easy to use.

User-friendly accommodation must be a key consideration and provision throughout the design, development and operation of the Space Station.

User friendly does not preclude complicated and sophisticated facilities, equipment, and procedures. It does, however, demand particular attention to ease of access, ease of operation, and freedom from burdens that are unrelated to the direct interest of the users.

Because these requirements associate with cost, there must necessarily be compromise. Different classes of users may emphasize different aspects of accommodation, requiring the compromise process to be carefully articulated among the developer, operator, and user communities.

Specific features of user-friendly accommodation can include but are not necessarily limited to the following:

   o A single NASA interface for all users. (This does not
      imply that all users must interface with the same
      person, but that each user has to deal with only one
      authority in the course of implementing and operating
      payloads, and conducting the related investigations).

   o The interfaces and integration procedures are to be
      simple and uniform, standardized and common.

   o Clearly identified goals, objectives, plans, and
      priorities.

   o Simple coordination process among and between user
      groups and the Space Station.

o Clearly stated and demonstrated "peer/equal" relationships among all users, and with program operations personnel.

o Clear, concise, accurate, effective and current documentation.

o Appropriate levels of standardization and commonality among hardware, software, and services.

o Easy access to all information.

o Autonomy of payload operation and investigation, relatively independent of Space Station operations.

Approaches

The user development and user integration aspects of the Space Station Program have been examined from four operational viewpoints:

o Space Station Marketing

o Space Station Pricing Policy

o Payload Selection and Accommodation

o Utilization Planning/Manifesting

Each is developed and discussed in detail in the respective subpanel sections of this report. The highlights and recommendations are presented in this summary (overview). The members of the User Development and Integration Panel believe that by adopting the recommendations, NASA will move in a direction that will provide user-friendly accommodation. The underlaying theme of these recommendations is to provide an organizational structure that allows the user to access the management structure at any level, up to to the highest level deemed necessary by the user, for the resolution of user-related issues or operational problems.

1.2 ORGANIZATIONAL RECOMMENDATIONS

The User Development and Integration subpanels have proposed organizational relationships that will enhance the ability to accommodate the user. Figures 1-1 and 1-2 illustrate an organizational framework. The specific recommendations developed concerning this organizational structure are discussed in more detail in the subpanels sections.

The proposed relationships between the U.S., its international partners, and the NASA Space Station management, as they relate to the user community, are illustrated in Figure 1-1. Detailed discussion of the Space Station Utilization Board may be found in the Payload Selection and Resource Allocation Section of the panel report.

The relationships between the proposed organizational elements of the Space Station Office, as they relate to user accommodations, are illustrated in Figure 1-2. Detailed discussions on the elements in Figure 1-2 are distributed throughout the Panel report as follows: User Accommodation is discussed under resource allocation, Utilization Planning is discussed under manifesting, and Market Pricing techniques are discussed under pricing.

External to the Space Station Program

The Space Station User Board - The Panel recommends that NASA establish a Space Station User Board reporting to the NASA Deputy Administrator. The board members would be representatives from the involved NASA science and technology codes as well as commercial communities and established users such as NOAA, DoD, the State Department, etc. The chairmanship would
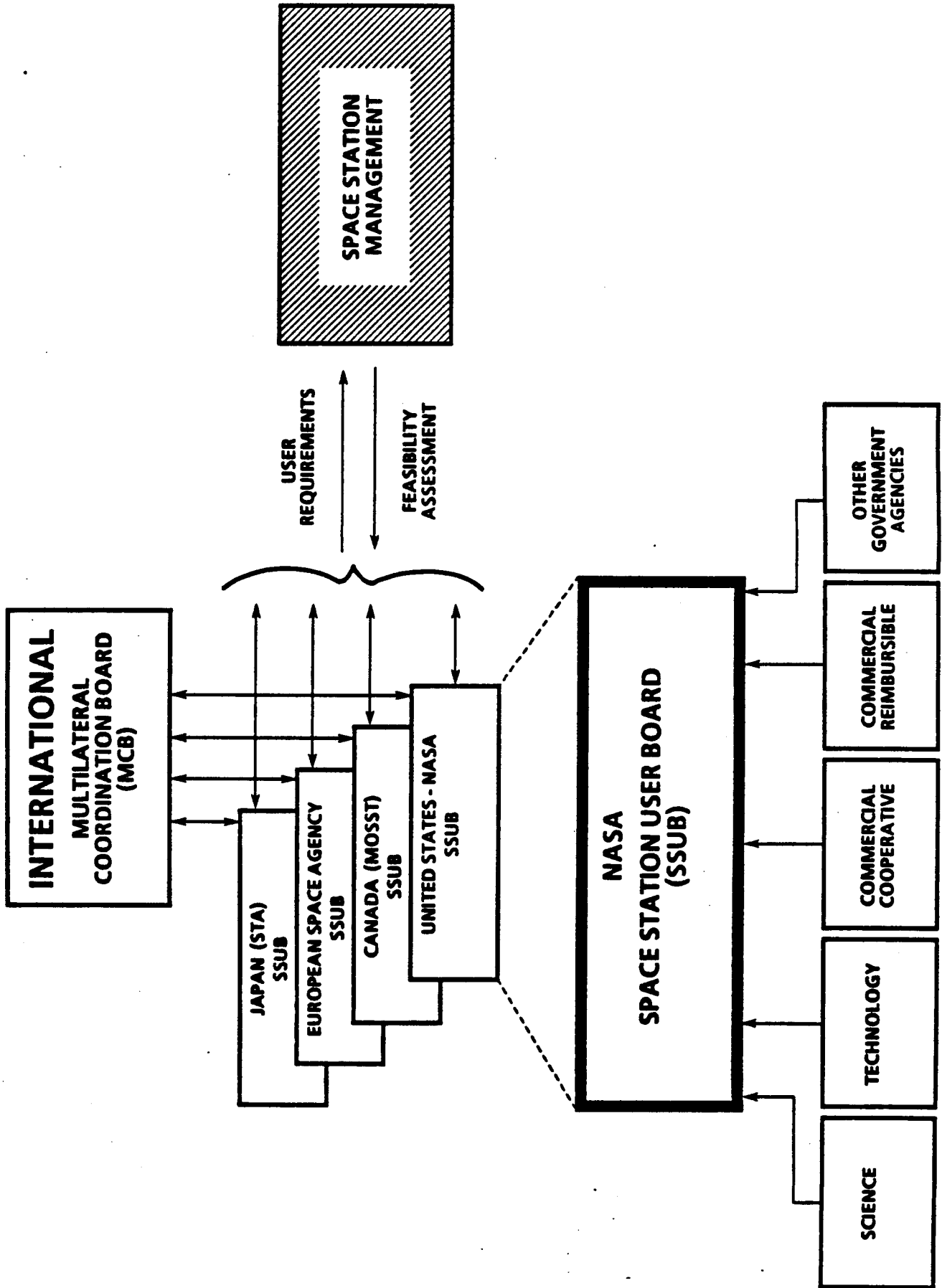
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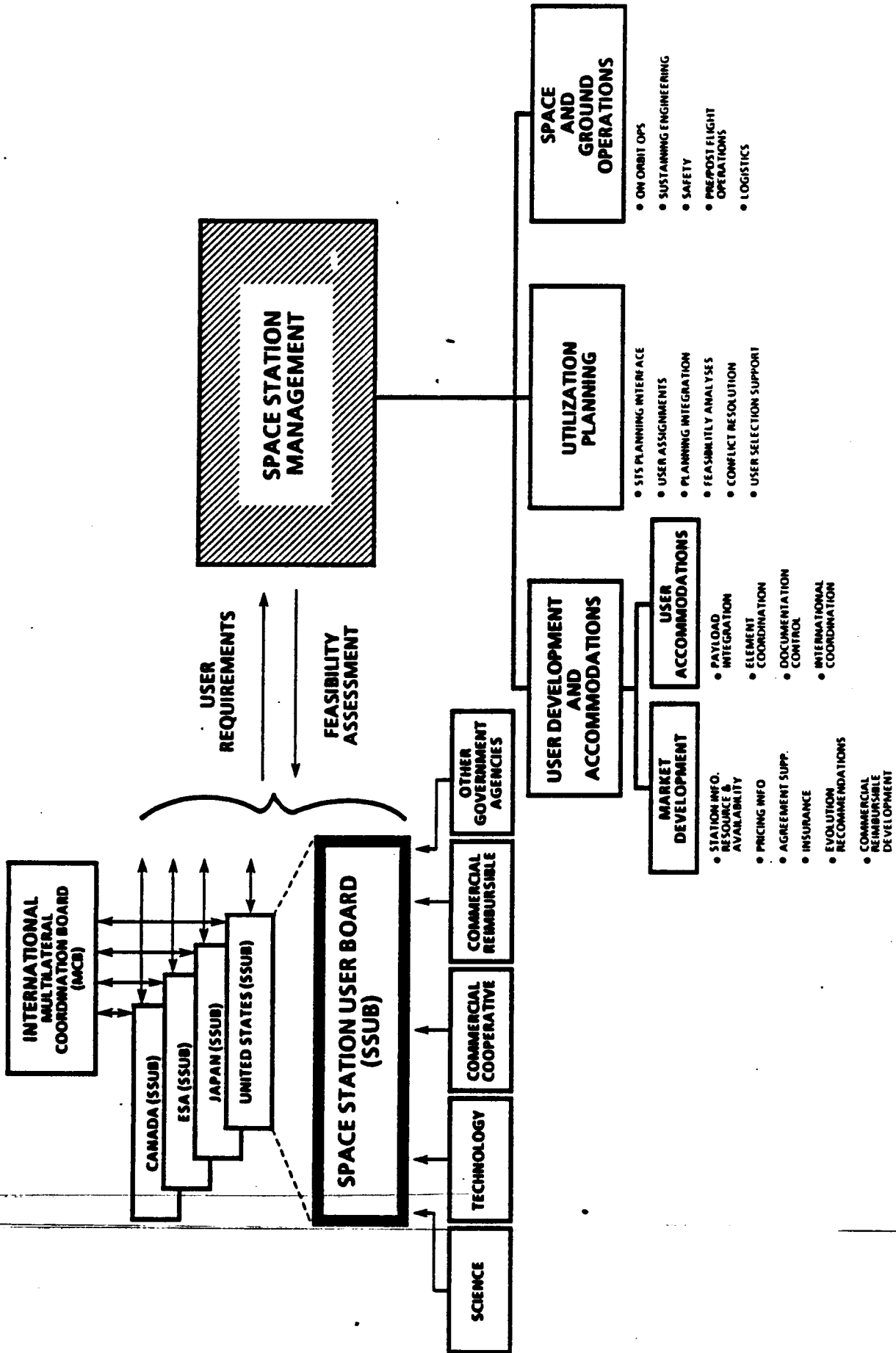
Figure 1-2

rotate among the board members. The board would establish advisory agreements with appropriate scientific and technical organizations.

The functions and purpose of the board are as follows:

- o Assure that the U.S. objectives for Space Station utilization are implemented.

- o Develop a five-year plan for Space Station utilization policies, goals, objectives, and rules.

- o Allocate resources to U.S. users.

- o Resolve conflicts among U.S. users.

- o Provide representation to the international organization for the U.S. users.

- o Consult with national advisory groups.

- o Provide ranked listing of selected U.S. users to the Space Station Utilization Planning Group.

- o Develop a transition plan (towards independent status).

- o Recommend evolutionary changes for Space Station.

- o Provide the ways and means to develop a process for selection among commercial-reimbursable users.

Internal to the Space Station Program

User Development and Accommodation Office - Within the Space Station Program, there should a group established with responsibility for all user requirements and composed of a dedicated staff whose functions include marketing and user accommodation. The purpose of this group is to stimulate and encourage user participation; assist the potential user in the application process (be it a NASA scientist or commercial firm); support negotiations (where appropriate); and assist the selected users in the manifesting, payload development, integration, checkout,

launch support and operations. This organization would repre-
sent the users' interests and assist them (users) in getting
through all the hoops and mazes that may be encountered.

The manager of this group should report directly to the Associ-
ate Administrator for the Office of Space Station. This is
necessary in order to provide a degree of user autonomy during
the development and operations process, and to minimize any
natural bias introduced into the decision-making process by
Station development and operations management philosophy.
There should be a dedicated market development staff, reporting
to the manager of this group, to assure that Station resources
and availability are accurately represented and marketed. There
should be a staff of user accommodation managers, reporting to
the manager of this group, to coordinate with the various center
payload integration, mission, and launch support managers through
a matrix concept. There should be a staff function to provide
coordination between the U.S. users and the international
partners'.

User Accommodation Group

The functions of the User Accommodation group are as follows:

o   Serves as a single point of contact for user
    accommodation

o   Supports payload technical assessment during payload
    selection process

o   Coordinates user requirements with element centers

o   Supports activities at payload development centers

o   Responsible for the development of payload support
    hardware and software

o Responsible for document control

o Supports integration activities

o Monitors resource utilization

o Responsible for user operations implementation

o Coordinates with international partners

Market Development Group

The functions of the Market Development Group are as follows:

o Provides information on Station resources and
   availability

o Provides pricing information

o Provides agreement support

o Stimulates facility utilization

o Develops evolutionary recommendations

o Actively markets commercial-reimbursable community,
   commercial developers/operators and other government
   agencies

The Utilization Planning Group

Within the Space Station Program there should be a Utilization
Planning Group responsible for all planning during Station
assembly, checkout, and verification, which evolves into a
distributed planning approach after operations mature.

The functions of the Utilization Planning Group are as follows:

o Integrate users' Station requirements, significant
   Station operations events, and capabilities of the
   transportation supporting the Station into one overall
   Space Station utilization plan.

o   Develop the manifests (tactical plan) for users and
    operations in conjunction with the transportation
    system.

o   Perform assessments of selected users to assure
    feasibility and/or compatibility with Station
    capabilities.

o   Implement the goals, objectives, and strategies of the
    Space Station Program by providing manifest
    assessments, evaluations and trends.

o   Coordinate and interface with organizations (including
    partners) providing transportation to and from the
    Station, and selecting users to the Station.

Organizational Functional Flow

The functional flow of user-related activity throughout the
proposed organizational provisions is presented in Figure 1-3.

The figure tracks the user from first contact with the Space
Station through being selected, manifested and integrated into
the user operation activity. Upon review, the prospective
users can see how their requirements are repeatedly threaded
back through the Space Station User Board (SSUB) for continuous
review. This assures user interaction with the SSUB at key
selection, resource allocation and manifesting points in the
flow.

In addition, this user selection process:

o   Is peer group oriented

o   Provides a forum for the user

o   Organizes and strengthens justification to
    accommodate user class requirements
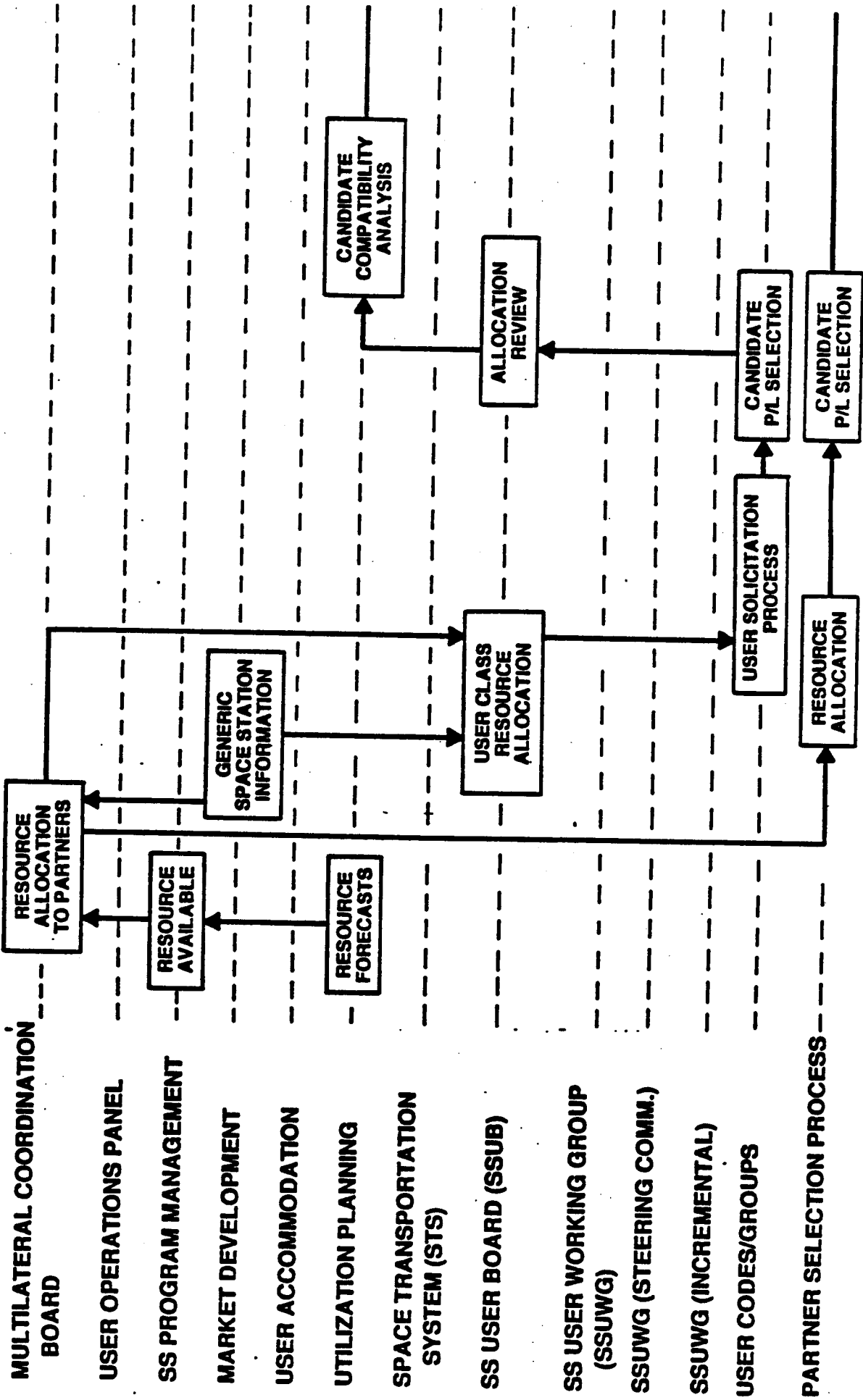
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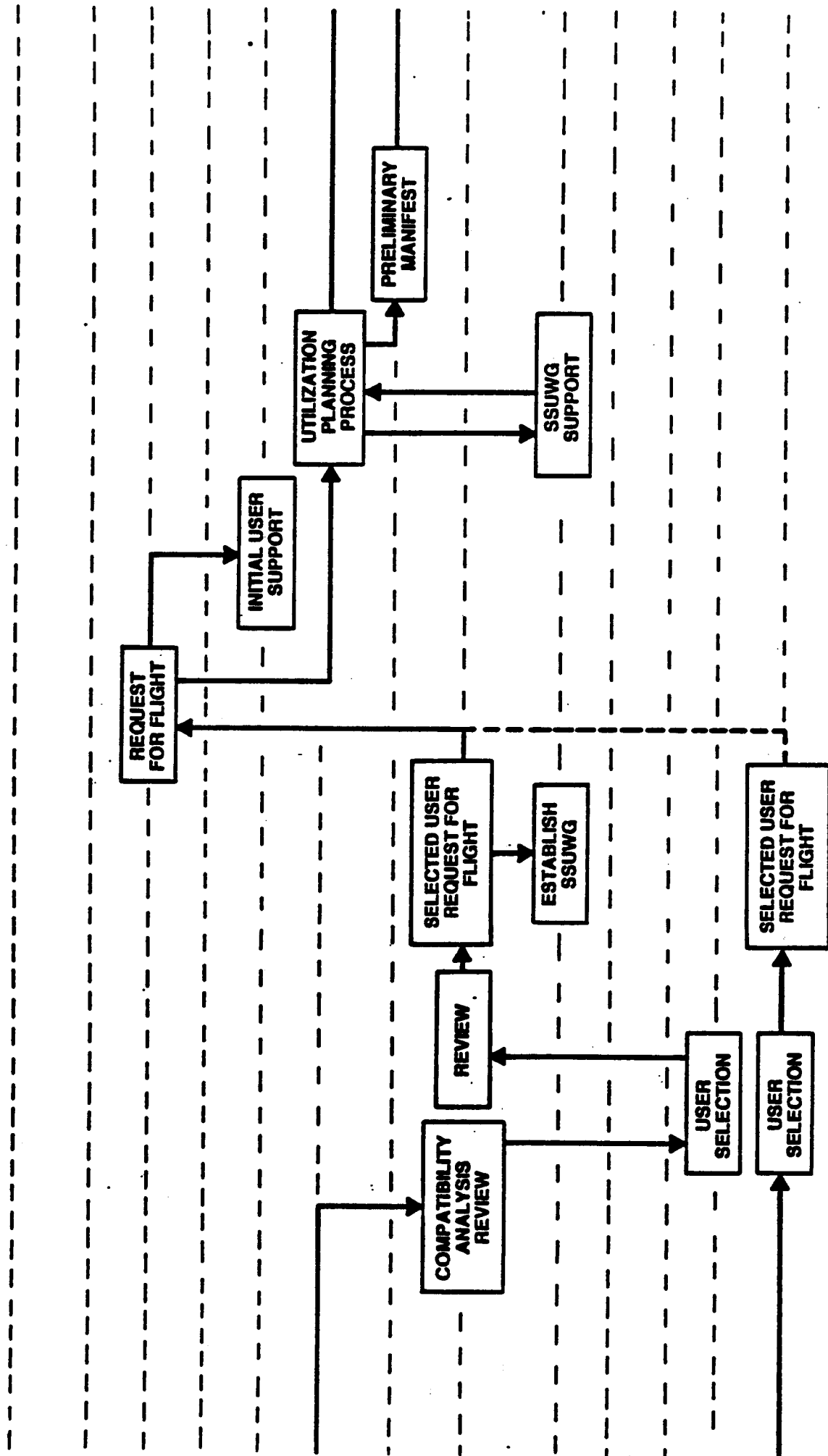
Figure 1-3 (continued)

Figure 1-(Continued)

USER OPERATION ACTIVITY

ESTABLISH INCREMENT WORKING GROUP

APPROVED UTILIZATION PLAN

ESTABLISH SSUWG STEERING COMMITTEE

INITIATE STEERING COMMITTEE ACTIVITIES

INCREMENT WORKING GROUP

APPROVAL FOR FLIGHT

SSUB CONCURRENCE

STS MANIFEST

RECOMMEND UTILIZATION PLAN

INTERNATIONAL CONCURRENCE
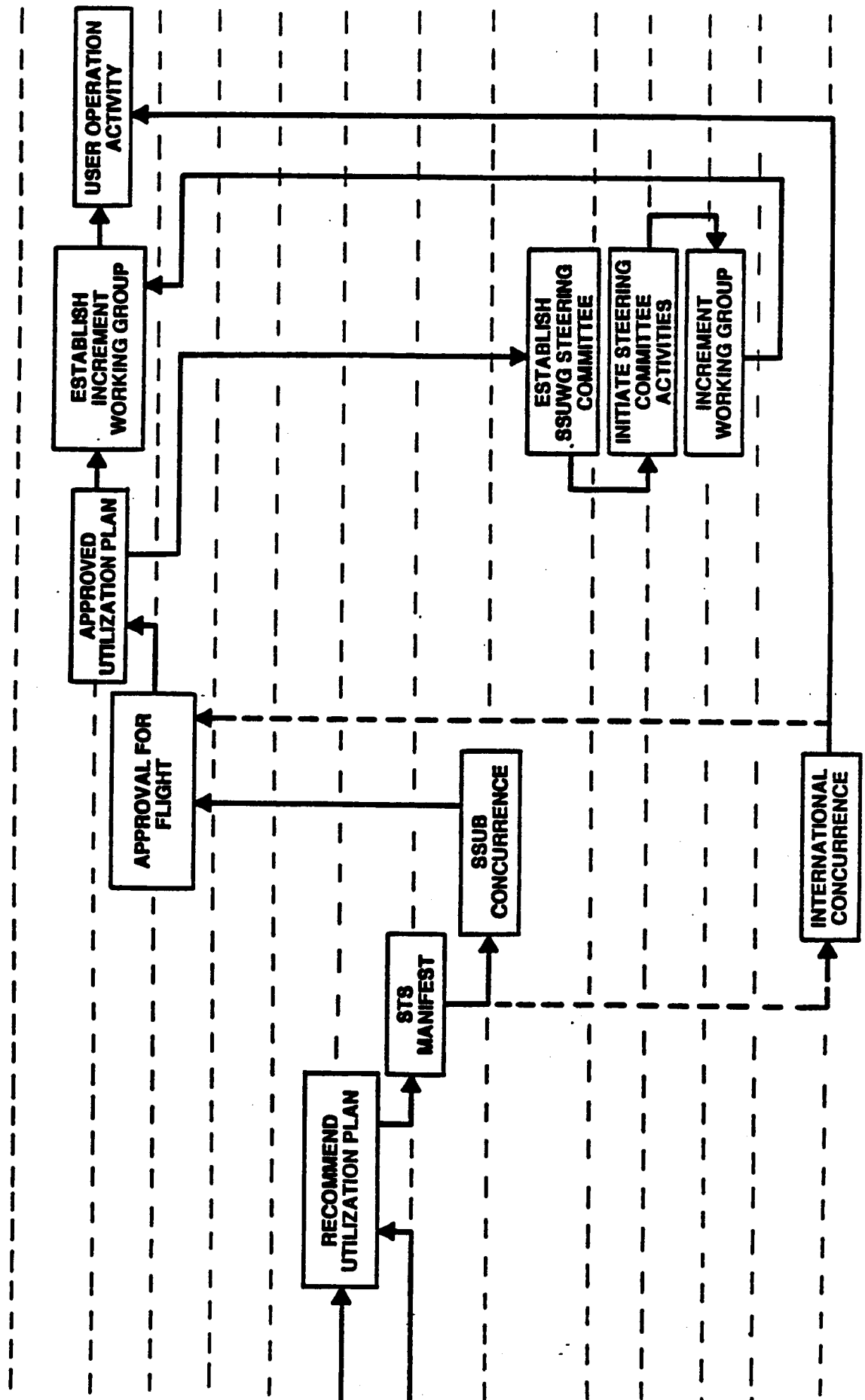
o   Provides a system of checks and balances between user
    requirements, resource allocations, and Space Station
    capacity and capability

o   Provides the user continuous representation and support
    at all user interfaces

1.3   OVERVIEW SUMMARY

Now is the time to address the issues associated with user-
friendly accommodation in the Space Station and the associated
space transportation systems. The recommended organizational
changes should be in place (or accounted for) within the next
six months: this allows development of a cohesive team and the
required information systems that the users and the user
support organizations will need by 1988.

The following four sections summarize the information and
recommendations contained in the four subpanel contributions
to this report.

1.4   MARKETING

While not as directly involved with the user accommodation
functions as the other aspects, the marketing function is
extremely important and requires special accommodation within
the future NASA organization. The panel members recommend
that the NASA establish two new organizational elements in the
marketing function: One is the Office of the Associate
Administrator for Marketing, reporting to the NASA Adminis-
trator; the other is the Marketing Support Group, reporting to
the User Development and Accommodation organization within the
Office of Space Station.

The NASA Office of Marketing provides an agency-wide marketing function to the Administrator, and deals with the total outlook for future opportunities and activities by the NASA. This office will be responsible for setting agency-wide marketing policy, for conducting basic market research and development, for investigating new user opportunities, for evaluating possible emerging synergistic relationships between new programs, and assessing future facility requirements. This office will explore and pursue market opportunities for the Space Station, but in full concert with the National Space Transportation System; the science, technology, and applications programs, and the user community at large.

The Space Station Marketing Support Group will receive policy guidelines and interpret them in terms of the Space Station activities. Other functions of the market development group will include the following;

- o Providing information on the availability of Space Station resources.

- o Providing pricing-related information.

- o Creating an environment that stimulates utilization of the Space Station.

- o Providing support to enable bilateral agreements.

- o Developing recommendations for the evolutionary changes in Space Station capability and capacity.

- o Actively stimulating, cultivating and sustaining participation by the reimbursing commercial community, commercial developers, the DOD and other government agencies in Space Station related research, development and commercial activities.

Recommendations

- o The responsibility and authority to enter into agreements with Space Station users should be as simple

as possible and require concurrence by a minimum number of NASA offices.

o Policy should be set at the Administrator level for use during routine negotiations. Only major changes in this policy sought during negotiations should have to be brought forward to the Administrator for approval.

o Dedicated legal, budgetary, policy and international relation resources should be provided to process Space Station agreements.

o NASA should initiate early dialogue with insurance community considering the risk of Space Station operations to allow industry time/expertise to react to insuring the Space Station.

o Resolve potential conflicts of applicable law which may arise on Space Station.

o Strengthen implementation of cross-waiver of liability.

1.5 SPACE STATION PRICING POLICY

Pricing policy establishes the levels and rates of reimbursement charges to be distributed among the users in accordance with various factors concerning the users' association with, and accommodation within, the Space Station program. Pricing the Space Station resources is a complex task that must integrate many sensitive issues to promote efficient, effective use and management of the Space Station.

It was determined to be more useful and important to compile and assess the many objectives, options, requirements and issues associated with pricing, and present the framework within which the future pricing policy can be developed. This report presents these discussions, but does not make any recommendations for a specific pricing policy. Some of the major issues that are addressed include:

o   What are the primary objectives for the Space Station
    pricing policy?

o   Who will have the responsibility for selling or
    allocating Space Station resources to potential users?

o   What Space Station resources are available for user
    allocation?

o   What are the methods for measuring, monitoring and
    determining the prices of Space Station resources?

In addition to these major issues, the report addresses a
number of related issues such as:

o   DoD pricing.

o   Non-partner, foreign government pricing.

o   Government pricing regulations.

o   Pricing of platform resources.

1.6   PAYLOAD SELECTION AND RESOURCE ALLOCATION

The approach for the selection of payloads and the method of
resource allocation is the foundation upon which the utiliza-
tion of the Space Station rests.

The fundamental philosophy used to develop these concepts is
that the Space Station is designed and operated for the user.
Therefore, the user communities should have the maximum
possible input into the selection and resource allocation
processes.

This Subpanel recommends that two separate functional groups be
established to support the accommodation of users into the
Space Station -- one within the Space Station Program and one
outside (and independent) of it. Within the Space Station
Program, a User Development and Accommodation office should be

formed with the director reporting directly to the Space
Station Associate Administrator. This office would include a
User Accommodation group. The User Accommodation group is to
provide the "single point of contact" for selected users.

Outside of the Space Program, a Space Station User Board should
be established. The initial membership of this board should be
the Associate Administrators for the principal NASA user
offices -- OSSA, OAST, and OCP -- plus any other principal user
groups such as the DoD, State Department, NOAA, commercial
reimbursable, etc. The board will report directly to the NASA
Deputy Administrator. The initial task of this board is to
develop a multi-year plan for the Space Station utilization
policies, goals, and rules.

1.7 UTILIZATION PLANNING (MANIFESTING)

Utilization Planning is the integration of user and station
operations requirements within the available station and
transportation (both launch and return) capabilities, over a
specific planning horizon.

The Manifesting Subpanel's recommends that the SSP adopt a
centralized utilization planning approach during station
design, development test, and evaluation (DDT&E) and to evolve
into a more distributed utilization planning process as
operations mature.

Additional conclusions and recommendations of the Manifesting
Subpanel are the following:

> o The Space Station Utilization Plan (SSUP) should be the
>   top-level planning document for the SSP, its users,
>   operators, and transportation suppliers,

o The SSUP should provide the information needed by users and their sponsors to plan, budget, and coordinate their use of the Station; by the Space Station Program to direct tactical operations planning; by the transportation (e.g., NSTS, ELV's) and logistics organizations to plan support,

o The utilization planning process should be responsive to management, users, and station operations,

o The SSUP should be developed, maintained, and controlled by NASA taking into account its commitments to the international partners,

o Utilization planning should be accomplished at NASA Headquarters with the participation of the user, station operations, and transportation organizations,

o A Centralized Utilization Planning Office should be established at NASA Headquarters as soon as possible with initial emphasis on developing the overall planning process, planning the transition from DDT&E to operations, station assembly phase planning, and development of the NSTS interface,

o NASA should transition to a Distributed Utilization Planning approach as Station operations mature,

o The Space Station Program should consider increased Utilization Planning by the partners after the planning process is established and station operations are routine.

2.0 OVERVIEW ON SPACE STATION PRICING OPTION

Establishment of a Pricing Policy is a complex task that must integrate many sensitive issues to promote efficient and effective use and management of the Space Station. Therefore, this report discusses potential policy options for pricing the Space Station resources but does not make a final recommendation. It discusses pros and cons of each and touches on other issues that must be considered in implementation of a policy.

The four major pricing policy issues are:

1. What is the primary purpose or objective of the Space Station pricing policy?

2. Who is responsible for selling or allocating Station resources to potential users?

3. What Space Station resources are offered for allocation?

4. How are prices of the Space Station resources determined?

Objectives of a Pricing Policy

A pricing policy can be designed to accomplish a number of objectives. While a policy can support more than one objective simultaneously, the relative importance given each can significantly impact the design of the policy.

Two objectives for a pricing policy are:

1. Recover NASA funds while encouraging Station use.

2. Promote efficient use and management of the Space Station.

While the differences in these objectives appear subtle, the effects are not. Historically, NASA has concentrated on the

first objective; that is, pricing policies for use of NASA
services by non-U.S. government users have been previously
designed with cost recovery as a primary objective. This
report argues that for large, complex, long-lived projects such
as the Space Station and the Shuttle, prices can significantly
impact the behavior of both Station users and operators. If
pricing policy is carefully designed, users and operators can
be motivated to behave in a manner that promotes flexible,
efficient Station operation and management. In addition,
policies designed specifically with this objective in mind may
result in the recovery of as much (or more funds) than the
posted price policies that NASA had previously specifically
designed to recoup NASA expenditures.

Who is Responsible

Two options are available with respect to the right to sell
Station resources:

1. Code S (Space Station Office) sells resources to all
    others.

2. User resources are allocated to internal NASA user codes or
    representatives who subsequently trade among themselves.

The first option requires significant organizational changes
within NASA to allow user codes to purchase resources from
Code S. It would required the user codes to have resources
authority to purchase Station resources, thereby funding some
Station operations.

The second option requires adoption of a management process to
determine initial resource allocations. It avoids the signifi-
cant budgetary and management issues raised by the first
option.

Station Resources

The degree to which the Station attempts to separately measure,
monitor, and price the resources produced by the Station is a
major issue. The list of potential Station resources is very
long. There may be 10 to 20 different classes of resources
with 10 to 20 different types within each class. Should we use
one or a few of these resources to represent them all, or
should we package a group of resources? In order to promote
the objectives of some pricing policies, it is necessary to
separately measure and price a large number of Station resourc-
es. While the costs of metering these resources do not appear
to be large, the complicated nature of a separate charging
system for many resources imposes costs and uncertainties of
unknown magnitude on both Station users and operators.

Resource Price Determination

The pricing policies discussed here develop two distinct
markets. One consists of NASA and International Partners; the
other consists of all other users. Within the NASA user Codes
and International Partners, each of which has an allocation of
Station resources, bartering or trading resources may determine
the price. There are two primary options for managing this
market: 1) trades consisting of bartering only, or 2) buying
and selling of resources for money by the user codes and
International Partners. Pros and cons of each option are
discussed, but a final recommendation is not made. The second
market consists of all outside users and the pricing of re-
sources to them. Here the options available depend on the
class of user considered. For instance, the provision of
Station resources to commercial users could be priced through
1) auctions or 2) posted prices. This report discusses the
pros and cons of each approach.

In addition to these four major issues, the report addresses a number of related issues such as: 1) DoD pricing, 2) non-partner foreign government pricing, 3) government pricing regulations, and 4) pricing of polar platform resources.

2.1 BACKGROUND

When NASA began supplying services to non-NASA users, the question arose as to what cost reimbursement NASA should require. As a result, NASA has adopted pricing policies for some missions and other NASA activities specifying levels of cost reimbursement for services used by various categories of non-NASA users.

The most widely known NASA pricing policy applies to non-NASA usage of the Space Shuttle. The DoD, other government agencies, commercial firms and foreign governments have paid NASA for Shuttle launches. Shuttle pricing policy has been controversial, with arguments centered largely around the appropriate level of cost reimbursement by each user category. Should users pay marginal costs, average costs, or short-run incremental costs? Which users deserve explicit subsidization or "incentives"? A major complication to the Shuttle pricing policy arose from the competition with Ariane pricing. In reality, Shuttle prices were ultimately affected by this competition. Congress has often entered the fray with specific directions to NASA on various user charge rates.

In addition to Shuttle rides, NASA charges non-NASA users for a variety of services supplied by such facilities as wind tunnels, research aircraft, launch pads, ranges, and communications satellites. In every case the focus of the stated pricing policy is the appropriate level of cost reimbursement.

Since the Space Station will supply services to non-NASA users, the development of a suitable pricing policy is required.

Given the history of NASA pricing policies, a Space Station policy based on cost reimbursement by non-NASA users would appear to be acceptable to NASA management. The development of such a policy is relatively straightforward. The Shuttle policy can be used as a pattern, and several improvements, discussed below, can be recommended.

However, improvements to a shuttle-type pricing policy which retains its primary focus on cost reimbursement cannot address its fundamental weakness. That weakness arises because NASA has not taken full advantage of the powerful role that prices can play in the coordination and integration of complex, widely-distributed activities, such as Shuttle or Space Station. To understand the reason for this requires a brief discussion of fundamental characteristics of NASA space missions.

2.2 NASA SPACE MISSIONS

Most spacecraft, including the Space Station, consist of a vehicle and a set of scientific instruments which fly or ride on that vehicle. The vehicle produces and supplies to the instruments (or payloads) a variety of useful commodities and services such as electrical power, thermal rejection, man-hours, data processing/transmission and pointing, in addition to supplying a ride through the required trajectory (propulsion/attitude control).

The decisions regarding which payloads fly on which spacecraft (manifesting) and what quantities of the various spacecraft

commodities and services each payload uses (resource alloca-
tion) are made through a centralized decision-making process.
For example, NASA planetary missions have been managed by a
single NASA center which simultaneously designs the spacecraft
and the scientific instruments. The selection of instruments
is managed through a scientific peer review followed by NASA
management approval. Conflicts among payloads and between
payloads and spacecraft are resolved by the management of the
NASA center.

This process has worked well for the vast majority of NASA
missions. The success of such a process is dependent, however,
on the characteristics of the mission undertaken. In particu-
lar, as long as the mission objectives are well defined and are
aimed primarily at a single scientific discipline or set of
closely related disciplines (e.g., planetary sciences), scien-
tific peer review can be heavily relied on for instrument
selection (manifesting). Furthermore, as long as the number of
scientists is relatively small, closely knit and stable,
centralized cooperation among the scientists (user committees)
is an efficient method for resource allocation. Finally, as
long as both spacecraft and instrument development are managed
by the same NASA center, management can efficiently resolve
conflicts among spacecraft designers, operators and users.

Some NASA missions do not meet these criteria. Shuttle and
Space Station stand out as the primary exceptions: many
different users of vastly different motivations are served; and
users, designers, builders and operators are widely dispersed
and numerous, rendering centralized coordination unwieldy and
inefficient. Partial decentralization of Space Station manage-
ment employing resource markets and associated prices can be an
attractive, important improvement.

2.3 ROLE OF PRICING POLICY

It is the contention of this report that adoption of an appropriate pricing policy presents a major opportunity to improve the coordination and integration of NASA space missions, such as the Shuttle and the Space Station, that do not fit the description of missions suitable for traditional centralized management. The primary purpose of such a pricing policy is not necessarily cost reimbursement, but to increase the efficiency and effectiveness of mission management. NASA should make a conscious decision to pursue such a policy if prices are to play this role.

This policy places the Space Station prices in a role similar to prices in private markets. Since markets typically involve hundreds, thousands, or millions of participants, with widely-disbursed knowledge of benefits and costs, centralized management is difficult and inefficient. (Witness Soviet central planning.) Economists have demonstrated both theoretically and empirically the large benefits which arise from decentralized coordination of suppliers and demanders by private markets. All essential information for efficient coordination is reflected in the market prices and the characteristics and quality of the commodities. In addition, the rewards implicit in selling and buying provide appropriate incentives to both suppliers and demanders to act efficiently.

By emulating such a private market when the characteristics of the mission warrant, NASA can improve both design and operation decisions and facilitate a smoothly functioning organization.

2.4 PRICING POLICY APPLICABILITY

NASA use of NASA services is typically furnished freely by one
NASA Headquarters organization (Code) to another. In order to
employ pricing policy as a management coordination tool, the
policy must be extended to include explicit allocation or sales
of Station resources to all NASA Codes that intend to use the
Station.

2.5 STATION RESOURCE OWNERSHIP[1]

Who owns the resources (power, man-hours, data processing,
etc.) produced by Space Station? The answer to this question
is fundamental to design and implementation of a Station
pricing policy. Does Code S own them all; that is, does Space
Station management determine who will get what resources and at
what price? Or should the Space Station transfer ownership of
Station resources to users? Should an independent user group
be established in whom ownership is vested? That is, should we
just let the users negotiate among themselves? This transfers
the problems inherent in coordination of the widely dispersed,
numerous and heterogeneous Station users to the user group, but
does not facilitate their resolution.

Ownership of Station resources is also presently a subject of
intense negotiation among the International Partners. It is
likely that these negotiations will lead to an allocation of
Station resources among the four partners roughly equivalent to
their proportionate projected investment in the Station. Thus,

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[1] In this section the term ownership is used in an economic
(not legal) sense implying actual control and use of Station
resources.

investment in the Station. Thus, the U.S. will own approximately 75 percent of the Station's useful output (above those resources necessary for non-user Station operations).

How will the U.S. divvy up its 75 percent share? Primary groupings of potential users of the U.S. Station resources include (1) Office of Space Science and Applications (Code E), (2) Office of Aeronautics and Space Technology (Code R), (3) Office of Commercial Programs (Code I), (4) Office of Space Station (Code S), (5) other government agencies.

The pricing policy discussed here begins with an allocation of Station resources by a user group to each of the interested Codes (E, R, I, and S) in a manner equivalent to the international partners. Since U.S. user categories[2] (4) and (5) above do not have internal NASA Code representation, their allocation would be held by other representatives or agencies.

Since Code E is envisioned as the largest U.S. user of Station, they could be allocated the largest share of the U.S. portion of Station, with the other user categories each receiving allocations of the remaining resources. The basis for such allocations should be a national consensus on the benefits of the various potential Station users and could be vested in the Space Station Users Group. Figure 2-1 shows how this allocation of Space Station use flows from the Station to the International Partners and U.S. users. If one Code is clearly more interested in some Station resources than other (e.g., Code R and Station attach points) while other Codes have different interests, the initial allocations of Station resources can reflect these interests.

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[2] Note that allocations to U.S. user categories bear no relationship to Station investments, unlike international shares.

OPTION 1
USER BOARD INITIAL ALLOCATION
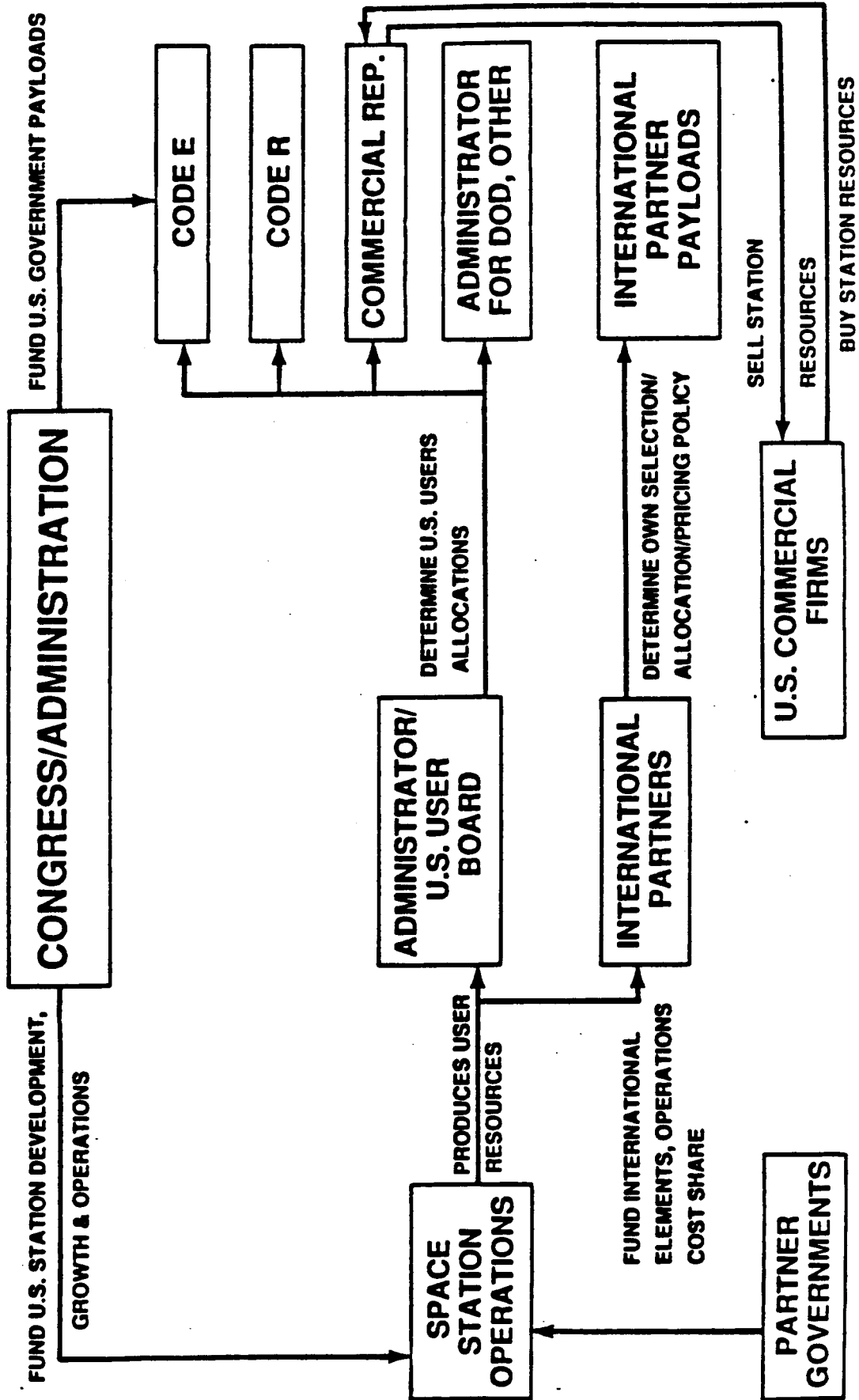
Figure 2-1

Explicit internal user allocations will undoubtedly be the focus of such debate. The Administrator will face pressures both internally and externally, including Congress, for changes to any given allocation. The potential for conflicts must not force abandonment of explicit allocations, however, or pricing policy is probably rendered useless as a management coordination tool.

The only viable alternative is to vest Code S with resources to fund U.S. Station development growth and operations not covered by resource sale and create an explicit market for Station resources with both external and internal users buying those resources from Code S that they wish to use (See Figure 2-2). This approach involves greater changes in NASA organization and management than the one discussed in this report, but has, nevertheless, received considerable attention from some analysts. It does offer some advantages, including: (1) Station resources become tangible; (2) Code S is given strong incentives to serve its customers; and (3) the structure facilitates transfer to non-NASA operation (spin-off). However, it appears that these advantages, attractive as they are, are outweighed by serious drawbacks centered largely around the fundamental realignments of NASA's budgeting process that is required.

Allocations should be periodically reviewed, perhaps annually, to allow for changing Station user emphasis.

2.6 DETERMINATION OF RESOURCES TO BE ALLOCATED

Space Station will supply a long list of valuable services to users. It is tempting to simplify the allocation and pricing problems by bundling the services into standard and optional packages. By doing so the transaction between Station and

OPTION 2
CODE S SELLS ALL RESOURCES
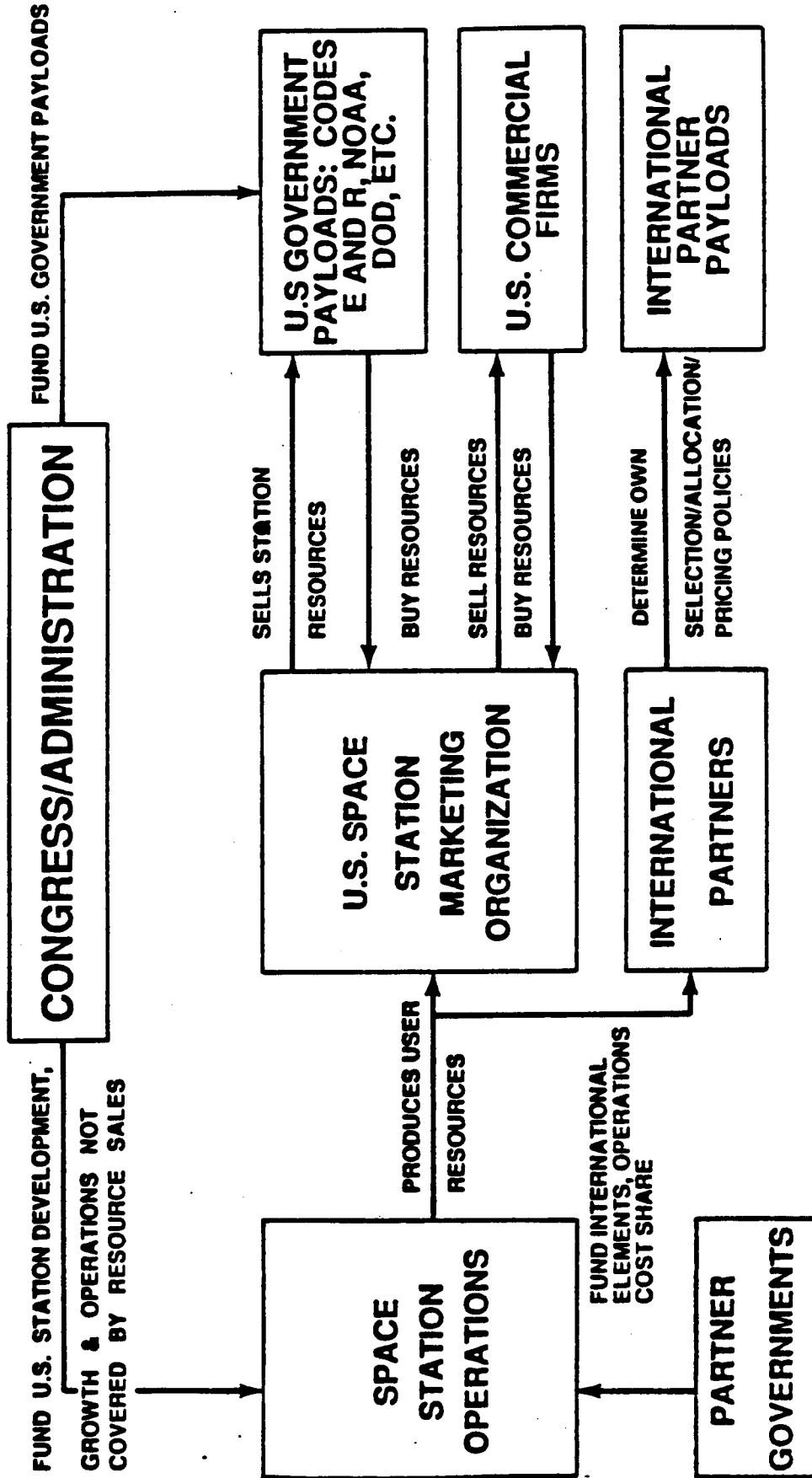
Figure 2-2

users is apparently simplified as each user contracts for one or more standard packages and, possibly, optional services.

On Station, the proportions of resources used by various payloads are exceedingly variable -- no typical or "standard" payload resource requirement currently exists. Thus, how does one meaningfully define a standard set of services?

Finally, if a resource is scarce and important enough to attract the interest of users, then it is important enough to track and price separately. The metering and accounting problems that arise as a result are minor relative to the problems which arise when scarce resources are ill-defined, not measured, or for which no market or market prices exist.

2.7 RESOURCE PRIORITY CLASSES

As an example of the difficulty of properly defining the scarce resources or commodities of Space Station, and the types of benefits which arise when one does so, consider those Station resources whose supply to users is stochastic. We could argue that the quantities of all resources supplied by Station to users are random variables dependent on exogenous events such as random parts failures, astronaut health, and subsystem performance. This implies that users will be interested not only in the total quantity of resources allocated to them but also in the priority with which they get those resources. If they are first in line (highest priority), they have a much better chance of actually getting those resources than if they are placed at the end of the queue where their success is dependent on the entire Station system performing up to its rated capacities.

In the past, when contingencies arose, a centralized decision-making process was imposed to assign priorities. This process is inefficient in that most manifesting decisions must be taken at very high levels where information and time are scarce.

A superior method for dealing with stochastic resource supply would be to define and allocate specific priority classes for such resources. Suppose power is supplied to users of the Station with the probabilities as shown in Figure 2-3. The rated capacity of the power available to users is 50 KW.

However, only the first 20 kilowatts are always available (100% certain). Sixty percent of the time all 50 KW will be available; 30 KW will be available 20 percent of the time; and only 20 KW are available the other 20 percent of the time.

In essence, three different kinds of power are available from the Station. To own power in the first priority class (first 20 kilowatts) is more valuable than to own power in the second or third priority classes. Thus, three priority classes of power should be allocated among users. Each international partner and NASA user Code should be allocated their share of each priority class.

Since all users will know ahead of time which priority they command for power, they can explicitly design their payloads and operations procedures to take advantage. Furthermore, the power dispatching problem is greatly ameliorated -- power is dispatched according to pre-determined priorities. No centralized decisions are required (other than the initial allocation). Coordination and operations in the face of resource contingencies are greatly simplified by this decentralization mechanism.
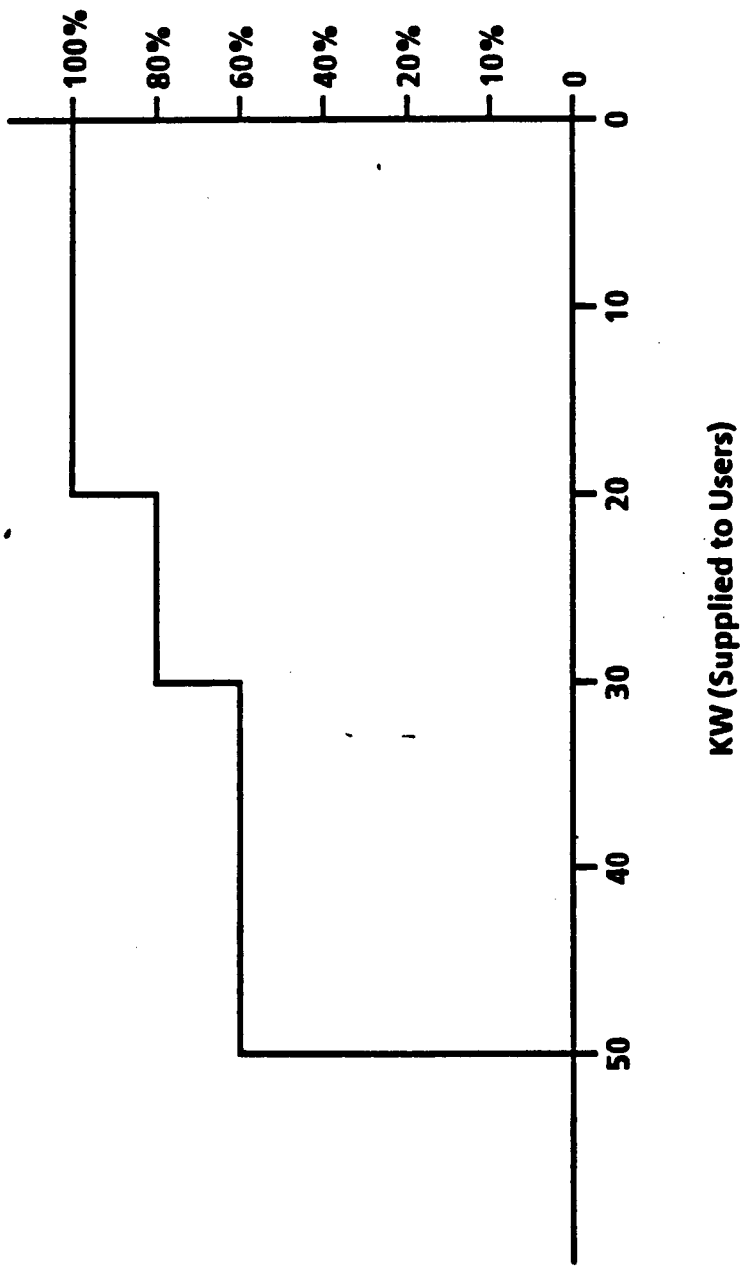
Figure 2-3. Resource Priority Allocation

2-15

It should be obvious, however, that appropriate definition of priority classes is quite difficult. The number of classes for each stochastic resource and their boundaries must be determined by the underlying shape of the cumulative probability distribution with which that resource is supplied to users. As the Station is operated and the actual distributions are revealed, the priority class definitions must be altered to reflect that reality or the benefits available will not be realized.

Thus, not only is the list of scarce resources long, including multiple priority classes for uncertain supplies, it is viable as new information arises. For these reasons definitions of allocable resources should be intensely investigated and periodically reviewed.

2.8 RESOURCE TRADING

Most discussions of Station pricing policy implicitly assume that Code S will determine prices for Station resources, presumably by reference to underlying resource costs, and will offer them for sale (at least to non-NASA users) in a manner analogous to Code M for Shuttle. However, as discussed above, this approach is based on the assumption that Code S owns all resources and not just those associated with revenue-generating commercial reimbursable.

If user resources are instead allocated to the using Codes, Code S does not establish prices or sell resources to anyone except commercial reimbursable. How, then, are prices for Station resources determined? Are prices even necessary or beneficial?

The answer to this question has two parts. First, the problem of establishing an appropriate pricing policy for non-NASA Station usage still exists. In addition, this report argues that it is very beneficial to allow and encourage trades or barters of Station resources among the various users, both domestic and international, who have been allocated resources. This will lead to much more productive and efficient Station use as mutually beneficial trades are executed.

Thus, the second step in the Station pricing policy is to allow each Code to trade or barter its initial allocations with other Codes and with the international partners. That is, internal NASA codes should not be constrained to actually use their allocated resources. Each Code can trade with other Codes and partners to assemble that bundle of resources which it finds most advantageous. The initial allocations determine only "chips" which each user category representative brings to the table. Actual usage of resources will very likely be much different than initial allocations as the various user communities voluntarily execute trades of resources to their mutual benefit.

2.9 BUYING AND SELLING RESOURCES

Execution of barter trades among the partners and user Codes will establish relative resource values (e.g., 1 first-priority man-hour -- 2 first-priority KWHs; or 1 first-priority KWHs -- 4 third-priority KWHs). However, it will not establish dollar values or prices for resources. This can happen only if the resource owners are allowed to buy and sell their allocated resources for dollars. Thus, if Code R needed more power but could not execute a barter with another user, it could instead offer to purchase that power. Another Code or partner may find

the money more attractive than whatever Station barter Code R had previously been offering.

This pricing policy component, while optional, offers several important advantages. First, it allows those Codes who value Station resources to purchase allocations of all resources larger than their initial share and vice versa for Codes (or partners) who value Station resources less than alternative methods for carrying out their missions. Thus, if Code E finds it can efficiently accomplish a mission independently of the Station while Code R sorely wants more Station resources than it is allocated, a sale of resources between these Codes may allow this to happen while pure barter may not. In addition, establishment of market determined monetary values for Station resources will give clear indications to Congress, NASA and Code S about the value of Station resources to users and, thus, in which directions the Station should (and should not) grow.

Monetary exchanges are a much more efficient trading mechanism than are bilateral barters. A bilateral barter can only occur if two traders can locate each other such that each has exactly what the other wants. Attempts at bilateral bargains inevitably lead to intermediate trades where each trader is attempting to assemble a bundle of goods that it believes it can trade for the bundle it really wants. It is the inefficiencies inherent in such bilateral barters that led to the introduction of money in prerecorded history.

If purchases and sales of Station resources for money are not allowed, it is very likely that the difficulties inherent in bilateral barter will prevent otherwise advantageous trades from occurring. To ameliorate this effect several alternative institutional arrangements can be explored, including estab-

lishment of a Station resource broker (possibly Code S) who makes market (trades on both sides) for Station resources; or a computerized bulletin board on which all offers for barter trades are continuously posted and on which transactions are consummated.

With any bidding or bartering policy, an inherent commitment to the buyer (user) that the resources will be available at a fixed point in time must be avoided. Such a policy must include a "best effort" or "buyer beware" caveat that will allow flexibility in the Utilization Planning process to accommodate the buyer. Omission of such caveats will lead to user dissatisfaction so they may not be accommodated as they expect. Inflexibility in accommodating the users will lead to inefficiencies in Station utilization because of the need to schedule other users around the commitments. Because of the nature of bidding processes and their interactions with the development of anchor points in the Shuttle and Station manifests specific categories/priorities which describe the flexibility of being manifested should be part of the resources being auctioned.

2.10 STATION OPERATIONS COSTS

It is tempting to relate pricing of Station resources to the costs of Station operations. Ideally, should not sale of Station resources cover the costs of operating the Station, at least for the portion of Station users who are subject to charge?

In reality, there is little to support such an argument. Private firms must not only recoup operations costs but also their capital investment costs from sales revenues if they are

to survive in the long-run. But even this private full-cost recovery analogy is of little relevance to public enterprises such as the Station.

Pricing policy as described in section 2.11-A. is not aimed primarily at cost recovery. Its explicit goal is design and operations coordination. With any pricing policy, operations budgets should be appropriated by Congress for Code S in the normal fashion. Although Code S only sells its resources to commercial reimbursable users, Code S must still have an operating budget for the entire Space Station.

Furthermore, it is probably unrealistic to assume the nation would allow a Station shut-down in response to slack demand for Station usage, given an alternative arrangement where Code S was dependent on sales of Station resources for all or portions of its operating budget.

2.11 SPACE STATION PRICING POLICY

How would a pricing policy be designed to facilitate Space Station design and operation? It is possible to suggest several feasible policies. This section outlines policies and points out several potentially useful variations. This report concentrates on a pricing policy designed for the operations phase of the Space Station.

A. Pricing for U.S. Commercial Users -- Auction Approach

Code I is charged with responsibility for representing U.S. commercial cooperative users in the pricing policy discussed above. A portion of Station resources should be allocated to Code I for this purpose as determined by Congress and the

Administration. Code I, in turn, should allocate these re-
sources to commercial U.S. users to promote commercial develop-
ment and use of space.

Congress and the Administration have established U.S. space
policy to include explicit promotion of private space commerce.
Code S should be responsible for commercial reimbursable users
that will raise revenue for NASA. A portion of Station re-
sources should be allocated to Code S for this purpose.
Appropriate techniques for such promotion are a matter of
dispute.

Many economists have argued that the government should not
involve itself in selection of commercially promising ventures.
Within this view, only the private firm considering a
commercial activity can make an informed judgment of its
commercial prospects. The best external reflection of the real
attractiveness of that activity is the amount the firm will pay
to enable it.

Thus, by this view NASA should establish a pricing policy
which, in effect, sells Station resources to those firms who
will pay the most for them. An obvious approach is to estab-
lish an auction process for commercial allocation of Station
resources tailored to the characteristics of Space Station.
Those firms which bid the most get the resources.

Several such auctions designed specifically for the Station are
under investigation. One approach would allow potential
commercial customers to place a bid for a combination of
services and resources to be provided by Space Station. The
commercial customer would specify both the resources desired
and the total price he will pay. Code S is tasked to select

that set of users which maximize the net revenue collected. If all or a portion of the bids do not exceed minimum levels of cost reimbursement required by Congress or the Administration, those bids may be rejected, although the methods by which such minimum bids are set can fundamentally undermine the purpose of the policy if not carefully designed.

As mentioned above, implementation guidelines and details for such an auction remain to be developed. These custom-designed features can have major impacts on the success of policy, however, with respect to both the difficulties inherent in administering the policy and in its substantive effects on the efficiency and management of Space Station. For example, requirements for high levels of cost reimbursement may discourage commercial bids. Congress and the Administration can use the auction results to gauge the value Station use has to the commercial sector.

However, some, including many NASA managers, will object to the basic premise for this type of commercial promotion, i.e., that government should not help select commercially promising ventures. Suppose Holiday Inn or another hotel chain outbid all other firms for exclusive use of the commercial allocation of Station resources? Would this satisfy the charge of Congress for commercial sector promotion? Two effects are mingled in this example. First, it would seem advantageous to avoid monopolization of commercial Station use, say, by limiting any firm to a fraction of the total commercial resources. Second, should NASA develop a process to decide hotelry or any other potential commercial space endeavor (divorced from questions of safety) not worthy of support? Or equivalently, that certain selected commercial ventures should be favored with government support? An auction process avoids such judgements, which may

be appropriate especially if the firm wishes to keep the results of its activities secret or if it anticipates commercial revenue and profits. For non-proprietary applied R & D a government subsidized peer review process is more appropriate.

There are three major disadvantages of an auction-type policy. It is difficult to compare individual bids in order to select the best experiments if net revenue is not the best measuring factor. Auction policy is more difficult to implement than posted prices. And, long range planning suffers because there is no predictable price.

B.   Price For U.S. Commercial Users -- Cost Recovery Approach

Background - A key question to address in any issue of pricing policy is: "Why charge at all?" There are actually several ways to address this issue: First, the Federal government provides services and products for the express purpose of promoting general welfare of the public. In some cases, the services and products provided do not exclusively benefit the general public, but rather, address the narrow needs of one group or individuals. Congressional committees and Presidents have repeatedly stressed their concern that the costs associated with providing such special services and products to narrow groups or individuals should not be borne by the general taxpayer. Subsequently, fees are charged to users for at least part of the costs of providing these services. Statutory requirements and authority for user charges are discussed in detail in section 2.12.2. Essentially, these statutes state that interpretation and implementation of policy is within the authority of the NASA Administrator as legislated in the NASA Space Act of 1958.

Second, user charges can also be a useful economic tool to determine whether special benefits provided by the government can meet the test of the market place. A product or service provided free of cost could create its own demand, which, in turn, leads to higher costs of maintaining those benefits. However, charging a fee for the benefits requires users to make an economic decision on the worth of that service or product.

Third, NASA budget limits may constrain the successful operation of the Station unless NASA recovers an appropriate level of cost.

Pricing based on cost recovery in some form has also been the stated goals of previous Administrations, Congress and NASA. Before developing the policy of cost recovery, however, NASA reviewed the position of other government agencies for their respective pricing policies. A representative list of these federal agencies and the types of costs previously recovered are contained in Table 2-1.

Objectives of Cost-Based Policy - The following contains some of the major objectives that should be addressed in the Station pricing policy.

(a) Recover reasonable and appropriate costs -- The system must be insensitive to minor changes in number of customers, compensate for uncertainties in forecasted operating costs, and adjusted periodically to increase appropriate level of cost recovery.

(b) Create fairness and equity in pricing -- Prices should be related to cost of services, similar prices for similar services, and consistent prices for repetitive services.

(c) Remaining competitive -- A rate structure economically attractive to a wide variety of users.

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FEDERAL AGENCY	INDIRECT COSTS				DIRECT COSTS	
	OVERHEAD	RETURN OF CAPITAL INVESTMENT	INTEREST ON CAPITAL INVESTMENT	DEPRECIATION ON EQUIPMENT	DIRECT PERSONNEL SUPPORT	MATERIALS
NASA	X(1)			X	X	X
ATOMIC ENERGY COMMISSION	X	X	X	X	X	X
BUREAU OF MINES (DIVISION OF HELIUM)	X	X	X	X	X	X
TENNESSEE VALLEY AUTHORITY	X	X	X	X	X	X
U.S. PARK SERVICE						
U.S. MINT	X			X	X	
PANAMA CANAL CO.	X		X	X	X	
U.S. FOREST SERVICE						
DEPARTMENT OF DEFENSE	X		X	X	X	X
GOVERMENT PRINTING OFFICE	X				X	X
MILITARY AIRLIFT COMMAND					X	X
FEDERAL AVIATION ADMINISTRATION						

Table 2-1. Outline of Costs Recovered From Outside Users
(Does not necessarily reflect current pricing policies)

(d)   Maximize efficient use of available resources.

(e)   Market stimulation -- flexibility to stimulate market development in specialized areas (cooperative agreements, deferred payments, etc.).

It is the contention of this option that a policy which is based at least partially on cost recovery can meet these objectives, and provide reasonably low cost access to space within the context of traditional NASA pricing policy framework.

NASA And User Considerations:

The foundation of cost-based pricing policy contains many various and sometimes conflicting considerations and objectives for NASA and the user community. NASA considerations:

1.   Internal establishment of long term fiscal and operations controls.

2.   Formalizing standard requirements and attempting to anticipate future requirements.

3.   Cost/risk implications and scenarios.

4.   Efficient use of Station resources (power, crew time, weight, etc.).

User considerations:

1.   Assurance of long-term policy stability -- price and charging algorithm

2.   Guidelines for efficient (and less costly to the user) payload design and operational constraints.

3.   Availability and frequency of service/resources.

4.   Certainty of projected schedules.

Pricing Concept - Although the cost recovery based concept seems relatively straightforward, several products must be generated to effectively evaluate the proper level of cost recovery and the subsequent price based on this cost. Some of the reports that should be produced for Station are:

- o Station operations costs

- o Cost sensitivity to user mix and traffic rate

- o Budget impact

- o Government and taxpayer risk assessments

- o Cost recovery alternatives for Government and non-Government users

- o Resources definitions.

If cost recovery is chosen as the preferred option, the question then centers around the level of cost reimbursement. Previous NASA policies have focused on: average cost of operations (Phase 1 Shuttle policy), out of pocket cost of operations (Phase II Shuttle policy), value of service, and full cost.(early ELV Programs and Shuttle optional service).

Many variations also exist on these options that have been investigated. Examples of variations include the appropriate period of cost recovery, the class of user (DoD, Commercial, etc.), the types of costs to be included in the cost database, and methods of amortization where appropriate.

In addition, one of the most difficult areas to evaluate on the Station is the question of resources: packaging, pricing, and availability. NASA faced similar though less complex situation when the Shuttle policy was in the development stage. One of the early scenarios was to price services (or groups of services)

independently. This theory was discarded because of the
complexity to estimate, measure, and price each service, and
customers were unsure of the price stability and availability
of the services. Therefore, it was decided to base the price
on the most critical resources: Shuttle length and weight.
The same could be accomplished for the Station by choosing the
critical resources or by packaging the resources. Although
NASA used length or weight as the critical resources for
charging purposes, all other Shuttle resources were packaged
into two large sets: standard and optional services. A user
was entitled to a pro rata share of these standard services
based on their utilization of the greater of the two critical
Shuttle resources. These examples serve to illustrate that
although pricing and accounting for the many varied resources
may be extremely complex for Station, packaging of resources is
a viable alternative.

The Advantages of this a policy are summarized as follows:

1. Posted prices allow users to perform long range budgeting
   and planning.

2. Algorithms can be developed to incentivize efficient use of
   critical resources.

3. It is relatively simple to implement; costs are estimated
   and allocated among users by simple formula designed to
   attract sufficient Station use by outside customers.

4. Arguments are reduced to the appropriate level of cost
   reimbursement and the methods available for predicting such
   costs.

5. NASA can argue that "costs are recovered."

The disadvantages of such a policy are: The focus on cost
recovery seriously undermines the development of a pricing
policy which promotes coordination among Station and its users.
Buyers and sellers respond in several important ways to the

incentives inherent in the prices they pay or receive. If we
do not design the policy explicitly to use these effects to the
benefit of Station design and management, then the policy may
lead to suboptimal results. For example, present Shuttle
pricing policy has led to:

1. Payload designs which effectively conserve use of Shuttle
    weight and length but with insufficient attention given to
    effective use of other Shuttle resources.

2. Inversion of Shuttle program pricing objectives to serve
    commercial instead of internal science users.

3. Pressure to constantly make exceptions to the policy to
    "incentivize" one deserving user or another, placing NASA
    in the position of selecting which activities are most
    likely to result in successful commercial space ventures.

These drawbacks are central to the dissatisfactions voiced by
present Shuttle users and operators.

The following section 2.12 addresses specific issues that have
been raised concerning an appropriate Space Station pricing
policy.

2.12 SPECIFIC PRICING POLICY ISSUES

This section addresses specific issues that have been raised
with respect to Space Station pricing policy. Several have
already been discussed in the previous chapter and are reempha-
sized here. Others are addressed for the first time.

2.12.1 Is Cost Recovery an Appropriate Primary Goal for Space Station Pricing Policy?

The traditional NASA pricing approach is full cost recovery,
which satisfies Congressional and fiscally conscious Government

agencies such as OMB. Charging full cost recovery price provides an incentive to Station operators to find ways of reducing costs, thereby lowering prices and increasing demand. There would be no outcry from taxpayers that foreign and commercial users are being subsidized. In addition, full cost recovery influences commercial payload designers to reduce consumption of resources that are priced. However, the prices may be high, discouraging small budget organizations and giving the appearance that Space Station is only for large organizations or NASA and its partners who will not be severely affected by these high prices.

In light of this, NASA could base a pricing policy on recovering long range marginal costs, thereby keeping costs to the user of space research lower. However, NASA could be accused of subsidizing foreign and commercial users in the near term. It also provides fewer incentives to control near-term operations cost since there may be no relation to price. Experience during Shuttle showed that there was a conscious attempt to keep cost per flight down, since cost increases impacted cost per flight and, therefore, Shuttle prices.

NASA also could develop a discriminating price policy that would benefit specific users who might contribute the maximum benefit to NASA and its partners. This approach could be easier to sell to Congress and Space Station partners, and could provide more benefit to mankind. A drawback to this policy would be that it might be difficult to implement initially, would obviously require greater cooperation among users, and would foster disagreements on who and what determines benefits.

Past experience within NASA seems to indicate that no matter what policy is developed, the NASA administrator must be responsible for its implementation and have the authority to make exception on a case by case basis or for a class of users that may benefit the program.

The preceding sections have argued, however, that cost-based pricing policies do not provide adequate information and incentives to result in a smoothly running and manageable Space Station. For this reason, market based policies that abandon posted prices (substituting custom designed auctions) should be investigated.

2.12.2 What Laws and Regulations Restrict NASA's Choice of Station Pricing Policy?

The constraints that Federal statutes and regulations place on NASA pricing policy lend themselves to interpretation. Therefore, the question ultimately is which one governs and in what circumstances. The following summarizes the sometimes conflicting regulations:

The "User Charge Statute" (Title 31) requires that Federal government agencies recover "all reasonable costs" for services rendered or property leased or sold. One of the documents that implements this statute is OMB Circular A-25. In summary the circular states that:

> Where a service provides benefits . . . above and beyond those which accrue to the public at large, full cost recovery should be imposed. A cost recovery charge should be imposed when a Government-provided service:
>
> 1. Enables a party to obtain more immediate gains than those which accrue to the general public; or

2. "Is performed at the request of the recipient and is above and beyond services regularly received by other members of the same industry or group, or of the general public . . . "

The responsibility for the development of these charges rests with the individual agencies. Therefore, each agency has the responsibility to identify the services covered, determine the benefits provided, determine costs, and establish the charges.

The Space Act of 1958 appears to provide NASA a greater amount of flexibility to establish prices, benefit relationships, and policy. Section 203(c)(6) allows the NASA Administrator to make judgements in determining the value of a particular service to the government (and, therefore, the public) and to establish a suitable pricing policy based on that determination. Traditionally, the Administrator has judged that cost recovery (in some form) is the guideline for non-NASA users. However, the Administrator does appear to have the flexibility to alter this cost recovery approach if he determines that an alternative market-based approach better promotes the goals of the program and the general welfare.

Nevertheless it appears that abandoning cost-related pricing would be difficult primarily because of NASA tradition.

If NASA decides to implement a charging policy contrary to OMB Circular A-25, it will probably have to seek at least tacit approval from OMB and Congress.

2.12.3 Should Individual Station Resources Be Priced Separately?

Discussion and negotiation of Optional Services for Shuttle flights has involved a substantial amount of managerial time.

The discussions encompassed determining the definition of optional services and implementation from requirements defini-tion to final billing. Because NASA wanted to keep the Shuttle cost per flight as low as possible the data base only included costs associated with what was required by NASA to process the STS system. Payload interface services beyond what NASA required were outside of the cost data base and therefore not part of the cost per flight. Payloads were required to negotiate separately with KSC or private suppliers for the price of these interface services. That approach can be used on Space Station and may keep costs of these types of services lower since users will be more cost conscious if they are paying extra. However, just as in the STS program there would be a requirement for measuring how much each user obtained. NASA tracked costs on ground and flight operations, while users of Spacelab measured resources allocated to individual payloads. If a new metering and monitoring system is required for billing purposes, the extra cost should be balanced against the accuracy obtained (See section 2.12.9). A task to estimate these costs should be established.

A separate pricing policy may be required for standard and optional services as currently done on STS. Scare resources may be priced at greater than operations costs recovery while others may be supplied as part of the baseline Station.

A simple pricing policy option NASA might entertain is to add a percentage of transportation costs to cover all Space Station costs. This would cover resources expended on orbit and those ground costs that NASA supports. There are some advantages to this type of system as there would be no need for a formal approval, tracking, billing and validation system for individ-ual users of many services. Station operations would be funded

as part of the overall program costs. All users would have an incentive to keep STS transportation costs as low as possible. Users who use ELV's for transportation will require a separate policy, such as a multiplier based on their mass or volume.

Packaging of services into a single product for sale is advantageous under one of the following combination of conditions:

Condition A.   Demand for use of the services occurs in constant proportions.

Condition B.   The integration or transaction costs of purchasing separate services is relatively high.

Condition C.   One of the services has an inelastic demand (tie-in) or is a monopoly service, such that net revenues can be increased by packaging.

Condition A is equivalent to a standard service package based on demand characteristics. For example, car purchases include at least four tires as a standard service since they must be consumed in order to drive the car. As another example, haircuts sometimes include a shampoo as part of the package. In general, Condition A implies consumption typically must be performed in a sequence or as a combined item.

Condition B relates mainly to the costs of searching, purchasing and integrating a group of services to get a product. For example, one does not purchase an oil change by separately contracting for manpower, oil, floor space, electricity, etc. Furthermore, the owner does not want to negotiate a contract of services for an oil change with each of his customers, given the routine nature of the package.

Condition C is a strategic tool used by monopolists (e.g., patent holders) to increase their net revenue. If an entrepre-

neur develops a new component, he can either sell the component
to those businesses that can use it, or he may choose to enter
those markets and be the only supplier of the enhanced product.
For example, when IBM made the first computers they also
developed special punch cards that would operate the machine.

For Space Station, it is clear that demands for resources will
not be uniform for all users. Furthermore, many payloads will
have various designs available which will result in alternative
resource demands. That is, many payload demands will not be
routine. Thus Condition A will generally not be present for
Space Station.

Some payloads, however, may lend themselves to packaging which
will maintain efficiency properties of price signals and reduce
transactions costs. For example, a "standard" satellite
service or launch from the Station may be very routine and
require a specific set and amount of services to be produced.
If a set of resources is packaged into a single service, the
package cost should be equal to the sum of the cost per re-
source used to make the package.

The main point here is to weigh the price signals provided to
designers to influence designs and resource use against the
reduction in contractual and manifesting hassles from standard
packages of services. In order to allow for the correct
signals about the relative scarcity of resources, packaging
should be confined to those activities which have routine and
constant proportional requirements for resources.

2.12.4 How Should the Use of Polar Platform Resources Be Priced?

It is anticipated that the Earth Observing System Program of the Office of Space Science and Applications (Code E) will be the primary user of the polar platform supplied by the U.S. Space Station. Code E has undertaken negotiations with the National Oceanic and Atmospheric Administration (NOAA) and with earth observing and other space scientists in Europe and the U.S. These negotiations have resulted in preliminary agreements: 1) allocating various scientific objectives and instruments to the polar platforms to be supplied by NASA and ESA, and 2) the coordination of NASA science and NOAA operational instrument selection and operation. In addition, NASA is investigating various methods by which commercial participation in the polar platform can be encouraged and accommodated to the mutual benefit of science and commerce.

These discussions and negotiations should result in simultaneous determination of polar platform resource allocation and prices for outside use of platform resources, if any. Thus, it appears appropriate to allow the evolution of a unique pricing policy for polar platform use, designed to the unique requirements of the polar platform and its payload complement.

2.12.5 What Pricing Policy is Appropriate for DoD and other Government Agencies?

Use of Station by other government agencies, including DoD, is likely. If explicit allocations of resources to users are adopted, DoD and other agencies will require allocations in order to conduct their space Station missions.

How will they reimburse NASA for the costs of supporting their missions? NASA has faced this issue before with respect to DoD and other agencies use of Shuttle and other NASA resources. A policy has been established to negotiate with these agencies a fair or adequate level of cost reimbursem:nt.

In practice, these negotiations center around reimbursement to NASA of direct costs incurred to support the missions. Fully allocated overhead and development costs are not included in direct costs.

It appears appropriate to continue use of this space policy for Space Station. NASA should negotiate recovery of direct costs incurred to support explicit allocations of Station resources to other government agencies.

Note that depending on the policy adopted for pricing to commercial users, other agencies may pay more for use of Station than commercial firms. For example, an auction policy with no or low minimum bid requirements could lead to this result.

2.12.6 What Pricing Policy Options Are Feasible?

The feasibility of a pricing policy is a matter of degree which depends on the requirements needed for its implementation, as well as legal and political constraints. What options are available, and what are their pros, cons, and implementation requirements?

Cost-Based Pricing. This option considers expenditures as the primary stated determinant for setting prices. One method frequently used is that of fully-distributed (allocated)

pricing. This alternative develops the total cost of providing services over a specified period (e.g., annual, bi-annual, . . .), using historical data that is adjusted for predictable future changes. The total cost is then allocated to the various services and user classes based on the direct cost of production and an allocation of overhead costs. A price per customer class and product is then determined so as to cover this cost. If costs are difficult to predict, this policy places the risks of absorbing overruns on Station.

A second method of determining cost-based pricing is that of long-run marginal cost pricing, defined as the cost of providing additional capacity, including operational costs and a capital charge for Design, Development, Test and Evaluation (DDT&E). This method is usually considered to correctly signal the scarcity of resources and the expansion of capacity to meet demand. This cost basis generally requires no arbitrary allocation of costs and is forward-looking; i.e., costs are based on replacement cost or opportunity cost. In general, this method does not allow for the recovery of cost when common cost and/or economics of scale are present. This policy leads to efficient use and growth of the Station, if the system can easily expand to meet demand. (Excess demands are infrequent or easily met.) On the other hand, if excess demands occur at these prices, use must be rationed by other means such as first-come, first-served.

Demand (Benefit) Based Pricing. The methods described in this section allow prices to be sensitive to the demand (relative benefits) in the market. For example, a hook-up may be imposed in conjunction with resource prices at long-run marginal cost. The hook-up fee is based on the benefits to the user of Station resources. In order to determine this fee, however, benefit data is required which may not be easily determined.

An alternative method for recovering cost while maintaining efficiency is the adjustment of marginal cost prices based on the sensitivity of demand to price changes (elasticity of demand). This type of pricing is referred to as Ramsey pricing in the economics literature. Again, extensive demand information is required to determine these charges.

Other demand-sensitive methods use information concerning system constraints. For example, if demand varies by time so that at some periods demand is slack (excess capacity), while at other capacity is strained, costs should be shifted to "peak" periods (peak-load pricing). Another example which is more relevant to Space Station is the pricing of priority service. If the output being sold has varying levels of reliability during operations, so that curtailment may be necessary, pricing of priority in the queue is an important consideration. The prices offered for high priority would signal the demand by users for system reliability.

Finally, methods are available which directly use demand information to select and manifest users: auction processes and iterative price adjustments. These procedures allow prices to adjust using demand information submitted by users. One procedure for Space Station would place up for bid a fixed capacity of resources and a time span in which they will be available. Users could then submit requirements and bids via an electronic bulletin board and a provisional manifest. A user can get on the provisional manifest by bidding for unused capacity or displacing payloads with lower bids. The market would close when either no new bids are forthcoming in a specific time interval or a time limit is reached possibly at random. Another alternative would involve the use of a set of posted prices and demands: prices are adjusted until the demand

information received equals supply. Both of these methods are driven by demand information and are best employed when the number of users is not large, excess demand is prevalent (or demands vary considerably over time), capacity adjustments require long lead times, and products for sale are "standardized" (not unique by period).

Table 2-2 provides a list of the options discussed above along with pros and cons of the policies.

2.12.7 How Should Shuttle and Station Pricing Policies Interact?

It is clear that contracts for the use of Station resources and transportation to and from the Station are linked. That is, a contract for a payload's use of Station resources is worthless without a concurrent contract for transportation services. The converse is true for any payload requiring Station services.

Given that Station and Shuttle services are linked in this manner, the price of either service will affect the use of the other. If Shuttle services are scarce, this will have a direct impact on the design and selection of payloads. In particular, relatively scarce or expensive launch services should cause payloads to conserve on launch mass, logistic support, and return, while using Station services more intensely. Pricing downweight high would increase demand for storage facilities on orbit, would increase the selection of payloads with long durations on Station, and would increase requirements for data returns only or onboard analysis.

Hence, the price of transport services affects the types of payloads that are viable and their resource requirements. High

TABLE 2-2

POLICY	DESCRIPTION	PRO	CONS
Fully-Allocated Cost Scarcity and - Full Ops Cost - Full Cost-Development - Full Cost	Costs are allocated to specific products (or users) and price is determined to cover this cost	Easy accounting procedures and calculations	Prices not related to scarcity provide wrong growth signals
Marginal Cost (MC)	Prices are based on incremental cost of service	Helps in directing expansion of service	Does not assist in short-run rationing, priority, or cost coverage
Marginal Cost plus Hook-up	Usage priced on MC with a flat rate fee per period by user	Helps in directing expansion and may cover cost	Not responsive in short-run
Ramsey Pricing	Price is based on MC and demand elasticity	Helps in cost recovery and growth decision	Requires extensive demand information (no resale permitted)
Priority Prices	Usage priced by variable cost plus fee for each unit/time per priority class	Assists in curtailments operations, and optimal use of capacity	Requires priority fees to be sensitive to demand (no resale permitted)
Auction Process	Fixed capacity and time frame is open to bids by users	Assists in short-run rationing of services and expansions - optimal use of capacity	Requires active participation of users in understanding bidding process
Peak-Load Price	Usage charge based on variable costs and demand charge for peak use	Assists in smoothing of demands and pricing of capacity	Price adjustment needed

Shuttle prices will promote the use of ELVs, closed Station
environment loops, increased Mean Time Between Failures
(MTBFs) and repair in orbit. If these price signals are
suppressed, the search for these alternatives and payload
designs can be hampered.

In order to firmly establish this link, transportation and
return services should be part of the resources offered by the
Station, or at least part of the Station manifesting process.
Prices for all the services should be coordinated and
determined simultaneously. NASA is considering plans for
combining all agency operations. As part of this, it would be
logical to develop an integrated pricing policy for all agency
operations.

2.12.8 Should Station Prices be Guaranteed by NASA Ahead of
        Actual Operations or Should Actual Incurred Costs be
        charged?

Fixed or guaranteed pricing of services was used by NASA to
stimulate use of Shuttle. Shuttle users know the flight cost
may change but the price does not after a Launch Service
Agreement is signed.

This approach also should be applied to Space Station and would
make it easier for the user to plan and budget. It would,
also, make it easier for NASA to negotiate, price services, and
bill the user. However, fixed pricing on the basis of costs
requires NASA to develop a good cost data base and may result
in NASA not charging enough to cover actual costs (as was the
case in Shuttle).

Another method, employed originally in the Expendable Launch
Vehicle (ELV) Program, was pricing all services on actual cost

incurred. This has two advantages, results in no risk to NASA, and it does not require that the requirements definition be as accurate in the early planning stages since prices are not fixed. However, under this method, the customer does not know his total launch liability until the project is complete.

2.12.9 Should Metering Requirements for Pricing of Space Station Resources be Set?

Three pricing policy options can be considered concerning metering: (1) full metering, (2) partial metering, and (3) a pricing policy based on some method other than metering. Each option has issues that should be addressed and evaluated.

Full metering would embrace monitoring of individual payload usage of data, power, cooling, and similar resources. This approach takes advantage of JSC 30000, Section 3.5.1 which directs Space Station and platforms to provide for monitoring and protecting of all interfaces that provide resources. Several issues arise. One is location -- should we meter at the Space Station or payload side of the attachment interface? Spacelab users already incorporate automatic monitoring of actual resource allocations to payloads. Should the Station require (and trust) all users to provide such data, or is it more cost effective to supply this metering service on the Station side of the interface? Another issue is level -- what are the benefits associated with monitoring at the user level versus the hardware costs of required monitoring equipment (e.g. higher launch costs, higher servicing costs, and higher data processing requirements)? The level of detail of the metering must be defined. Some resource usage (e.g., thermal), even if directly metered, may not be 100 percent determinable because of parasitic heat loads or losses or because of inaccu-

rate and costly monitoring sensors and equipment. Power usage probably represents an acceptable "measure" of heat rejection use by payloads employing active cooling, given the difficulties and costs inherent in directly measuring active heat rejection use at the payload level.

Partial metering may provide adequate monitoring for some pricing policies with partial metering. Billing is based on either one (e.g. power) or a few key resources. The issues are similar to those with all resources metered. However, the determination of what to meter implies that NASA knows ahead of time which ones are critical, scarce or most highly valued. In addition, a policy for effectively allocating the unmetered resources must be developed.

The third option available is to price resources without reference to metered or measured usage. An "overhead allocation" scheme could be implemented. Fairness should be addressed. Who pays for what at what rate? Also, are the scarcest resources being priced and are the price signals affecting user behavior? What is the best level of allocation; are the right groups getting the appropriate pricing signals; can overhead assessment be tied into the size, quantity and timing of resources; what exceptions are there, and are thermal resources adequately covered?

Thus, metering requirements for Station depend on three factors:

    a. The form of user contracts/charges

    b. Accountability of the delivery of services

    c. Costs of metering

If contracts for Station resources are based on actual consumption (flow) of resources by a payload, then metering will be essential in accounting for payment. Without metering capabilities, charges could not be correctly assessed.

If peak load pricing (See section 2.12.3) is to be instituted, it will be necessary to monitor not only the cumulative flow of resources but also the time and peak amount. This form of pricing policy will necessarily require metering payload resource use.

If pricing contracts are written such that user is given rights to some fixed amount of resources over x years, and must pay for these whether they are used or not, then minimal monitoring capabilities are necessary for implementing the policy.

Nevertheless, monitoring of payload resource use must still be implemented to insure compliance of payloads to their operational envelopes. Also, compliance with international agreements will require metering of resource use. Given the variations in resource use over the life of a payload, metering devices will most likely be required by the users themselves, similar to the practice of Spacelab users.

All of the above reasons for metering/monitoring resource use must be weighed against the cost of metering. However, given that most or all of the sensors needed for metering are already planned or required for other than pricing policy reasons, along with a sophisticated computer/data system for tracking use, and given that any additional hardware involves small additional costs, the costs of metering appear minimal in light of the ultimate hassles that will surface without such accounting.

2.12.10 Should a Minimum Bid be Established if an Auction Pricing Policy is Adopted?

In addition to the traditional approach of setting prices at a level dictated by cost recovery or an auction with no "floor" bid, one could adopt an auction including minimum bids. This minimum would be useful in minimizing the risk that the Government might "give away the farm" if supply exceeds demand. It also allows for early corporate planning based on costs at least equal to the required minimum bids. It reduces the need for judgments of the promise of commercial ventures by the NASA Administrator as might be required in an auction with no floor, and would probably be more politically and legally defensible in the NASA environment.

There are several alternatives in determining a minimum. It could be a form of cost recovery (full, marginal, "out of pocket", etc.). Resources can be priced in discrete packages, using weight, volume, or some other gauge. The minimum could be set low enough to encourage commercial use of Station but sufficiently high to cover some basic cost elements, and could be adjustable once the market is better defined. The best method for setting minimum bids has not been determined.

Finally, past experience has established that customers want to know the price of NASA services, and that this information is essential for their planning.

2.12.11 What Congressional approval of Station pricing policy Should be Sought?

As mentioned in section 2.12.2, NASA may require approval from Congress for the Station pricing policy.

The traditional approach is that the initial pricing policy is approved by Congress and then NASA implements the policy within guidelines. This approach gives NASA the latitude to change particular prices, and requires NASA to seek approval only once with Congress. If NASA adopts a traditional method of pricing, approval by Congress should not take an unusual length of time. However, if a unique pricing policy is developed it may take a significantly longer period of time to receive Congressional approval.

An alternative would be for NASA to determine the pricing policy and pricing rationale without seeking Congressional approval. This provides more flexibility in pricing, and allows NASA to quote prices quickly after policy adoption. However, Congress may object and NASA could be pressured for political reasons to make concessions to a specific user or class of users. This, in turn requires NASA to develop implementation procedures that are specific, manageable, and workable.

2.12.12 When Should NASA Develop Algorithms and Data to Support the Pricing Policy?

Pricing policy should be adopted and implemented before significant activity is required by users with respect to designing and building payloads. Given that Station is to be ready for use before 1995, payloads must begin development soon. Thus, a pricing policy and the tools necessary to support it deserve immediate attention. Some of these tools will also support Station during its design and development phases and aid coordination of payload and Station design.

<u>Design to Lifecycle Cost Process.</u> A policy based on long-run
marginal costs can help direct users and subsystem designers to
conserve scarce resources in their decisions concerning Station
and payload design. If payload and subsystem designers are
provided incentives to incorporate these estimates of relative
scarcity in their decisions, then they will seek designs to
minimize the costs their decisions place on the Space Station
system. For example, if payload sponsors had to pay for the
EVA hours their payload will require, they will attempt to
redesign their payload (automate) or select an alternative
payload mix to conserve use of EVA resources.

If the requirements data Mission Requirements Data Base (MRDB)
is updated using the decisions sensitized by these prices and
subsystem capacities, and if designs are adjusted using the new
requirements (payload and housekeeping), then a more efficient
Station can be constructed. Management of this process
requires cost models and cost/engineering integration models
which generate required cost and design trade information.
Development of such models requires significant time and
effort, and should be initiated immediately.

<u>Payload Planning.</u> Considering the long lead times required to
develop and construct a space-qualified payload, users will
need early information concerning the cost, reliability, and
availability of Station resources prior to committing their own
resources. Hence, as soon as NASA can obtain accurate esti-
mates, NASA should provide the availability and price of
resources on a computerized bulletin board (or scheduling
program) accessible to users to make planning decisions. If
auctions are adopted, they should occur prior to payload design
and development. The sooner such a system is in place, the
sooner relevant data can be obtained so that future accommoda-
tions can be planned.

Contract Formation. On a very practical level, while a bulletin board can provide information for planning, it will not be taken seriously unless the provided information can be acted upon. That is, users will want NASA to commit to a contract for future resources as soon as they finish initial planning. Also, the only way NASA will find out who is really interested in using the Station is to sign binding contracts with users.

While the early signing of contracts with users provides planning information, it can leave the parties exposed to risks. In particular, if NASA does not "guarantee" the allocation of resources, users are asked to bear the risks of resource contingencies. On the other hand, if NASA guarantees prices and delivery, then it will bear the risk of possible contingencies.

In order for NASA to offer such contracts and their associated provisions, it will require knowledge about chances of contract fulfillment and costs. Thus, NASA should be developing models and updating costs and availability data as soon as possible to determine the risks it is willing to take.

2.12.13   Should Pricing Policy Be Phased?   How Long Should Prices Remain Constant?

Pricing policy phasing should be considered in order stimulate participation, influence design, and keep U.S. Government costs as low as possible.

New programs usually are broken down into two phases: Development and Operations. Sometimes when a new technology is initiated, an interim transition phase evolves or the operational phase slips. This occurred during the Shuttle Program,

Separate pricing policies can be initiated for each period in
order to stimulate growth in particular areas such as life
science or materials research. User mix can be influenced by
NASA pricing policy.

Although pricing policy phasing gives NASA flexibility, it also
requires NASA to maintain the repricing infrastructure for
longer periods of time. It would be more troublesome politi-
cally if NASA is required to obtain Congressional approval on
each policy charge. Such a policy would restrict user ability
to forecast accurately the long range costs on Space Station.

One phasing option is to have one pricing policy and reprice
only at certain intervals (such as was done for Shuttle).
There would be fewer political problems if the pricing policy
is not changed and user's long range planning would be more
certain. However, there would be less flexibility, and NASA
may be restricted on how they deal with the other Space Station
partners.

3.0 MARKETING STRATEGY OVERVIEW

3.1 DEFINITION OF MARKETING

Classic: Activities that quantify and qualify markets, which
in turn attempt to actualize potential exchanges for the
purpose of satisfying human needs.

NASA: The marketing function determines and defines those
segments to the science, technology and commercial communities
which can utilize the Space Station facility. This determina-
tion is based on the economic and technical capabilities of
both NASA and the potential user. The marketing function takes
the user up to the point of the final sale.

3.2 OVERVIEW

The SSOTF Marketing Subpanel has examined policy options and
developed a strategy for Space Station Marketing.

The policies and strategies proposed are based upon accepted
private sector marketing operations. They are designed to use
the present marketing infrastructure and to cooperate with
existing offices to adequately promote the Space Station.

In conducting this task the marketing subgroup identified
potential users by technical discipline, investigated various
organizational marketing options, analyzed various agreement
and insurance issues, and developed an end to end marketing
strategy.

These are the major recommendations of the Marketing Subpanel.

1. The first is to establish the Office of Associate Adminis-
trator for Marketing, reporting to the Administrator. This
office would be structured upon acceptable private sector
marketing guidelines. The AA for Marketing would set policy
and be responsible for basic market research and development
activities, investigate new user opportunities, emerging
synergistic relationships and future facility requirements.
All other marketing related functions will be responsibility
the Office of Space Science and Applications (Code E), Office
of Commercial Programs (Code I), Office of Aeronautics and
Space Technology (Code R), and Office of Space Station
(Code S).

2. Establish within the Office of Space Station a marketing
support group. This group within the Space Station user
development and accommodation division would receive policy
guidelines from the AA for Marketing.

The goal of the group is to stimulate, cultivate and sustain
participation by reimbursable private sector companies engaged
in commercial, technical and scientific areas, and the DoD and
other governments and agencies desiring Space Station services
in conjunction with the existing offices of Codes I, E, and R.

The objectives would be to:

Identify potential users in the commercial reimbursable commu-
nity, DoD, other governmental agencies, and developer/opera-
tors.

Create an environment that stimulates utilization of the
facility.

Develop evolutionary recommendations for the Station user or developer/operators.

The Space Station Marketing Support Group (SSMSG) would market actively to the commercial reimbursable community, commercial developers/operators, and other government agencies. Also, other individual user communities; i.e., science, cooperative commercial, and technology which will be the responsibility of the cognizant program offices (Codes E,I, and R, respectively), based on specifically defined allocations in cooperation with the SSMSG. The SSMSG will coordinate the individual program office requirements, and act as a focal point for new Space Station user development and user feedback.

3.3   INTRODUCTION

The SSOTF Marketing Subpanel examined policy options and developed the elements of an end-to-end strategy for Space Station marketing. This approach is based on our understanding of the Station as a "user friendly" facility designed to serve the needs of the scientific, commercial and technical communities. Our approach is based on accepted private sector marketing programs. Work involved four primary tasks:

1.   <u>Identification of potential users by technical discipline</u>

The subpanel conducted a computerized literature search, compiled a bibliography, contacted users and advisory groups, reviewed existing studies, and integrated this information into user-by-discipline matrix. The task results are summarized under Section 3.4.

2. Investigation of a variety of organizational options for management of the Space Station marketing group

The subpanel conducted a survey of existing NASA marketing organizations. An essential part of this survey was to research NASA's past marketing efforts. This information is presented in Appendix C. The subpanel then investigated several organizational options and discussed the pros and cons of each option. These options are summarized in Section 3.5.

3. Analyze agreements and insurance issues studying the potential impact on Space Station marketing activities

For agreements, the subpanel surveyed the inventory of existing contracts used by NASA, compared these instruments with the users identified in Section 3.4, and developed a baseline list of agreements and framework to generate ideas for agreement terms to encourage private sector utilization of Space Station.

The subpanel identified major insurance issues, canvassed outside sources for innovative concepts and ideas, and developed recommendations for NASA management action. This information is contained under Section 3.8.

4. Development of an end-to-end marketing strategy

For this task, the subpanel searched databases for related reports, developed specific program elements, compared the program elements with reports, reviewed the organizational options developed under Section 3.5, and the contracts and insurance issues developed under Section 3.8. In Section 3.6 the subpanel delineate the marketing participant roles and responsibilities. Based on the above information, the subpanel

developed an end-to-end marketing strategy. This information
is contained in Section 3.7.

3.4 POTENTIAL USERS CATEGORIZED BY TECHNICAL DISCIPLINES

A successful marketing strategy must be supported by a compre-
hensive database. This database should include, among other
elements, current customers, short and long-range market
analyses, and summary information on potential users and
companies potentially benefitting from the space environment.
While the marketing subpanel did not develop a complete data-
base, they investigated two key elements essential to both the
strategy development and Space Station policy. These elements
include the identification of currently known potential users
and a review of potential users according to technical disci-
plines; reflected by NASA's Codes S, E, R, and I. These disci-
plines were grouped into six major categories with hierarchical
subcategories. Table 3-1 depicts the result of this analysis.
Included in Appendix A, is information pertaining to the
potential applications of technical disciplines. Additional
information can be obtained from the attached bibliography in
Appendix B.

3.5 MARKETING MANAGEMENT OPTIONS

The subpanel considered a number of options for the management
of the Space Station Market/Support Group (SSMSG). These
options indicate various ways to support the marketing func-
tion by defining an overall approach to Space Station market-
ing policy and decision-making. These options do not propose a
specific strategy for organization of the marketing function
(e.g., organizational charts, specific NASA centers, etc.)
Rather, they illustrate different organizational concepts for

POTENTIAL USERS

TECHNICAL DISCIPLINES		NASA	DOD	OTHER GOV'T	INDUSTRY	INT'L PARTNERS	INT'L NON-PARTNERS	ACADEMIC & RES. ORGS.
MATERIALS PROCESSING IN SPACE	BIOTECHNOLOGY	●	●	●	●	●		●
	COMBUSTION SCIENCE	●	●				●	●
	ELECTRONIC RESEARCH	●	●	●	●	●		●
	FLUIDS & TRANSPORT	●	●			●		●
	GLASSES & CERAMICS	●	●	●	●	●		●
	METALS & ALLOYS	●	●	●	●	●		●
EARTH SCIENCE & APPLICATIONS	EARTH/OCEAN OBS. SYSTEM	●	●	●		●	●	●
	SOLAR & COSMIC RAY PHYSICS	●	●	●		●	●	●
ASTROPHYSICS	PLASMA PHYSICS	●	●					●
	ASTRONOMY	●				●	●	●
AUTOMATION & ROBOTICS	INDUSTRIAL SERVICING	●			●	●		●
	DESIGN/OPERATIONS	●			●	●		●
COMMUNICATIONS	COMMUNICATIONS SYSTEMS	●	●	●	●	●	●	
LIFE SCIENCES	HUMAN FACTORS	●	●	●		●		●
	PHYTOLOGY	●		●	●	●		●
	ANIMAL SCIENCE	●		●	●	●		●
	BIOMEDICAL	●	●	●	●	●	●	●

Table 3-1. USER/DISCIPLINE MATRIX

Space Station marketing. This section briefly describes the following options and presents the advantages and disadvantages associated with each: Corporate NASA Approach, Separate Code S Marketing Function, and the Commercial Allocation Approach. From these options, the subpanel developed a hybrid approach. Refer to Sections 3.6 and 3.7 for a thorough description.

3.5.1 Corporate NASA Approach

With the Corporate NASA Approach option, NASA Headquarters retains total control of market research and market development initiatives. One Headquarters office is responsible for end-to-end marketing activities for all NASA's endeavors. The focus of this responsibility will be the securing of commitments from all targeted user groups to utilize the Space Station (SS) for scientific research, industrial applications, technology developments and national security. As a means of developing firm commitments toward Space Station use, promotion of existing facilities (Shuttle, aircraft, drop towers, etc.) will be initiated to perform proof-of-concept experiments.

Two suboptions within the corporate NASA approach are as follows:

In-House Support

NASA Headquarters will develop and implement a plan utilizing in-house personnel of Headquarters and Field Centers. Headquarters will be responsible for establishing the original contacts with potential users and for subsequent user follow-up with an appropriate NASA Field Center. Corporate discussions will be held by Headquarters personnel and a senior user decision-maker. Further discussions of Space Station or

Shuttle use involving resource allocation and technical
requirements will be the responsibility of an appropriate Field
Center, with Headquarters supporting these discussions. NASA
Headquarters will be responsible for all final decisions on
accommodation arrangements for committed users.

Advantages:

o Eliminates third party considerations that may inhibit
   NASA's decision-making processes

o Provides the surest means of maintaining close
   cooperation necessary between the marketing function
   and NASA Space Station program, especially with regard
   to the engineering/technical base, NASA policy, and
   budget development

o Least expensive in near-term

o Represents the U.S. Government directly to the user.
   The user will develop a one-on-one relationship with
   NASA and Field Center personnel. Requirements and
   decisions are made directly with those in charge of
   developing and operating Space Station elements. For
   NASA, this suboption gives the individual engineers
   opportunities to understand specific payload
   requirements.

Disadvantages

o NASA's proven marketing capability is limited and lacks
   qualified personnel to work private sector marketing
   issues.

o NASA's bureaucracy is not designed for commercial
   operations. Legal requirements not imposed on the
   private sector may constrain commercial activity.
   Also, this suboption may lead to another bureaucratic
   layer that may impede transfer to the private sector.

.o Users with limited resources (commercial, academic, and
   science/technology) cannot afford the time and money
   required to attend extensive meetings and may discover
   difficulty responding to NASA's complex technical
   requirements and paperwork.

o Field Centers may feel that their roles are diminished by this approach. Each cognizant Code may feel reluctant to surrender any control over the marketing of their own specific projects.

NASA Headquarters Uses Third-Party Intermediary for Developing and Implementing a Marketing Plan

With this suboption, NASA Headquarters retains control of the marketing functions but contracts with a third-party intermediary to encourage user interest, explain the benefits of using the Space Station and NASA resources, and introduce the user to the Space Station selection process. Support will be provided by both contractor technical personnel and NASA Field Center personnel. The contractor will assist in devising short term projects for potential users utilizing ground-based laboratories and facilities as well as the Shuttle. The contractor would work closely with the NASA Headquarters marketing office and be directed by Headquarters policy.

Advantages:

o Provides established and experienced marketing function with some degree of flexibility

o Makes use of the existing network of field centers for policy implementation and, with contractor support, assists in developing potential users

o Reduces NASA's marketing requirements

o Represents a step toward possible private sector commercialization

o Allows NASA to concentrate on science/technology research and development activities, while the contractor focuses on those functions that can be separated from NASA day-to-day control

o   Spares the user community from dealing with a multitude
    of NASA personnel and provides a single point of
    contact for all issues before the users are actually
    selected for the Shuttle or Space Station

Disadvantages

o   Increases separation from engineering/technical base
    development processes

o   Space Station and Shuttle operations may not be mature
    enough to permit stable contractor role

o   Increases cost to NASA

o   Field centers may view their roles diminished by this
    suboption, and each cognizant Code may be reluctant to
    surrender any control over marketing of their specific
    projects

3.5.2.   Separate Code S Marketing Function

With this suboption, the marketing function for Space Station
will be provided solely by Code S. User development is con-
trolled by Space Station Working Groups and Task Force for
Scientific Uses of Space Station (TFSUSS) whose goal is to
identify, encourage and support potential Space Station users.
Users interested in additional NASA capabilities will be
directed to the appropriate NASA office. Similar to the first
option, a third-party intermediary may be selected to assist in
specific marketing activities. Outreach activities will be
accomplished by peer groups or field center personnel involved
in Space Station activities.

Advantages:

o   Ensures close cooperation between marketing function
    and the Space Station Program, especially in the areas
    of Space Station policy, resources, accommodations,
    services, and budget development

o   Represents the U.S. Government directly to potential
    Space Station users

o   Assists in the development of new Space Station users
    through existing network of field center personnel
    available to assist in the development of new Space
    Station users

o   Reduces confusion about whom the user must deal with in
    order to fly on the Station

Disadvantages:

o   Duplicates other codes' efforts without an overall NASA
    marketing strategy

o   Confuses users by the many available contacts and the
    seeming lack of cohesiveness in scope and presentation

o   Separates Space Station from other NASA capabilities
    and excludes the considerations of the fundamental
    agency role: Space Station is dependent upon so many
    of NASA's other capabilities, including launch
    facilities and the Shuttle

3.5.3   Commercial Allocation Approach

This suboption proposes approaching utilization of the Space
Station by enhancing the commercial incentives of a business
venture to develop users. With this option, NASA negotiates an
envelope of capabilities with a single firm or multiple private
firms who will derive profits from marketing and developing
users of the available capabilities. Either in-house NASA
options described above will provide marketing functions or
user development for NASA personnel.

The first step in establishing an appropriate organizational
structure is to define the available capabilities of the Space
Station in terms of interest to commercial users. NASA would
then announce a tentative partition of these identified
capabilities into amounts available for commercial science and

technology users, DoD, and international users. NASA will also determine and announce a pricing structure for these capabilities.

Based on the tentative partition, commercial firms (and perhaps eventually science, technology and international markets) will be invited to propose business arrangements to use the available capabilities. Businesses will be able to suggest and negotiate alternative partitions based on their own market research, as well as negotiate prices. All arrangements will occur between the commercial bidder and the private firm selected to market and allocate the resources.

Today, commercial use of space is a speculative venture. A private firm's decision to participate in this program without NASA support is unlikely. Thus, the organizational structure of the private firm necessarily will evolve from the relative success of the venture. Initially, the private firm will act as a government contractor with its costs covered, but with its profits tied to success in user development. To encourage the firm, NASA should propose a pricing scheme for the Space Station capabilities that rewards the firm for marketing success. For example, the firm could have the right to purchase additional resources at cheaper prices, or discount negotiated partitioned prices based on a volume basis over a period of time.

NASA plays a crucial and unfamiliar role in this organizational scheme. First, NASA must agree to surrender partial control of its assets. Second, NASA must encourage actively an outside agent to market to its programmatic offices, negotiate with the offices for supporting science and technology, and provide a basis for deriving a profits from government program.

Advantages:

- o Provides established and experienced marketing
  functions with flexibilities not available within
  government

- o Increases sales through profit motive

- o Separates commercial interests from traditional NASA
  science/technology users, allowing each type of user to
  work in a comfortable sphere

Disadvantages:

- o Calls for significant changes in NASA's traditional
  role. To be successful, NASA must surrender control of
  a certain percentage of its Space Station and Shuttle
  resources

- o Prohibits commercial firms from negotiating changes
  resulting from unexpected events

- o Assumes Space Station and Shuttle operations are mature
  enough to permit stable private sector role

- o Degrades user confidence by dealing solely with a third
  party intermediary

3.6 MARKETING PARTICIPANT ROLES AND RESPONSIBILITIES

3.6.1 Background

The concept of marketing has broadened over the past several
decades, and has become a discipline that is no longer merely
devoted to increasing sales. The original definition of
marketing is "the performance of business activities that
direct the flow of goods and services from producer to consumer
or user."[1] However, this definition is currently viewed as

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[1] Committee on Terms, Marketing Definitions: a Glossary of
Marketing Terms (Chicago: American Marketing Assn., 1960)

restrictive, since it confines marketing to business activities and is commonly interpreted as applying only to commercial interests that supply a commodity. Because marketing has been viewed in this light in the past, many public institutions and governmental agencies, NASA included, have not applied suffi- cient efforts toward the development of an appropriate market- ing strategy.

The currently held view is that marketing is a relevant disci- pline for all organizations insofar as the organization can be said to have users or a product. Marketing itself then, is specifically concerned with how transactions, or exchanges are created, stimulated, facilitated and valued.[2] Given this definition of marketing, it becomes clear that NASA's business of supplying and encouraging the use of ground and space-based systems and related expertise must be properly marketed to insure optimal use.

3.6.2   Definition of Marketing as Applied to NASA and the Space Station

In this report, the subpanel offer an approach for marketing of the Space Station that embraces the broader view of the marketing concept. Marketing, therefore, is a function that should be researched and included in the overall Space Station operations plan, and that should be actively and interactively supported throughout the life of the Station.

As defined throughout this report, a distributed marketing function, supported by NASA Headquarters and each of the program offices, will determine, define and encourage those segments of the science, technology, and commercial communities that can effectively utilize the Space Station facility. This determination will be based on the economic and technical capabilities of both NASA and the potential user. Responsibil- ities of the marketing function include identification of potential users, research, development and implementation of the marketing strategy, and monitoring of user relations/ support. The marketing function, as envisioned by this subpanel, is responsible for the user up to the point of selection.

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[2]   Kotler, Philip, "A Generic Concept of Marketing," Journal of Marketing, April, 1972.

3.6.3 NASA Marketing Function: Assistant Administrator for Marketing

An effective market strategy must begin at the corporate level in order to provide uniform direction for each of its divisions. To adopt this approach, it is recommended that the marketing function within each NASA Code, receive direction from an agency-wide source.

An end-to-end marketing strategy would start with the establishment of an AA for Marketing (AAM) that reports directly to the Administrator's Office. The overall objective of this function would be to determine and disseminate policy and guidelines to stimulate and encourage use of NASA's ground and space-based systems. The AAM would develop a continuous and evolutionary planning effort supported by the NASA Codes responsible for accommodating users in ground and space systems under their management.

Field Centers provide support and facilities in the technical disciplines associated with their expertise. Additional support and commercial expertise should be provided by appropriate external professionals. This marketing planning effort should also involve those individuals from the NASA Codes who will implement the AAM policies in the science, technology, and commercial communities. By involving the implementers in the initial planning effort, marketing policies will be propagated to all parts of NASA. This will contribute to the success of the policies and guidelines determined by the AAM.

The establishment of a NASA Marketing Function (NMF) will greatly facilitate the entire agency's marketing efforts. Central agency-wide directives will eliminate redundant

C - C

marketing activities and will be of particular value to the
Space Station since the Station will require a unified NASA
effort to assist and direct potential users towards a
commitment to on-board operations. Specific responsibilities
and organization of the NMF is beyond the scope of the SSOTF;
however an agency-wide marketing effort is a fundamental
element of a successful marketing strategy. Whether or not
such an office is established at NASA Headquarters, a Space
Station marketing function is essential to stimulate partici-
pation by the science, technology, commercial and commercial
developer/operator communities.

3.6.4   Space Station Marketing Support Group (SSMSG)

Working within the policies and guidelines set by the AAM, the
Space Station Marketing Support Group will be responsible for
end-to-end marketing of the Station to commercial reimbursable
users, commercial developer/operators, and other government
agencies. The science, technology and U.S. commercial coopera-
tive communities will be marketed directly to by their respec-
tive codes, with support from the SSMSG. The distributed
marketing organization is represented in Figure 3-1.

In the recommended distributed marketing system, the Space
Station Marketing Support Group has primary responsibility for
the creation of an environment that stimulates utilization and
development of the Space Station. For commercial reimbursable
users, commercial developer/operators and other governmental
agencies, the SSMSG has primary responsibility for identifica-
tion of potential users. After identifying a pool of potential
users the SSMSG must then create an environment that responds
to the potential user's questions and inquiries, offers
direction and assistance and develops general informational

SPACE STATION MARKETIⁿ ORGANIZATIONAL CHART
RECOMMENDED APPROACH
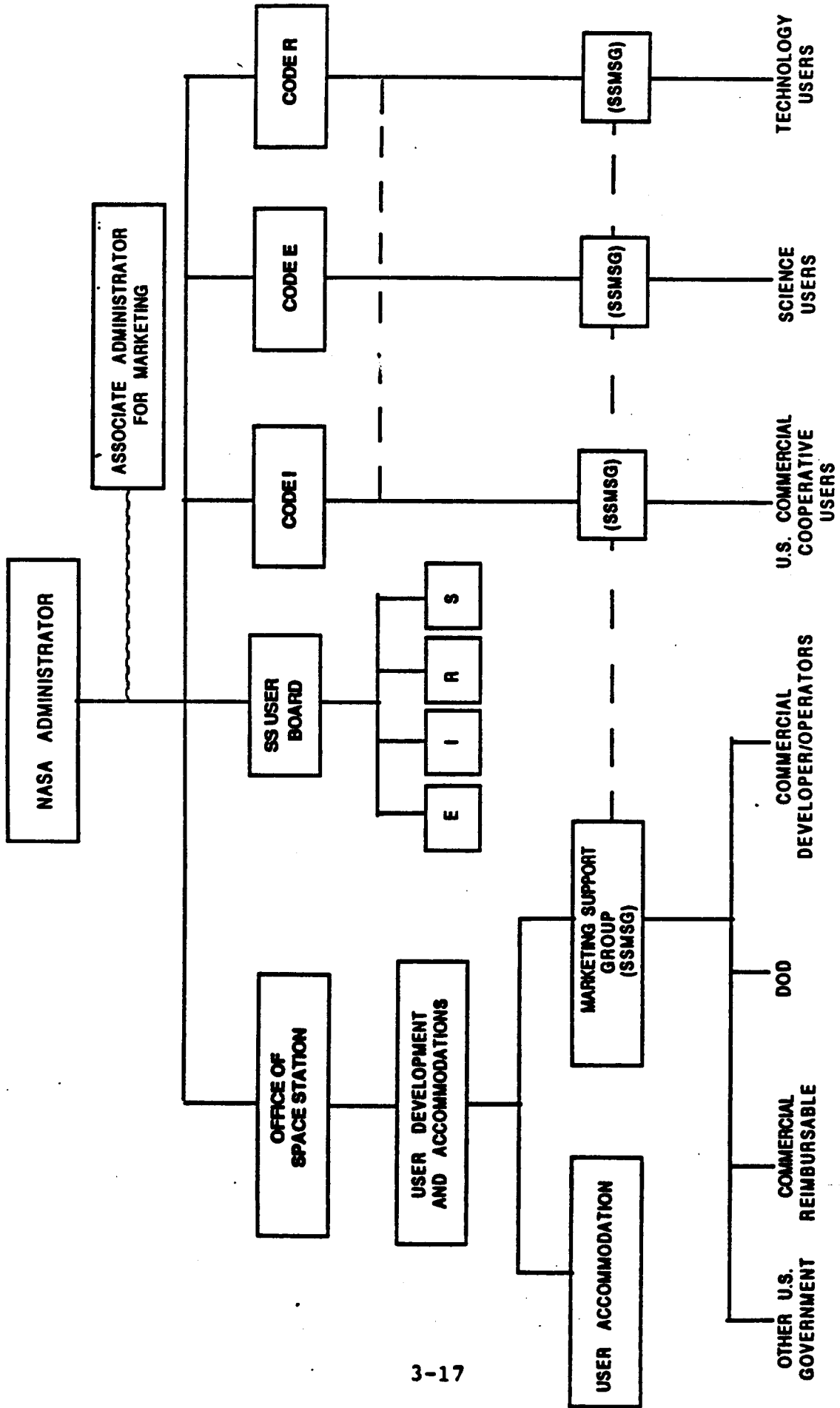
Figure 3-1

materials on the Space Station as well as detailed technical
information on the available user services.

3.6.5   Space Station User Board

The function of the Space Station User Board (SSUB) is to
determine the allocation of Space Station resources to each
NASA Code. Allocations are based on a prioritization process
developed by the SSUB, which is composed of representatives
from each program office. (See Figure 3-1) By defining
allocations, the SSUB plays a role in defining each Code's
potential users. Program Offices will be held to their
allocation, thus the allocated resources are the only ones that
can be marketed. Therefore, potential users will be further
defined as a result of the resources available to each Code.
To ensure an evolutionary process, the Program Offices will
feed information back to the SSUB to aid in the allocation
process.

3.6.6   Other NASA Program Office Marketing Responsibilities

NASA Program Offices will utilize the information developed by
the AAM in order to carry out their responsibility for
end-to-end marketing to their potential Space Station users.
Users are defined in cooperation with the AAM SSMSG, as well as
the SSUB who defines the resource allocations.

For example, the Office of Commercial Programs (OCP) is respon-
sible for all domestic commercial companies utilizing the
Space Station via agreements developed by that office, so long
as this use is within the OCP allocation. The Office of Space
Science and Applications (OSSA) is responsible for all science
users entering the Space Station through the OSSA allocation.

Likewise, the Office of Aeronautics and Space Technology (OAST)
is responsible for all technology users of the Space Station
through the OAST allocation.

Each Code will remain solely responsible for identifying and
supporting users not (currently) interested in the Space
Station.

3.6.7 Interactive Process Between the AAM for Marketing and the NASA Codes

Space Station will be central focus of the agency far into the
foreseeable future. In order to ensure that Space Station
marketing is a success the AAM for marketing must be supportive
and cooperate within the infrastructure depicted in the dis-
tributed organization in Figure 3-1. Also, as illustrated by
Table 3-2, this office will have certain primary and supportive
roles that cooperate with the participating offices of Codes I,
E, R, S and M as well as the users and NASA Field Centers.

The basic function of setting overall agency policy and guide-
lines by the AAM determines its primary role for market re-
search and development. Once the first two tasks of Table 3-2
are complete user assessment, implementation, identification of
future projects and user relations/support become the responsi-
bility of the appropriate cognizant codes.

Table 3-3 illustrates the relative levels of involvement
between the AAM and the Code that has responsibility for the
selected class of user that is being marketed to. For example,
if potential U.S. commercial cooperative users are being
researched, this table represents the transfer of responsi-
bility for marketing from the AAM to Code I's marketing support
group.

INTERACTIVE PROCESS BETWEEN NASA MARKETING (AA)
AND COGNIZANT CODES

TABLE 3-2

P = PRIMARY RESPONSIBILITY S = SUPPORT RESPONSIBILITY	E	I	R	S	M	AA FOR MARKETING	USER	FIELD CENTERS
• MARKET RESEARCH 　• RESEARCH 　• ESTABLISH TARGETS 　• STRATEGIC PLAN	S	S	S	S	S	P	S	S/P
• MARKET DEVELOPMENT 　• TARGET VISITS 　• FOLLOW-UP 　• IMPLEMENTATION PLANS 　• POTENTIAL PROJECTS 　• FINANCIAL ASSESSMENT	P	P	P	P	P	P/S	P	P + CONTRACTOR
• USER ASSESSMENT 　• TECHNICAL ASSESSMENT 　• SELECT PROJECT 　• STRUCTURE AGREEMENT 　• NEGOTIATE AGREEMENT 　• CLOSE THE DEAL	P	P	P	P	P	S	P	S
• IMPLEMENTATION 　• RESOURCES 　• MANIFESTING 　• FLIGHT/OPS	S	S	P	S	P	S	P	P
• FUTURE PROJECTS	P	P	S	P	S	P	P	S
• USER RELATIONS/ SUPPORT	P	P	P	P	P	S	S	S/P

RELATIVE LEVELS OF INVOLVEMENT BETWEEN NASA MARKETING (AA) AND THE COGNIZANT CODES

TABLE 3-3

	MARKET RESEARCH	MARKET DEVELOPMENT	USER ASSESSMENT	IMPLEMENTATION	FUTURE PROJECTS
				CUSTOMER RELATIONS	

NASA MARKETING (AA)

COGNIZANT CODES (E,I,R, & S)

0 - LEVEL OF LEAST INVOLVEMENT

1 - LEVEL OF MOST INVOLVEMENT

During the market research phase, the AAM has the primary responsibility for activities involved in identifying potential users. During the market development phase, the cognizant Code becomes more involved in the marketing process and assists in defining an applicable strategy, planning target and follow-up visits to potential users and beginning a financial assessment of potential users. It is during the user assessment phase that primary responsibility for the marketing effort shifts to the Code. The crosspoint on Table 3-3 is not meant to indicate a specific time when the transfer is to occur; rather it represents a gradual shift of responsibility. Thereafter, the Code has primary responsibility for implementation of the marketing strategy, development of future projects for that Code, and for ensuring and sustaining customer relations. In order for this market cycle to be truly effective, the AAM and the Code's market support group must work in tandem. Each group needs interaction and support from the other to ensure that the appropriate class of user is being identified and marketed to.

3.7 ELEMENTS OF AN END-TO-END MARKETING STRATEGY

3.7.1 Strategy Program Elements

The next step in organizing an approach for developing a Space Station marketing strategy is the identification of the major program elements. To accomplish this task, the subpanel developed specific program elements based on a search of NASA and other databases for reports on marketing, in general, and Space Station marketing, specifically. The subpanel reviewed generally accepted marketing theory with the University of California, Berkeley (UCB) Graduate School of Business Administration and compared the database information with UCB provided information. Based on this process, the subpanel

developed Figure 3-2, which represents the major elements of our marketing strategy and how these elements interact in an end-to-end approach. See Appendix E.

For the purposes of this report, the elements of the end-to-end strategy are described under four major topics; Database, Objectives, Implementation, and User Satisfaction. Each of the major topics are described below:

Database - Any high technology activity is based, at a minimum, on an accumulation of information which describes the product or service in terms of capabilities and should contain information on the market reactions to the product or service. Since marketing of the Space Station is no different in this report, it is imperative that the AAM and Space Station marketing function compile, organize and distribute information on capabilities of the Space Station and the markets response to this capability. Both technical information and market database activities are required to market effectively the Space Station. The subpanel recommend that this information be contained in an electronic database assessable from several remote locations.

Technical information answers the question, "How do I do it?" for the following issues: Training, manifesting, transportation, interface requirements, system performance, payload return, and safety requirements. This information is found in all Space Station marketing materials.

The market database contains information on the user's reaction to the product: the committed and potential users, user concerns, and rate of utilization. Additionally, long term marketing opportunities and major user concerns that may motivate these opportunities are identified.
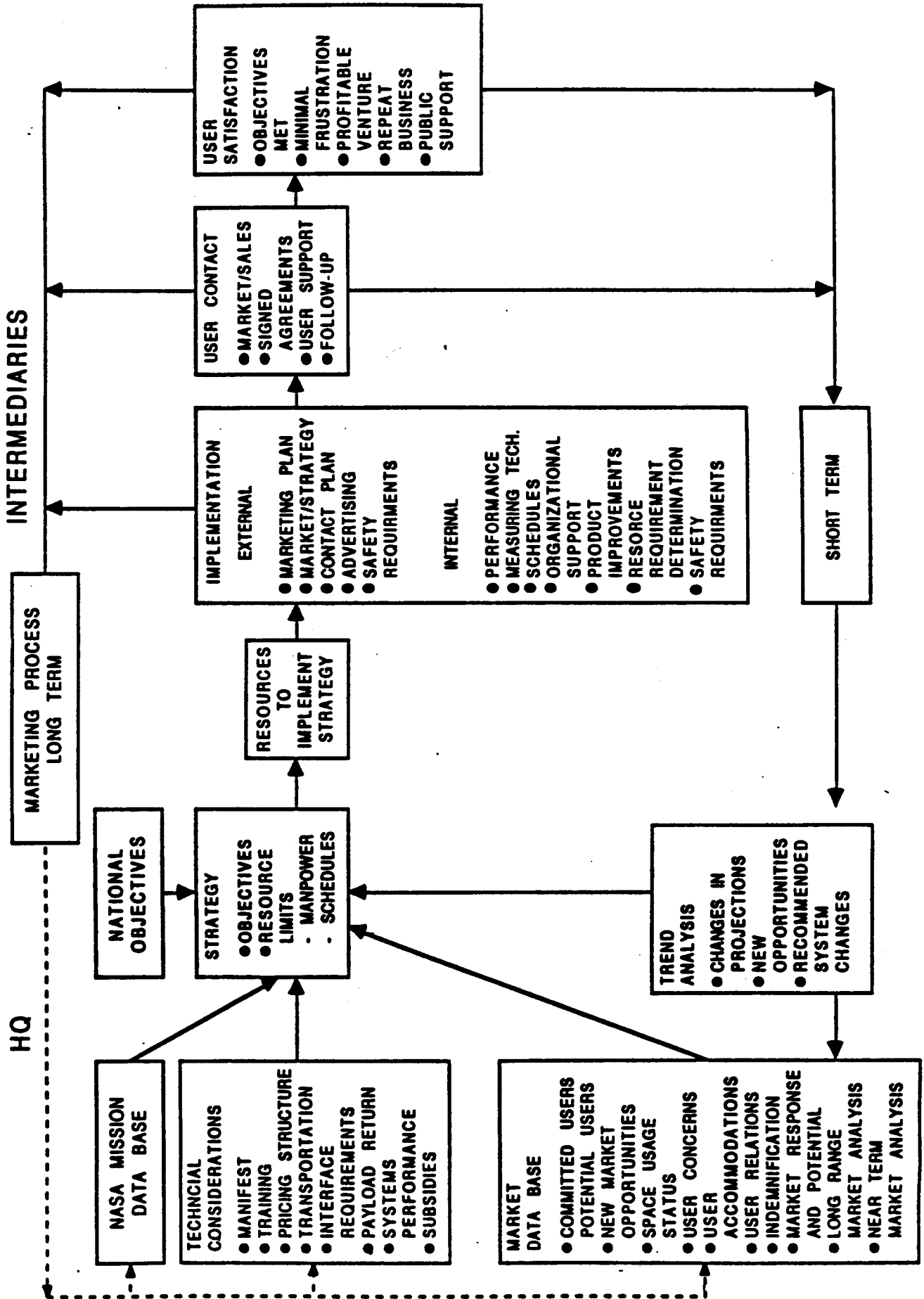
ELEMENTS OF AN END TO END SPACE STATION MARKETING STRATEGY

FIGURE

Objectives - The United States objectives for Space Station
utilization are communicated to the SSMSG via the Space Station
Program office, the SSUB and the AAM. Within the framework of
these objectives, the Marketing Office will develop strategies
and tactics which support the national NASA objectives.

The SSMSG develops strategies and tactics based on technical
consideration, market database and trend analysis. Technical
considerations and market database are described under Section
3.4. Trend analysis is the systematic accumulation of informa-
tion on how users prefer their needs to be satisfied.

Implementation - Implementation of the marketing strategy, for
the purposes of this analysis, can be described in two primary
elements: internal and external. These primary elements are of
equal importance and require close coordination to implement
the marketing strategy effectively and efficiently.

External implementation focuses on marketing policy, market
segment strategy, advertising and contract planning. As
illustrated in Figure 3-1, the subpanel recommends that the
Space Station Marketing Support Group develop marketing
materials that will be used by the program offices in marketing
to their specific constituencies. In addition, marketing
policy, market strategies, and contract plans can advertise
those elements to be marketed directly to other government
agencies, commercial developer/operators and DoD.

Internal implementation focuses on organizational support,
product improvements, resource requirements, determination, and
schedules. After external commitments are made, the marketing
organization must work the internal NASA system to ensure
timely delivery of the product or service.

<u>User Contact</u> - User contact by the SSMSG is focused on potential or actual commercial developer/operators, DoD, and other government agencies. User contact with other users identified in the discipline/user matrix will be undertaken by the cognizant program offices (see Table 3-1).

3.8 AGREEMENTS AND INSURANCE ISSUES, INCENTIVES AND RECOMMENDATIONS

This section is broken into two parts: agreements and insurance. For both agreements and insurance areas, the subpanel present a brief description of the terms, major issues needing NASA examination early in the Station program, possible incentives, and recommendations. The incentives primarily will be targeted at the private sector. However, to a lesser degree, some incentives will need to be devised to encourage utilization of the Space Station by the academic community. Typically, academic institutions respond to grants and cost-sharing agreement incentives.

3.8.1 Agreements

A variety of agreements or contracts between the various users and NASA will be necessary to set parameters of terms and conditions governing use of the Station. Although all of the agreements discussed will not necessarily be defined as legal contracts, the terms "agreements" and "contracts" will hereafter be considered to be interchangeable.

A minimum number of different agreements to accommodate all the users is desired. The following are current agreements used by NASA which may be used collectively as a basis for the required Space Station agreements. Summaries and outlines of these agreements are included in Appendix D.

1. Space Shuttle Launch Services Agreement

2. Space System Development Agreement (Modified Launch Service Agreements)

3. Joint Endeavor Agreement

4. Small Self-Contained Payload Launch Service Agreement

5. Memorandum of Understanding with Foreign Government

6. Technical Exchange Agreement

7. Industrial Guest Investigator Agreement

8. Department of Defense Memorandum of Agreement

9. Memorandum of Understanding between NASA and other Government Agencies

In the near term, four basic types of agreements are recommended for Space Station users. They are: 1) reimbursable agreements, 2) cooperative agreements, 3) memoranda of understanding, and 4) special or unique agreements for a particular user or class of user, such as the DoD. The following is a description of each of the four agreements.

Reimbursable Agreements - Reimbursable agreements provide for the sale of Space Station accommodations to science, commercial and foreign users. Key provisions will include financial arrangements, responsibilities; scheduling, allocation of risks, intellectual property rights, and applicable law. Users may include domestic commercial companies, foreign governments, foreign companies, and consortia of companies.

Cooperative Agreements - Cooperative Agreements provide the
terms required for cooperative ventures performed on the Space
Station by NASA and the user. NASA will provide Space Station
accommodations in return for collaboration on the experiment
and a share in the results. Different types of cooperative
agreements may be negotiated with users of different levels of
cooperation with NASA. Generally, the user will fund its
participation in the cooperative venture and NASA will fund its
involvement; however, cooperative agreements which provide for
an exchange of funds may be negotiated. Key provisions will
include responsibilities, releasable information, allocation of
risks, intellectual property rights, and applicable law. In
addition, some cooperative agreements may include financial
arrangements.

Memoranda of Understanding (MOUs) - MOUs provide for the terms
and conditions for agreement between the U.S. and other govern-
ments or other agencies within the U.S. government, and as a
precursor to cooperative agreements with private sector enti-
ties. MOUs between NASA and other governments will be used for
cooperative programs jointly pursued by NASA and an agency
within the foreign government. Key provisions in these MOUs
will include responsibilities of the parties, scheduling,
exchange of data, releasable data, and standard versus optional
services. MOUs between NASA and other government agencies will
concentrate on the responsibilities of the parties and the
working interfaces between organizations. MOUs which act as a
precursor to cooperative agreements with private entities are
useful to private entities in obtaining financial support for
the contemplated venture.

Special or Unique Agreements - Special or unique users or
classes of users will require unique agreements in addition to

those discussed above. For example, a simple two-page launch agreement for Small Self-Contained Payloads (SSCP) was developed by NASA to serve as a standard agreement for the large and diverse set of SSCP users. These agreements require a minimum of negotiation and administrative work by both NASA and the users.

Future Agreements for Operational Use - As the operations of Space Station evolve, the subpanel anticipate new agreements will be required. Several long term cases may arise, for example, Space Industry Inc.'s Industrial Space Facility will be available for long term commercial operations. Companies such as Space Industries, Inc. may wish to negotiate cooperative or sharing agreements with NASA which allow the commercially-owned space facilities to operate on, or in proximity of, the Space Station. In this example, utilization of certain Station utilities, accommodations or services and new agreements will need to be developed to meet potential long term sharing/lease/sales relationships.

Issues Concerning Agreements

   o Commercial organizations must believe that the
      government will be a reliable business partner
      committed to commercial operations on the Space
      Station over the long term. Changing levels of
      government support, policy, and terms and conditions
      create uncertainty for doing business in the commer-
      cialization of space activities

   o The Space Station Marketing Group may need to negotiate
      a variety of different types of agreements with a
      diverse set of Space Station users. Given the terms,
      conditions, and complexity of the agreements, the Space
      Station Market Development Group will require an
      effective and efficient process

o A future NASA decision to offer incentives to commer-
   cial organizations to encourage and promote use of the
   Space Station may become necessary due to potential
   competition between the Station and commercial space
   facilities

o Given finite resources, NASA cannot provide incen-
   tives to all users. NASA must develop a fair and
   equitable policy that can be used to distinguish
   between firms that should be subsidized by contrac-
   tual incentives and those that should not for any
   given project

o NASA will need to recognize and determine the dura-
   tion of incentives for a particular user, subsequent-
   ly treating the user as a commercial reimbursable
   user

o Trade secret/proprietary data protection agreements
   will become an issue for a variety of commercial
   users working in close proximity on the Space Station

Incentives Concerning Agreements

Commercialization of space activities will continue to be a
high risk activity with the potential for significant economic
returns to the nation.   Because of the high risks and poten-
tial return, NASA will need to develop incentives to encourage
and promote U.S. utilization of the Space Station. The
following lists some of the incentives investigated:

o Mitigate capital investment costs;

   - Free access to NASA facilities, equipment,
      technical expertise during preliminary R&D stage,

   - Free use of the Shuttle for R&D as a preliminary
      to use of Space Station,

   - Free or significant price break for R&D use of
      Space Station,

   - Limit application of full charge policy to
      commercial revenue generating phase,

- Encourage consortia on a given project.

o Mitigate Operating Expenses;

- Make operating expenses a function of commercial success of the project,

- Mitigate insurance costs,

- Free/low cost NASA human-tended service support,

- Mitigate transportation costs to/from the Space Station if customer elects the Shuttle as mode of transportation.

o Mitigate Effective Cost of Capital to the Private Sector;

- Government backed loans/guarantees, partially guaranteed by the government diminishes effective loan rate,

- Seek favorable tax legislation regarding investment tax credits and accelerated depreciation write-offs.

o Improve Private Entity's Realized Revenues;

- Provide some assurance of the government market for products produced on the Space Station if a legitimate government need exists for such products,

- Provide competitive advantage of domestic private users of the Space Station in government procurement actions for products other than those produced on Space Station.

o Time Value of Money Considerations;

- Offer deferred payment provision for lease, Space Station utilities, and transportation (if the Shuttle is used).

o Reduce Uncertainty for the Commercial User;

- Establish government as a reliable business partner by offering compensatory provisions if NASA cannot deliver.

o   Encourage industries to do business with NASA;

  ————— -   Run SSMSG as an effective, efficient,
            business-oriented marketing organization that
            can deal with commercial users with an absolute
            minimum of government restrictions and "can't
            do" mindset,

        -   Structure a simple agreement negotiation/
            signature process to involve only a few NASA
            officials to authorize.

Recommendations

The SSMSG should be delegated the responsibility and authority
to enter into agreements with Station users without a cumber-
some approval process whereby major offices in NASA and the
Administrator must concur on each negotiated agreement.

Guidelines should be set at the Administrator level for the
SSMSG to follow during routine negotiations. Only extreme
changes in this policy sought during negotiations should be
brought forward to the Administrator for approval.

SSMSG should be provided dedicated legal, budgetary, policy and
international relation resources with the authority to approve
Space Station agreements on behalf of their respective NASA
offices.

3.8.2   Insurance

NASA should consider the implications of insurance for a
commercial Space Station and space transportation to and from
the Station early in the Space Station program. This is
especially important today because of the problems of availa-
bility and high rates endemic to the current space insurance

industry. This section discusses the risk categories perceived
by the insurance industry, identifies the issues involved in
the risk categories, and provides some incentives for the
subsequent categories. A brief background discussion of the
insurance market is included in Appendix E, Section III.

Background Discussion of Insurance Markets

Many of the risks of doing business in space incurred by
commercial organizations are similar to the same risks of doing
business on Earth. Just as is done on Earth, many of these
risks can be transferred by means of commercial insurance.
Space Station operations will be characterized by long-term
operations with a variety of crew members and equipment from a
variety of organizations, therefore insuring those operations
will be more like insuring conventional operations on Earth.
Currently space insurance has concentrated mainly on insuring
transportation risks and third party liability. Operators on
board the Space Station will need to consider product liability,
health and medical, political risks and workmen compensation
insurance. Commercial organizations will have basically two
choices in dealing with the risks of Space Station operations.
One choice will be for the commercial firm to self-insure and
accept responsibility for the potential risks. For example,
the RCA Corporation recently assumed the risks of a new
satellite launch on the Shuttle because the company perceived
the launch insurance premiums as too high. Large companies
like RCA can afford to self-insure such a large risk
occasionally; this will continue to be difficult for small
companies. The other alternative is for the companies to
transfer the risks to insurance underwriters.

Current Space Insurance Market

The current state of the space insurance market is not good. The amount of space-related insurance capacity available has decreased to roughly $100M or approximately one third of that available in 1983. This is primarily attributable to the space insurance industry's net underwriting position, or payouts less premiums, of -$485M over the past ten years. The price for all types of space-related insurance, accordingly, has soared as insurers have set rates in accordance with a perceived higher risk and to compensate for previous underwriting losses. Consequently, the lack of adequate insurance coverage at reasonable rates inhibits space related private capital investment opportunities. Potential creditors will not finance a project without an assurance of adequate insurance coverage against various risks so that the insurance policy can be used as collateral against the loan.

Translation of Space Insurance Market Problems to the Space Station

It is true that the current state of the space risk insurance market is primarily a consequence of losses associated with the attempted placement of communication satellites into proper orbit. Notwithstanding, insurers do not appear to distinguish continual on-orbit operations from the much risker launch, deploy, early operations, or return activities. Consequently, commercial ventures aboard the Space Station will be penalized with unfairly high insurance premiums and diminished insurance capacity until these distinctions are made by the insurers.

The following represent the risk categories perceived by the insurance industry:

1. Company assets

   a. Property

   b. Personnel

2. Company income

   a. Loss of revenue/business interruption

   b. Extra expenses

3. Third party liability

   a. Bodily injury

   b. Property damage

   c. Personal injury

   d. Contractual   (

   e. Products and completed operations

   f) Errors and omissions

The main concern of the insurance industry is management of the
potential risks for commercial companies. The following
represent the significant aspects of the risk management
process:

1. Identification of the potential risks

2. Evaluation of the potential risks

3. Control of the potential risks

   a. Possible avoidance of the risks

   b. Prevention of losses

   c. Reduction of losses

   d. Transfer of the potential risks

The main insurance areas impacting commercial reimbursable Space Shuttle launches have been third party liability, property damage and the NASA requirement for all customers and participants in the Shuttle operations to agree to an inter-party cross-waiver of liability. The following gives a brief description of mechanisms NASA has used for the insurance categories.

Third Party Liability - NASA requires all commercial customers to provide $500M worth of third party liability coverage for each major commercial payload to fly on the Shuttle. NASA set the maximum limit of required coverage per Shuttle flight to $750M (changed from the original limit of $1B). Multiple customers on a Shuttle flight can pool their insurance resources to share the expense of the $750M insurance coverage. If the full amount of insurance coverage is not available commercially, NASA is authorized to provide indemnification to commercial customers for a reasonable fee. The U.S. government indemnifies customers for third party liability claims in excess of the $500M/$750M limits. NASA has become flexible in setting third party liability limits for Joint Endeavor Agreement payloads which fly in the Shuttle payload bay, and NASA has agreed to indemnify all users flying payloads in the crew cabin middeck area and payloads in the SSCP Program (Get-Away Special Program).

Property Damage - Recent launch failures led to very high insurance premiums due to increased property damage, lost revenue and personal injury claims. Presently, no NASA requirements for this coverage by commercial companies exist. In the past, NASA provided a free reflight for launch/deployment failures attributable to NASA. Also, as a special incentive for certain customers and as a replacement for the free

reflight discussed above, NASA offered a reflight at Shuttle marginal costs for launch/deployment satellite failures regardless of fault for a specified period during and after the launch.

Cross-Waiver of Liability - All participants in the Space Transportation System (STS) operations are required by NASA to agree to an inter-party cross-waiver of liability during a period defined as "Protected STS Operations". The cross-waiver is required because of the participants' work with property and employees in close proximity to others involved in "Protected STS Operations". Under the terms of the cross-waiver, each party agrees not to bring a claim against any of the other parties. Each party also agrees to absorb the financial and other consequences for damage it incurs to its own property and employees as a result of participation in "Protected STS Operations". Cross-waivers apply irrespective of whether such damage is caused by NASA or other customers involved in "Protected STS Operations" and regardless of whether negligence was involved. The cross-waiver applies to all contractors and subcontractors at every tier of the parties participating in "Protected STS Operations".

Issues Concerning Insurance:

o New areas of insurance for commercial Space Station Operations will arise. These areas will include health and medical benefits, workers' compensation, life insurance, political risks, and product liability. This applies both to products manufactured on the Space Station and commercial firms working on construction of the Station.

o The current insurance industry is characterized by high rates and low capacity. Therefore, NASA needs to keep aware of the state of the space insurance industry.

o   More risks will need to be assumed for the Space
    Station program.

o   Financial commercial space ventures are closely
    linked to the availability of insurance. Financing
    is only available when insurance for the risks
    involved in the venture (shared by the financial
    institution) is available, or guarantees exist which
    assure its availability.

Incentives Concerning Insurance

o   NASA could consider full or partial indemnification
    of third party liability claims for commercial
    operators on the Space Station.

o   The government could act to set up a pool of money to
    insure commercial operations on the Space Station
    similar to the Overseas Private Investment
    Corporation (OPIC), insuring international political
    risks.

o   The government should act to guarantee the availability
    of insurance to commercial users.

o   Maintain inter-party cross-waiver.

Recommendations

o   Provide early dialogue between NASA and insurance
    community considering risks of the Space Station
    operations to allow industry time and development of
    expertise to react to insuring the Space Station.

o   As a final option, use the government as an insurer or
    government insurance business to guarantee availability
    of insurance to users and financial institutions.

.o Resolve potential conflicts of applicable law which may
    arise on the Space Station.

o   Approach areas of insurance industry (with insurance
    communities help) that have not yet been involved in
    space insurance activities.

o   Strengthen implementation of cross-waiver of liability.

3.8.3 <u>Summary</u>

If NASA is committed to robust commercial utilization of the
Space Station, then it should consider incentives to the
commercial community to promote and encourage commercialization
of space, especially on-board the Station. The subpanel
suggest some incentives in the areas of agreements and
insurance. NASA should recognize the importance of developing
these incentives early in the Space Station Program to ensure
significant commercial use of the Station in its early
operational years.

4.0   PAYLOAD SELECTION AND RESOURCE ALLOCATION OVERVIEW

The approach for the selection of payloads and the method of
resource allocation is the foundation upon which the utiliza-
tion of the Space Station rests. The Space Station resource
referred to in this discussion are those allocated to users as
opposed to those required for Space Station operation.
Although the results accrued from the payloads themselves will
eventually attest to the value of the Space Station, the
mechanisms by which these payloads are selected and
accommodated are the initial element in the process. The
selection process must therefore be solid enough to assure that
payloads can be operationally accommodated with minimum
interference from other payloads and systems, and at the same
time be flexible enough to accommodate several classes of
payloads (e.g., science, technology, and commercial)
simultaneously. The selection process must also be able to
accommodate standard selection procedures--such as
Announcements of Opportunity with peer group evaluations--and
at the same time accommodate commercial reimbursable research
and development and production facilities. No single process
is adequate or acceptable for all of these users; although, for
the Space Station to achieve optimum utilization, payloads from
all of these classes must be included. The members of the
Payload Selection and Resource Allocation subpanel have
examined several alternatives and have accumulated significant
input to arrive at our recommendation. The method of resource
allocation permeates every element of payload development--from
the preparatory phase (e.g., preparation of an Announcement of
Opportunity) through the execution phase. Even though the
selection process is the initial element, selection may not
proceed until some initial allocation of Space Station
resources has been made.

The fundamental philosophy used to develop these resource allocation concepts is that the Space Station is designed and operated for the user. Therefore, the user communities should have the maximum possible input into the resource allocation process. It is also true that the U. S. government and its international partners are providing the facility and may, for some time at least, be subsidizing part of the cost of operating the station. It is thus appropriate that the U. S. government and its partners should have a significant input in determining the various users to which the resources are supplied. Finally, the partners in the development of the Space Station are making different contributions to the facility and are therefore entitled to varying proportions of the available resources. These facts lead to a decentralized resource allocation concept that deals with resource envelopes with considerable flexibility within the allocated envelopes. The concept deals with the allocation of resources in the strategic timeframe to permit planning for the development of the equipment to be used on particular payloads as well as the evolution of the Space Station in response to the demand for resources; the tactical timeframe to reflect operational planning and more mature requirements as the equipment is developed; and the execution timeframe to deal with operational timelines and contingency situations where demand for one or more resources is higher or lower than the available supply. The following sections will describe four major options defined by the subpanel. Five major topics will be addressed for each option: 1) allocation among partners; 2) payload selection/resource allocation within the U. S.; 3) underutilized resources; 4) contingency reallocation; and 5) payload development and integration.

This subpanel recommends that two separate functional groups be established to support the accommodation of users into the

Space Station--one within the Space Station Program and one outside (and independent) of it. Within the Space Station Program, a User Development and Accommodation office should be formed with the director reporting directly to the Space Station Associate Administrator. This office would include a User Accommodation group. The User Accommodation group is to provide the "single point of contact" for selected users. When a payload is selected, a payload Accommodation Manager would be assigned to the payload and would provide all required support to the user from the Space Station Program including:
1) coordination of user requirements with the Space Station element centers (including internationals); 2) support activities at the payload development centers; 3) assume responsibility for development of program provided payload support hardware and software; 4) assume responsibility for document control; 5) support payload integration activities; 6) monitor payload resource utilization; 7) assume responsibility for user operations implementation; and 8) maintain contact with user until all user-Space Station interaction is complete. This office would also provide an international coordination function to assist partners and users in interfacing with the Space Station organizations as required.

Outside of the Space Station Program, a Space Station User Board should be established. The initial membership of this board should be the Associate Administrators for the principal NASA user offices--OSSA, OAST, and OCP--plus any other principal user groups such as the DoD, State Department, NOAA, commercial reimbursable, etc. The board will report directly to the NASA Deputy Administrator. The initial task of this board is to develop a multi-year plan for the Space Station utilization policies, goals, and rules. This plan will demonstrate Space Station utilization melds with the overall

goals and policies of the NASA user offices. As other classes
of users of the Space Station come into the program, the plan
will be updated to include them, and a representative will
become a member of the board. The Space Station User Board
will also be responsible for the following: 1) allocation of
resources to user classes (e.g., science, technology,
commercial, etc.); 2) resolve conflicts between user classes;
3) provide representation to the international User Operations
Panel (UOP); and 4) consult with the outside national advisory
groups. Users selected for the Space Station will become
members of the multinational Space Station User Working Group
(SSUWG). A Steering Committee made up of representatives from
each selected discipline group is also on the SSUWG. The
primary functions of the SSUWG are the development of Space
Station payloads and the definition of user requirements, but
it also is responsible for other areas such as: 1) resolution
of conflicts between users; 2) selection and payload operations
training of the payload crew; 3) bartering of resources among
users; 4) user operations planning and replanning; and
5) support to Space Station utilization planning. See Appendix
E for discussion of user selection process.

4.1 SPACE STATION USER BOARD OPTION

This is the recommended option for Space Station payload
selection and resource allocation. It does not attempt to
dictate the allocation process within classes of users, for
example the U. S. science community. A number of the user
communities already have well developed methods of allocating
their available resources. Furthermore, there will be a number
of different classes of users and it is probable that different
methods of payload selection and resource allocation will be
required for the different classes of users. There will be

examples given, however, of possible methods for different classes of users. Figure 4-1 shows the relationships between the users organization and the Space Station program.

4.1.1 Resource Allocation Among Partners

The Space Station Operations Task Force does not have the authority to determine how resources will be allocated among the partners in the development of the Space Station. These allocations will be determined by Memoranda of Understanding negotiated between the partners. Several basic concepts should be pointed out, however. First, resources should be allocated to each partner as well defined envelopes. Second, each partner should have complete control of how those resources within its envelope are allocated to individual users and not be subject to the review of the other partners, as long as the Space Station, its crew, or the operations of any other user are not endangered. Third, any partner should be able to trade resources with any other partner, sell resources to any user, or incorporate a mission from any applicant with its program, subject to guidelines about non-partner participation. Fourth, each partner's resource allocation should be directly related to that partner's investment in the Space Station. Fifth, there should be a direct relationship between the resources allocated to any partner and that partner's contribution to the operating costs of the Space Station.

These concepts lead to an important conclusion: resource allocations should not be made to individual users by an international panel. Allocation by an international panel could lead to numerous conflicts as national pride could prevent one partner from wanting another partner to be "first" in a particular area. It could also prevent some classes of users

PAYLOAD SELECTION AND RESOURCE ALLOCATION
SPACE STATION USER BOARD OPTION
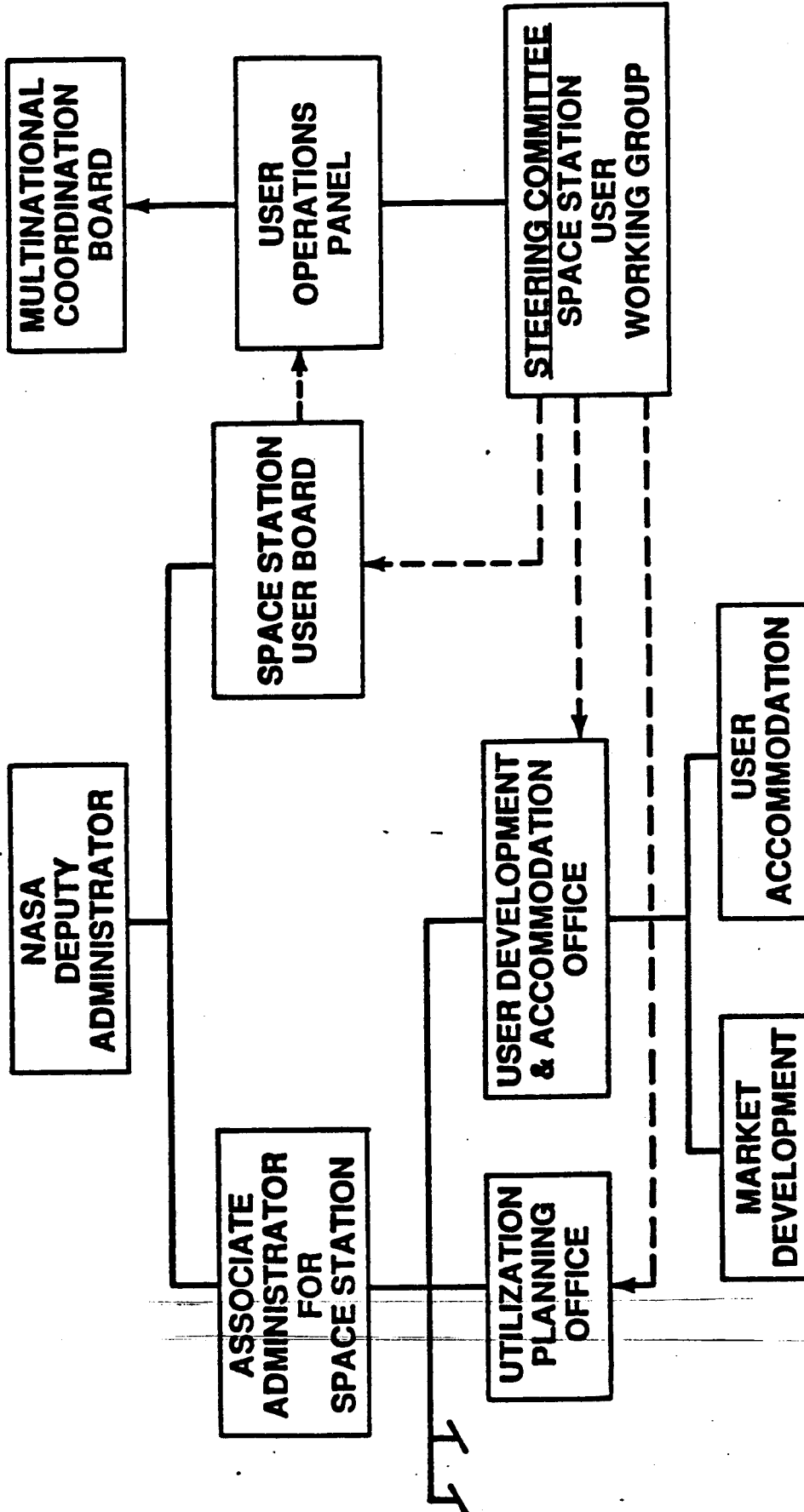
Figure 4-1

from having access to the Space Station because of philo-
sophical differences as to what is an "appropriate" use of the
facility. International resource allocation could also lead to
technology transfer problems or the compromising of proprietary
or security information since the international panel would
have to know a great deal about a specific experiment or
payload to intelligently allocate resources to it.

Resource allocations among partners define the limits of a
partner's program and tend to be strategic in nature. The
capability to trade, buy, and sell resources allows for the
tactical adjustments required as specific payloads are
developed. Any adjustments to resource allocations would have
to be presented to the Utilization Planning Office for assess-
ment before they could be finalized. At the execution level,
each partner should be required to stay within its operating
envelope of resources, with its own control over how those
resources are divided among its users.

4.1.2 Payload Selection/Resource Allocation Within the U.S

The User Board option for payload selection/resource allocation
assumes that international agreements have made resource
allocations to each of the partners and each has complete
control of sub-allocating his resources and selecting payloads
within his allocation. This discussion then addresses how the
United States allocates its share of the resources and selects
its payloads. The only international considerations in this
option are conflict resolution, exchanges of resources,
contingency reallocations, and the payload implementation
process.

The philosophy of the User Board option is that the United
States' share of the Space Station is a facility which exists

to satisfy national goals, and that payload selection should be performed by those organizations where the expertise exists to develop programs to achieve those goals. Thus, NASA's Office of Space Science and Applications (OSSA) would select science payloads within a science resource allocation given to OSSA by the User Board.

The members of the User Board would be chosen to represent classes of users, e.g., science, technology, commercial cooperative, commercial reimbursable, NOAA, and other user classes, such as the DoD, as they come into existence as users of the Space Station, and it would report to the Deputy Administrator of NASA. Chairmanship of the board would rotate annually among the members. Ultimately the User Board might be "spun off" from NASA and become an independent board responsible to the President of the United States to reflect a national viewpoint if non-NASA users became a large segment of the user community. The User Board would then develop into a board similar to the Board of Directors of National Station Operations Corporation option as it related to users. One of the early tasks of the User Board would be to prepare a plan for the eventual transition to a non-NASA board.

The two commercial categories differentiate between commercial cooperative activities where incentives are provided to a commercial entity based on an evaluation of the benefits of the commercial activity to the nation, and commercial reimbursable activities which are strictly "pay for services" and should not be subject to outside review and disclosure requirements. The word "reimbursable" does not imply any particular pricing policy, only that the user competes in the market place for his resources.

The User Board members for science, technology, and commercial cooperative would be the Associate Administrators for OSSA, OAST, and OCP. The representative for commercial reimbursable could be the CEO of a commercial firm or other figure from the commercial community. Since the purpose of the User Board is to determine what share of the U. S. resources should be available to each user class and to set overriding policies regarding market development, pricing, and operations, the members should have the stature to both speak for and make policy for their particular class. The board would initially develop a multi-year division of resources as a percentage of U.S. resources as a guideline to the various user classes of how much they could propose to fly on the Space Station over a period of time. The percentages could vary from year to year if the board decided that was in the national interest, or could remain constant over some period of time. Based on this initial allocation, each class of user would put together its program over the multi-year period and return to the board with its total resource requirements by resource. The board would then assign resource envelopes to each user class based on its requirements, the total available resources, and the relative share of the U. S. resources that each class had been assigned by the board. This allocation would then remain fixed except as the user classes conducted trades of resources among themselves. It is desirable that resources be assigned by the board with several priority classes to facilitate conflict resolution and contingency reallocation of resources. <u>It is not the purpose of the board to judge the relative merit of individual payloads, but to determine what proportion of the total resources should go to each class of users.</u>

At this point, each class of users has a resource envelope that it can use to meet its programmatic goals. Most of the currently defined user classes have peer review systems in

place to determine what payloads they will develop and fly based on their available financial resources. These same systems would do the payload selection within the user class, using the assigned resource envelope to determine the magnitude of the program. Each class would be free to barter some of the resources within its assigned envelope with other classes in order to enhance its program, subject to coordination with the Utilization Planning Office, but unused resources would revert to the User Board for reassignment.

The commercial reimbursable user class does not have, and should not have, a peer review system to select payloads. Within the User Development and Accommodation Office of the Space Station there should be a market development organization which would market the resources allocated to that class. This market would not be constrained by evaluation of the merit of the activity, but function only to make a market in Space Station resources within its allocation. Its method of selection would be to maximize the net revenue to the Space Station through the sale of resources.

The User Board is supported by a number of advisory groups, which generally advocate certain classes of users. Examples of advisory groups would include the National Academy of Science, the National Academy of Engineering, the Task Force on the Scientific Uses of Space Station (or its successor), and various commercial advisory groups as well as the various NASA user organizations. The board would have input from the President and Congress as to national policy in space, and its decisions could be overturned by the President. The board also provides U. S. representation to the international User Operations Panel.

The principal investigators or payload managers of payloads selected to be on the Space Station become members of the Space Station User Working Group (SSUWG). The SSUWG reports to the User Operations Panel. Also on the SSUWG is a Steering Committee made up of representatives from the various user disciplines. The members of the SSUWG Steering Committee are permanent employees to provide continuity and to facilitate conflict resolution and contingency reallocation of resources. Increment Investigator Working Groups are formed consisting of the SSUWG members scheduled to have payloads on the Space Station during the same mission increment. These groups perform many of the functions of the Spacelab User Working Groups in coordinating timelines and settling conflicts both during operations planning and real time.

In cases of conflict resolution action is taken at the lowest possible level. Solution is first attempted within increment investigator Working Group if it has no effect on other mission increments, then proceeds to the SSUWG Steering Committee if necessary. If no resolution can be reached within the SSUWG Steering Committee or by the User Operations Panel, the mission increment manager will have the authority to impose a solution within the policies of the User Board and User Operations Panel and the priorities or categories assigned to the individual payload resource allocations.

The User Board provides the user class allocations and policy guidelines to the Space Station Associate Administrator who is responsible for implementing them. The SSUWG Steering Committee interacts with the Space Station organization at all levels in providing information about payloads and recommendations regarding timelines and scheduling to the user operations and operations integration functions.

The User Board option accomplishes several goals for payload selection and resource allocation. It provides a high level group to define the goals and objectives of national policy concerning use of the Space Station. The board allocates resources to the various classes of users which have the expertise to sub-allocate their resources to individual payloads. Thus, each user class can evaluate the best means of accomplishing its programmatic goals and optimize its benefits within the constraints imposed by national policy. It also allows a free economic market to function for the commercial reimbursable user class within the resources allocated to that class. The use of priorities simplifies conflict resolution and contingency reallocation of resources both during operations planning and in real time by providing definite guidelines for payload priority. This option also avoids partner control over the U. S. selection and allocation process and U. S. control over the partner's selection and allocation processes while providing a functional interface with the defined international Space Station organizations.

The User Board option develops a user-based organization that interacts with NASA's Space Station program at several levels to involve the user in the operation and control of the Space Station. The User Board interacts with the Space Station Program at the highest level to provide policy direction and resource allocation by class while the SSUWG and its Steering Committee works directly with the working level personnel to provide information about payloads and solutions to conflicts. The members of the Increment Investigator Working Groups are involved in the individual payload requirements and operations requirements definition. The User Board consists of individuals who can speak authoritatively for the user classes. The SSUWG Group Steering Committee provides continuity over the long term to allow the give-and-take atmosphere to develop that

is necessary for effective conflict resolution. The Increment
Investigator Working Groups provide a forum for the individual
users within a mission increment to have a meaningful impact on
mission operations.

Several weaknesses also exist in the User Board option. It may
be difficult to recruit top-level people to the User Board,
particularly non-government representatives. Individuals with
other responsibilities may not be able to devote sufficient
time to the board and either the staff would actually control
the board or lower level deputies would represent the members,
weakening its ability to set policy. Control over the Space
Station program by the user organization would be difficult
because of lack of time to monitor the implementation of its
policies.

4.1.3 Underutilized Resources

In a facility as complex as the Space Station with a variety of
users that change over time, there may be some resources that
are underutilized. The resource underutilization can occur for
the resources available on the Space Station, within the
resource allocation envelope of a partner, or within a user
class. Except for the first case, a procedure is needed to
reallocate resources that would not otherwise by utilized. The
basic approach taken for the reallocation of underutilized
resources is that the resource allocation is the property of
the organization to which it has been allocated. Among
partners, it has already been suggested that a partner should
have the right to trade, buy, or sell part of its resource
allocation. That right would certainly apply to underutilized
resources: European Space Agency (ESA) could sell pressurized
volume or trade it to another partner for power or crew time if
it didn't need the volume for its own use. Similarly, if one

U. S. user class did not need all of its allocation of a specific resource, it should be able to trade it for other resources that it does need. If the U. S. user class cannot trade the underutilized resource for one that it needs, that resource would revert to the User Board for reallocation to another user class.

How to treat underutilization of a resource by an individual user would depend on how the resource allocation within the class was made. If the resource was sold to the individual user, as might be the case for a commercial reimbursable user, that user should be able to either sell or trade the resource to another user within the class. If the individual user is not able to sell or trade the resource, it should revert to the Market Development organization for resale. Whether or not the purchase price of the resource was refunded would depend on the initial terms of the sale. In the cases where the resources were simply assigned to an individual user, the organization to which the class allocation was made would then own that resource and it could reallocate it within the class or trade it to another class. In all cases, the resource would revert to the User Board if no sale or trade was made.

4.1.4 Contingency Reallocation

During the day-to-day (execution timeframe) operations of the Space Station, and even in the tactical timeframe, shortages will occur in particular resources. A major goal of resource allocation is to avoid conflicts or arbitrary decisions during the contingency reallocation process. Probably the best model of contingency reallocation is the Spacelab experience during operations. Some of the Spacelab missions have been international and interdisciplinary with a large number of individual payloads. The concept presented here builds on the

Spacelab experience while considering the greater complexity that will be experienced on the Space Station. The key feature of this concept is the use of the SSUWG Steering Committee and the Increment Investigator Working Groups. These user groups should take part in the timeline preparation prior to the specific mission increment and would resolve conflicts during the mission increment. The Steering Committee members would have the support of the Increment Investigator Working Group to provide information and guidelines for the resources required for minimum operation of the individual payloads and possible time sharing solutions to conserve resources. At the head of an Increment Investigator Working Group would be a mission increment manager, who after consultation with users and flight crew personnel would have final authority to resolve real-time conflicts between users.

One additional complexity factor for the Space Station as compared to the Spacelab experience is the presence of classes of users other than science users. Operational users such as NOAA, DoD users, and commercial users would have different criteria for evaluating the relative importance of the individual payloads than science (and perhaps technology) users. To minimize the conflicts between classes of users requires the allocation of priorities to specific payloads within classes may vary from day to day so that the user working group is the first line decision making organization for priority allocations. The commercial reimbursable user probably presents the greatest problem of conflict resolution within the user classes since the problem comes down to whether a commercial user will be allowed to make use of its investment. For this class of users, a resource might be priced differentially depending on priority.

The important factor in contingency reallocation of resources is to have the process in place well before a contingency situation arises. Priorities should be assigned along with the initial resource allocation. Users groups should be organized and assist in timelining well before the mission segment begins, and the process should be tested during timeline preparation (perhaps during operations training exercises).

The use of priorities also helps reallocation of resources when additional resources become available (e.g., when a payload fails). Payloads with lower priority resource allocation which were not able to operate could now be activated. The user groups would also provide recommendations during the planning phase as to the use of unexpected resources.

4.1.5 Payload Development and Integration

Upon completion of the payload selection process by the appropriate selecting organizations, the payloads are submitted to the User Board. The board reviews the submission to ensure that the various user groups have stayed within their resource allocations. Having assured this, the board submits the selected payloads to the Space Station program. (The other partners would be carrying out similar processes in parallel with the U. S.). The Space Station program, through its Utilization Planning, office performs an analysis on the proposed payloads which would include: 1) resource assessment; 2) operations assessment; 3) transportation assessment; 4) compatibility assessment; and 5) readiness assessment. The output of this study would provide the possible manifest options and recommendations, an identification of critical issues, recommendations for payload increment assignment, and a preliminary evaluation of the utilization of the Space Station resources by user class and by partner. Through an iterative

process with the User Board, tentative manifests will be developed and approved.

Once a payload has been approved by the User Board for implementation on the Space Station, the user must enter a phase of coordination with the Space Station program. The user will, in most cases, be developing an instrument or an experiment which will be op ated on the Space Station using resources provided by the Space Station.

Upon entering this definition/development system, the user will become a member of the SSUWG. The SSUWG is expected to be a continuing functional user body with Increment Investigator Working Groups. Since the Space Station is expected to be in continuous operation over a lifetime of 20-30 years, the Increment Investigator Working Groups will work with the Space Station Operations to plan and implement the user operations during specific increments of this overall lifetime.

During each of the mission increments, user operations will be changed since some payloads will be removed, other payloads will be put in place, and still other payloads will change operating modes (and hence their resource utilization). The Space Station systems themselves may also be evolving (e.g., addition of modules or addition of a solar dynamic power system) and crews will be rotating. It is necessary that some mission planning and analysis tools be in place early to enable comprehensive mission increment planning.

We expect that the SSUWG will be headed by a Steering Committee. This Steering Committee will include representatives from each of the user disciplines and will coordinate the overall planning for utilization of the Space

Station as well as serving as the focal point for planning of each mission segment.

Upon entering into the definition and development cycle, the user will be assigned a Space Station Payload Accommodation Manager who reports to the User Development and Accommodation Office in the Space Station program. This manager will be a single point of contact for the user as he defines his experiment and develops his payload. This includes the coordination with international partners when U.S. users are assigned to partner elements for payload implementation. The Payload Accommodation Manager will be assigned from the center responsible for the element where he will fly. Thus if a payload were to be in the U.S. lab module, he would come from MSFC. The payload accommodation responsible for a minimum number of payloads consistent with staffing constraints.

In order to define the Space Station resources required by an experiment or payload and to define how the user must design and build his systems to effectively utilize these resources, a number of documents and references are provided to the user. Examples of these types of documents include safety requirements, design guidelines and requirements, interface specifications, user handbooks, test and verification requirements, and software specifications.

The user will use these documents to design his system hardware and software. During the course of this design, the user will begin to provide documentation back to the payload accommodation manager which specifies how he will use the Space Station resources. These documents will, at a minimum, verify necessary safety compliance as well as criteria to ensure that the user will not interfere with other Space Station payloads or systems. In addition, the user will probably be required to

provide documentation on the payload operations requirements,
interface requirements and specifications, materials usage,
analysis and test requirements and specifications, and
integration requirements (both for the Space Station and the
STS).

Documentation has become a large and expensive part of payload
development. The panel thus recommend that, if possible, the
documentation be implemented through an electronic medium. The
Space Station documents should be menu driven, with extensive
help features, automatic updates, and queuing. In addition,
the documentation should be backed up by manned action teams
who can assist and answer questions for users as they encounter
problems or uncertainties. This electronic system should also
include a schedule prompt which continually alerts the user
when documents have been changed or updated.

Likewise, the user should use an electronic medium to provide
his documentation to the Payload Accommodation Manager. The
features which the electronic medium provides would include
routines to allow easy updates of requirements, cross
correlation among documents (so that when one document is
updated this information is automatically updated in all other
appropriate documents), graphics, and control and approval
features. Schedule prompts will also be used to remind the
user of need dates for specific documents.

There should also be optional services and facilities which may
be provided to users to test and validate the payload hardware
and software. These services and facilities include vibration
and load test facilities, thermal vacuum facilities, and
electromagnetic test chambers (for both susceptibility and
generated EMI). An operations and interface verification test
system should also be available to allow the user to test and

verify his electrical, command, and data interfaces. This test system should also be capable of testing the operational protocols which have been developed by the user.

Finally, it seems reasonable to assume that, as the Space Station matures operationally, some type of Space Station operations planners with the necessary tools to develop timelines for resource usage for each mission increment. With user payload and experiments continually changing with each mission increment, some system must be available to enable the Space Station to plan for changing command and data formats, electrical power loading, thermal distribution loading, field of view variations, microgravity conditions, and numerous other variables. An operations simulator would also be useful for some test and training exercises with the users and payload crew.

4.2 ALL NASA WITH SALE OPTION

This option assumes that Space Station resources are initially allocated to the NASA user offices (subject to Space Station User Board agreement), but outside government agencies or commercial firms may purchase resource blocks. The funds received from these purchases would revert to the NASA user offices which relinquish the purchased resources.

The primary feature of this option entails a mechanism through which NASA would assume the total operations funding and utilization of the Space Station, but provide Space Station resources to other U.S. users based on a progressive cost reimbursement rate. Space Station resources may be distributed within NASA primarily to the user offices (OSSA, OAST, and OCP). Within each of these user offices the resources are to be subdivided down to the discipline levels (e.g., solar,

astronomy, high energy, space plasma, earth resources, atmospheric, communications, etc.). Anyone outside of NASA may purchase (based on a rate which has been fixed by the annual operations cost of Space Station) the resources needed to support his investigation. The purchased resources would be taken from each of the NASA user offices in the same proportion as the resources were originally allocated.

The general features of this option are outlined below. Users outside of NASA (e.g., commercial reimbursable, DOD, NOAA, etc.) have two means of access to the Space Station.

Route A: (Interaction with NASA utilization offices)

Outside users may come to the NASA utilization offices (OSSA, OAST, and OCP) and arrange to provide an investigation to be performed in a specific discipline area. The subject investigation must be either publishable in the open literature (science) or shared within the U.S. (commercial or technology). In these instances the specific discipline chief may choose to release some of his Space Station resource allocation needed to support this investigation. The results of this agreement must be such that the successful completion of that investigation will enhance the state-of-knowledge in the discipline from which the allocation was granted.

Route B: (Purchase of Space Station resources)

Outside users who cannot (or do not wish to) arrange an agreement with the NASA utilization disciplines may directly purchase from the Space Station marketing organization a straight percentage of Space Station resources needed to support his investigation. As long as the subject investigation can be proven to be safe and does displacement of

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planned investigations. Funds may be used to pay for a delay
for planned investigations, or for the development of
alternative means of conducting investigations.

The All NASA with Sale option provides a separate user
organization similar to that of the User Board option, thus
preventing domination of the Space Station by the operators.
Although initially all resources are allocated within NASA, it
provides multiple routes for other classes of users to gain
access to the Space Station. This option further ensures that
NASA is reimbursed for its expenses of operating the station to
the extent that non-NASA users are using it and even provides a
means of accumulating the funds for station expansion or
replication.

Several potential problems exist for the All NASA with Sale
option, however. In order for the user codes to retain the
funds from the sale of resources, changes may be required to
current law. Another problem is determining what the total
operating costs of the Space Station actually are. To fully
reimburse NASA for resources provided to non-NASA users, all of
the personnel and maintenance of facilities cost would have to
be included, perhaps even life cycle replacement costs.
Including all of these costs might result in extremely high
resource prices to non-NASA users and inhibit use of the Space
Station.

4.2.1 Resource Allocation Among Partners

The allocation of resources among the Space Station partners is
as described in the preceding option (Space Station User Board
option). In summary, each partner would receive an allocation
of resources with no constraints attached (other than

non-interference with other users and with Space Station
systems).

4.2.2 Payload Selection/Resource Allocation within the U.S.

A Space Station User Board comprised of the Associate
Administrators of Space Science and Applications, Aeronautics
and Space Technology, Commercial Programs, other government
agencies (e.g. DOD, NOAA) and a commercial reimbursable
representative will be formed to develop a multi-year plan for
Space Station utilization. This plan would include an initial
resource allocation to the NASA user organizations with a limit
on the percent of resources for sale to users outside the NASA
organizations (DOD, NOAA, other government agencies, and
commercial reimbursable). The sale of Space Station resources
would be managed by a Space Station marketing organization
which would develop the necessary pricing formulas. These
formulas would be keyed to "critical" resources such as power,
volume, attach points, command and data and the resulting price
structure would provide reimbursement of the total station
operating costs when a significant percentage (say 40%) of any
critical resource was purchased. The funds received from the
sale of resources would go to the NASA user codes to support
the definition and development of the NASA-sponsored Space
Station payloads.

The multi-year plan would be updated on an annual basis and
would take into consideration the demand for Space Station
utilization by the non-NASA users by ensuring that a block of
resources is always available to them. The plan would also be
the top level document to set policies for Space Station
utilization. When funds from outside users exceeds the annual
operating costs of the Space Station, those excess funds·would
then go to an account to pay for Space Station growth or

replication. NASA and other government agencies would use
their established procedures for the selection of their
payloads and the commercial reimbursable segment would be
assured of proprietary rights and protection of their
activities. The User Board would undertake the responsibility
for conflict resolution among classes of users, and would
provide members to the UOP. The User Board would also act as
the payload advocacy body to submit payloads to the Space
Station for technical evaluation.

Once a user is selected for flight on the Space Station, he
will become a member of the SSUWG. In the working group, the
selected user will begin a period of interaction with other
users to establish a basic understanding of other user needs.
This understanding is necessary to establish the personal
communications links needed to meld the various users and
classes of users into a team with the goal of accomplishing the
most effective use of the Space Station for each mission
increment.

The User Working Group will include a Steering Committee made
up of discipline representatives as in the Space Station User
Board option. The Steering Committee will provide the day to
day interaction with the Space Station in mission increment
planning. The Steering Committee will also assist in conflict
resolution among users and support contingency reallocation of
resources. Within the Space Station program, each user is
assigned to a Payload Accommodations Manager who will serve as
the single point of contact for the user with the Space
Station.

4.2.3 Underutilized Resources

Each class of user should have the right to trade, buy or sell its underutilized resources with other classes. In the event that these underutilized resources cannot be traded or sold, the resource would revert to the User Board for reallocation. This procedure follows that procedure discussed in the Space Station User Board option discussed previously.

4.2.4 Contingency Reallocation

In the event of a decrease in resource availability (such as a decrease in power resulting from a power system failure) or an unexpected increase in resource availability (resulting from a failure of a major payload), the first level of reallocation of resources would be handled by the Increment Investigator Working Groups, the SSUWG, and its Steering Committee. This process also follows the scheme outlined in the preceding option.

4.2.5 Payload Development and Integration

The support required from the Space Station to the user and from the user to the Space Station is identical to that defined in the Space Station User Board option.

4.3 MULTINATIONAL ORGANIZATION OPTION

This option provides for an international selection of users and allocation of resources. Although resources are allocated to each partner, the resource allocation and payload selection processes are performed at the international level. The Multinational Organization option is shown in Figure 4-2.

PAYLOAD SELECTION AND RESOURCE ALLOCATION
MULTINATIONAL ORGANIZATION OPTION

```
                              MULTINATIONAL
                               COORDINATION
                                  BOARD
                                    |
                                    |
                                  USER
                               OPERATIONS
                                 PANEL
                                    |
                                    |
                            STEERING COMMITTEE
                              SPACE STATION
                                  USER
                              WORKING GROUP
                                 |      |
                                 |      |
                         UTILIZATION    |
                          PLANNING      |
                           OFFICE       |
                                        |
                                        |
  NASA                              USER DEVELOPMENT
 DEPUTY                            & ACCOMMODATION
ADMINISTRATOR                          OFFICE
      |                              |          |
      |                              |          |
 ASSOCIATE                      MARKET        USER
ADMINISTRATOR                 DEVELOPMENT  ACCOMMODATION
    FOR
SPACE STATION
```
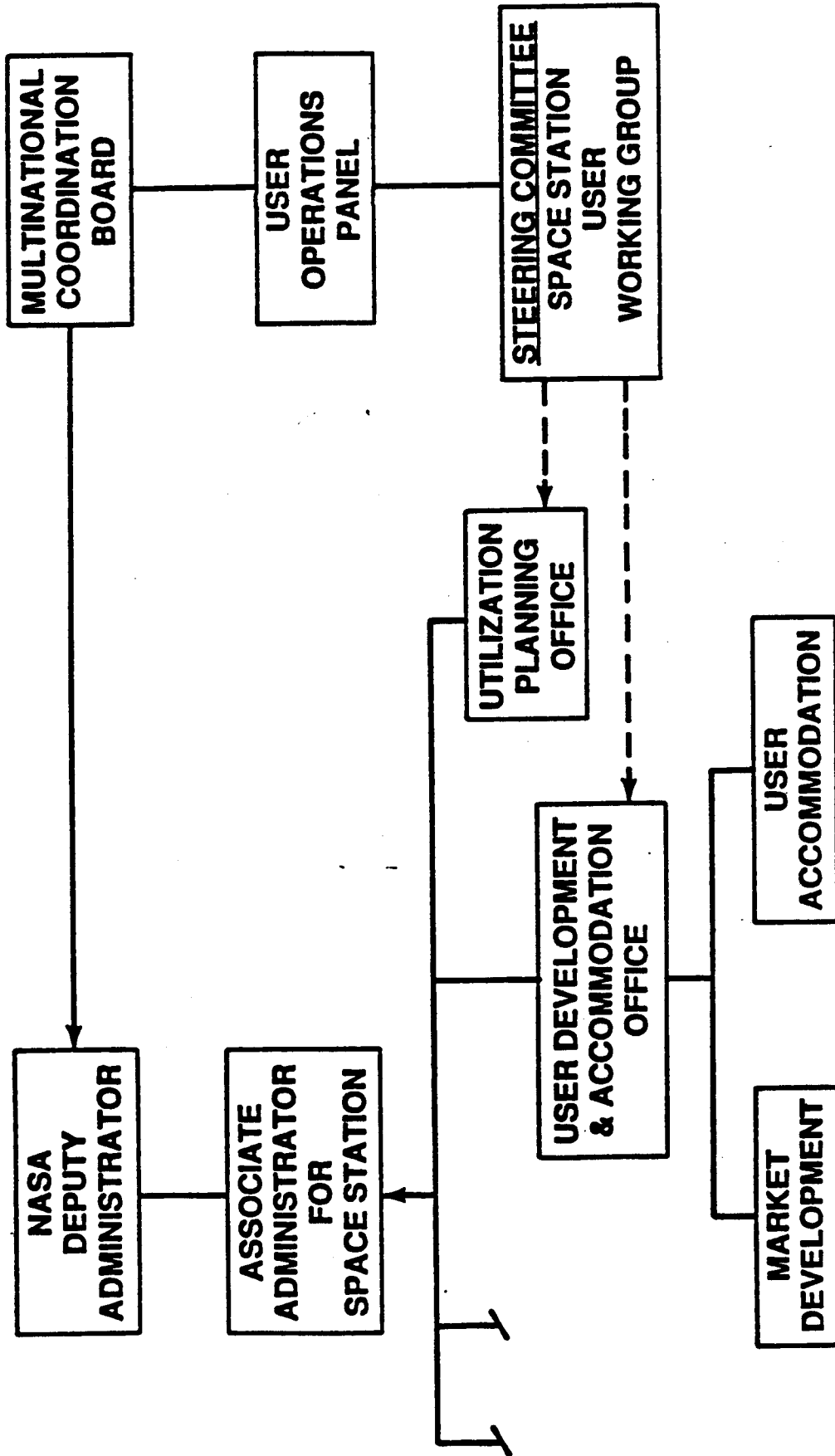
Figure 4-2

4.3.1 Resource Allocation Among Partners

As in the Space Station User Board option, resource allocation among partners is controlled by the Memoranda of Understanding between the partners. These allocations would continue to be observed as the individual payloads are selected and resources allocated to them.

4.3.2 Payload Selection/Resource Allocation Within the U.S.

The User Operations Panel (UOP) would assign resource allocations to each class of users, probably based to some extent on the recommendations of NASA user office Associate Administrators and other U. S. spokesmen. After the resources were allocated to the classes of users, specific proposed payloads would be submitted to the UOP by the various user classes and would have resource envelopes assigned to them. The SSUWG probably with a Steering Committee as in the Space Station User Board option, would be composed of all of the selected users of the Space Station. Increment Investigator Working Groups would be formed to deal with each mission increment.

These international organizations would interface with the Space Station program in much the same way as the User Board, User Working Group, and Increment Investigator Working Groups would in the Space Station User Board option. Organizations would still exist in the Space Station program to provide Utilization Planning and User Development and Accommodation support to the UOP and to the users. Based on the current status of the international Memoranda of Understanding, conflicts that could not be resolved at the UOP level would be raised to the Multilateral Coordination Board (MCB) for resolution.

The major drawback to this option is the substitution of an
international body for a U. S. User Board. Since decisions
about resource allocation and payload selection are made at the
international level, those decisions will reflect some set of
international goals rather than U. S. national goals and
priorities. Some classes of users might have difficulties in
being selected due to perceptions of national advantage or
"appropriate" use of the Space Station.

4.3.3   Underutilized Resources

The same methods for buying, selling, and trading underutilized
resources that were discussed in the Space Station User Board
option could apply to this option. Since an international
board is setting policy regarding resource allocation, however,
there is no guarantee that the user classes or individual users
would have the freedom to make these types of adjustments. For
example, the UOP could decide that all underutilized resources
would revert to it to be reallocated.

4.3.4   Contingency Reallocation

Reallocation of resources due to contingency situations would
probably function in the same manner under this option as under
the Space Station User Board option.

4.3.5   Payload Development and Integration

The payload development and integration functions would be
similar to those under the Space Station User Board option.

4.4   NON-NASA NATIONAL SPACE STATION OPERATIONS CORPORATION
OPTION

The Non-NASA National Space Station Operations Corporation
(NSSOC) option is a significant change from the present NASA
"way of doing business". Under this concept, the Space Station
would be operated by a national corporation responsible to an
appointed Board of Directors (BOD) completely independent of
NASA. The BOD would set policy, monitor the corporation
performance, and hire a Chief Executive Officer (CEO) who would
be responsible to the board for carrying out its policies. The
board would consist of representatives of the major user
disciplines nominated by the President of the United States
subject to Congressional approval. This option is shown in
Figure 4-3. Funding for the U. S. share of Space Station
operations would be provided directly to the corporation with
reductions based on the amount of revenue generated by the
Space Station.

4.4.1   Resource Allocation Among Partners

Resource allocation among partners will be conducted under
international Memoranda of Understanding as in the Space
Station User Board option.

4.4.2 Payload Selection/Resource Allocation Within the U. S.

The BOD will make the initial allocation of Space Station
resources to the various classes of users based on input from
various advisory groups. After the initial allocation, it
would be the responsibility of the CEO to make the final
allocation of resource envelopes based on the programs
presented by the user classes under the guidelines laid down by

PAYLOAD SELECTION AND RESOURCE ALLOCATION
NATIONAL SPACE STATION CORPORATION OPTION
OPTION
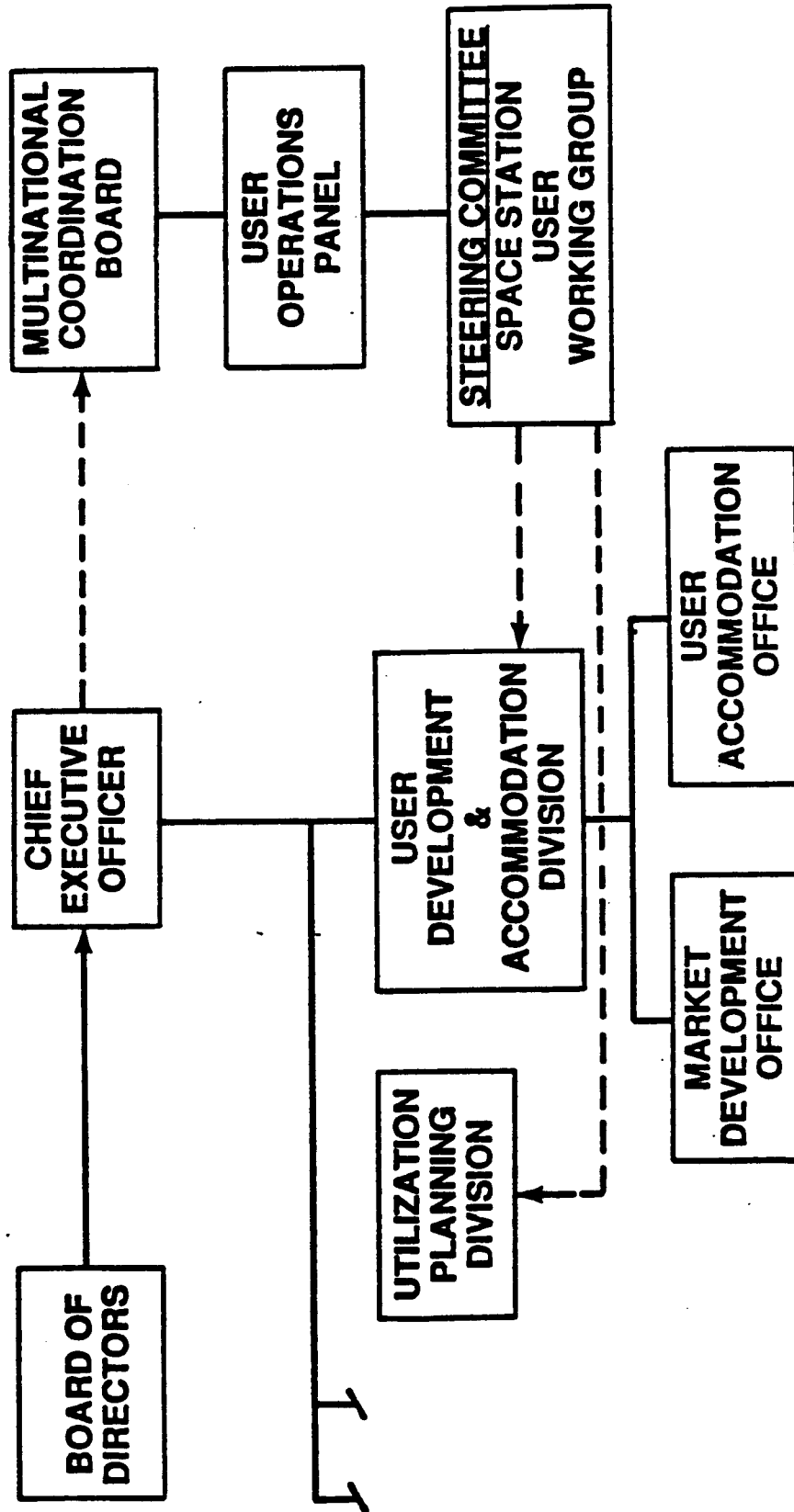
Figure 4-3

the BOD. Each class of users will use their established procedures for selecting individual payloads within their resource envelope. The NSSOC would have the responsibility for making a market in Space Station resources for the commercial reimbursable class of users.

The CEO of the NSSOC would sit as the U. S. representative and chairman of the Multilateral Coordination Board. His ranking deputies for User Development and Accommodation and Operations would sit on the UOP and Systems Operations Panel, respectively. The SSUWG and Increment Investigator Working Groups would function the same as in the Space Station User Board option.

The NSSOC option provides a completely different way of preparing for Space Station operations. As described, it retains the user input, through the BOD, to the resource allocation process and permits payload selection to take place at the level of expertise required to optimize programmatic goals. On the other hand, NASA would have to give up much of the control of the Space Station except as a significant part of the user community. While the users have input at the highest possible level, the BOD, this body now is also responsible for operating the Space Station, thus diluting the independence of the users from the operators that is a feature of the Space Station User Board option.

4.4.3   Underutilized Resources

The process for dealing with underutilized resources would be very similar to that described under the Space Station User Board option, except that the resources that could not be traded or sold would revert to the NSSOC. Having these

resources revert to the NSSOC would probably improve the efficiency of reallocation since the NSSOC would be composed of full-time employees, but the users would not be as well represented in the process as when the User Board had responsibility for the reallocation.

4.4.4   Contingency Reallocation

Contingency reallocation due to variations in the available resources would be performed in the same manner under this option as in the Space Station User Board option.

4.4.5   Payload Development and Integration

The NSSOC would have the same organizations as described under the Space Station User Board option to perform utilization planning and user development and accommodation support.

5.0 MANIFESTING OVERVIEW

Manifesting is a term from the National Space Transportation System (NSTS) program that refers to the assignment of payloads to flights. In this sense, the definition of the word manifest is a list of cargo carried to a vessel. However, there is more to the Space Station manifest than a list of cargo, for it must not only assign payloads to the Station, but also consider the Station operation requirements and the transportation services to and from the Station - all as a function of time. With these additional considerations, the Space Station manifest in essence becomes a Utilization Plan (UP) rather than a list of cargo. Thus, the Space Station Operations Task Force Manifesting Subpanel considers Space Station manifesting as Utilization Planning and so refers to it in this report. Space Station Utilization Planning is defined in the following manner:

Utilization Planning is the integration of user and station operations requirements within the available station and transportation (both launch and return) capabilities over a specific planning horizon.

Figure 5-1, illustrates where Utilization Planning is functionally located relative to Resource Allocation User Selection, Pricing, and Marketing.

The subpanel examined how Utilization Planning is performed in other NASA programs; specifically, the National Space Transportation System (NSTS), the Tracking and Data Relay Satellite System (TDRSS), the Deep Space Network (DSN), and the Spacelab program, in order to benefit from their experience. Only the NSTS and Spacelab planning/scheduling processes were

SPACE STATION MANAGEMENT

USER REQUIREMENTS

FEASIBILITY ASSESSMENT

SPACE AND GROUND OPERATIONS
- ON ORBIT OPS
- SUSTAINING ENGINEERING
- SAFETY
- PRE/POST FLIGHT OPERATIONS
- LOGISTICS

UTILIZATION PLANNING
- STS PLANNING INTERFACE
- USER ASSIGNMENTS
- PLANNING INTEGRATION
- FEASIBILITY ANALYSES
- CONFLICT RESOLUTION
- USER SELECTION SUPPORT

USER DEVELOPMENT AND ACCOMMODATIONS

USER ACCOMMODATIONS
- PAYLOAD INTEGRATION
- ELEMENT COORDINATION
- DOCUMENTATION CONTROL
- INTERNATIONAL COORDINATION

MARKET DEVELOPMENT
- STATION INFO, RESOURCE & AVAILABILITY
- PRICING INFO
- AGREEMENT SUPP.
- INSURANCE
- EVOLUTION RECOMMENDATIONS
- COMMERCIAL REIMBURSIBLE DEVELOPMENT

INTERNATIONAL MULTILATERAL COORDINATION BOARD (MCB)

CANADA (SSUB)
ESA (SSUB)
JAPAN (SSUB)
UNITED STATES (SSUB)

SPACE STATION USER BOARD (SSUB)

OTHER GOVERNMENT AGENCIES

COMMERCIAL REIMBURSIBLE

COMMERCIAL COOPERATIVE

TECHNOLOGY

SCIENCE

Figure 5-1

deemed applicable to the Space Station Program (SSP). It is assumed that lab module planning will be similar to, if not patterned after, Spacelab manifesting and the subpanel's recommended operations concept is modeled after the NSTS process.

The subpanel examined how Utilization Planning is performed in other NASA programs; specifically, the National Space Transportation System (NSTS), the Tracking and Data Relay Satellite System (TDRSS), the Deep Space Network (DSN), and the Spacelab program, in order to benefit from their experience. Only the NSTS and Spacelab planning/scheduling processes were deemed applicable to the Station. It is assumed that lab module planning will be similar to, if not patterned after, Spacelab manifesting and the subpanel's recommended operations concept is modeled after the NSTS process.

The subpanel developed a comprehensive description of the Space Station Utilization Planning process which includes the flow of information and recurring activities that must be performed. In conjunction with development of the planning process description, the subpanel reviewed several organizational concepts for Utilization Planning. The following three concepts were identified as the practical alternatives available for the SSP. They are illustrated in Figure 5-2.

Centralized Utilization Planning is accomplished by a single in-line Utilization Planning Office (UPO) which is located at NASA Headquarters and reports directly to Space Station Management. In this concept, the UPO is responsible for developing the U.S. Space Station Utilization Plan (SSUP) and is a variation of the manifesting process used by the NSTS.

CENTRALIZED UTILIZATION PLANNING
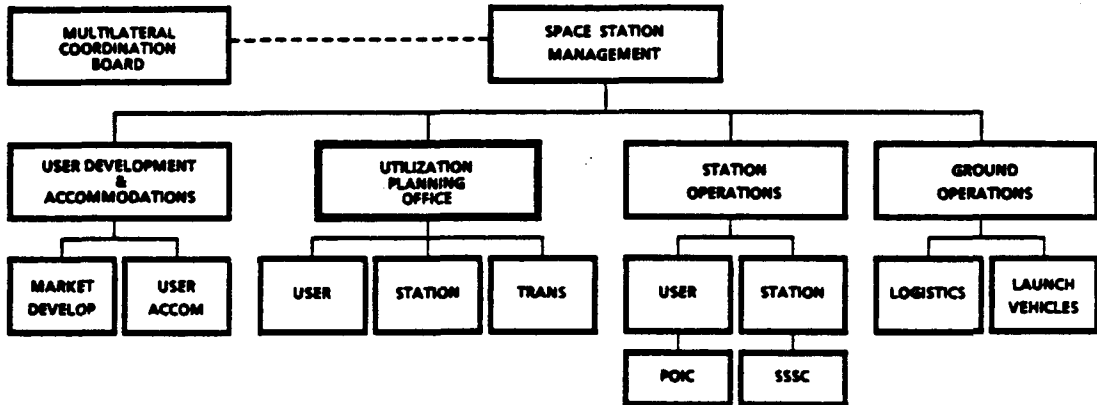
DISTRIBUTED UTILIZATION PLANNING
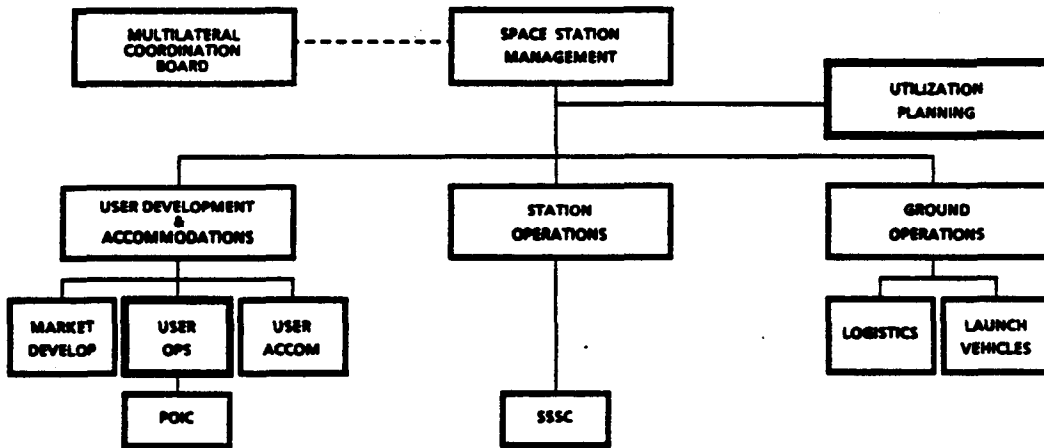
PARTNER UTILIZATION PLANNING
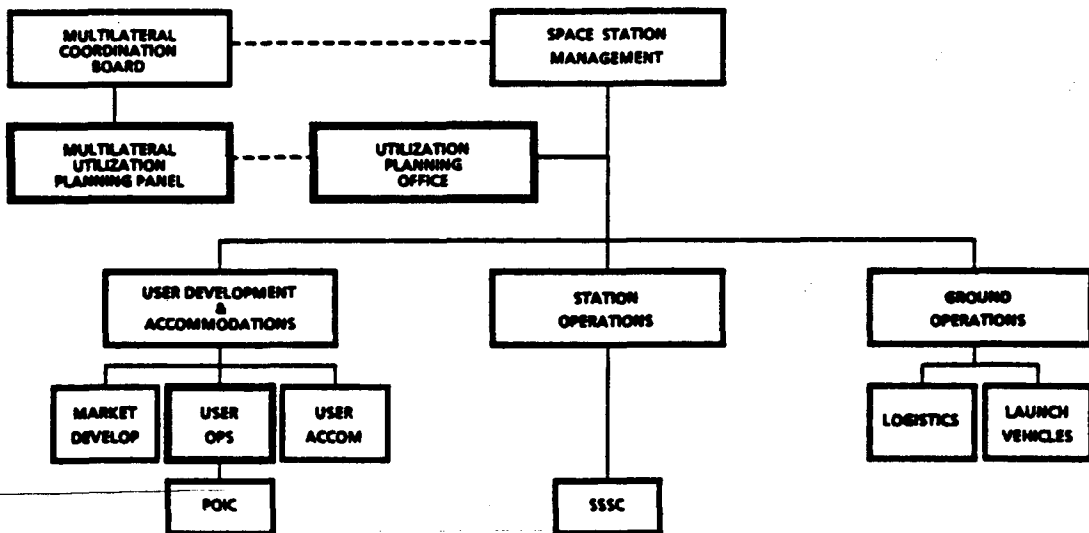
Figure 5-2

Distributed Utilization Planning is accomplished by a small staff, attached to Space Station Management, which coordinates the planning activities of the user operations, station operations, and ground operations/transportation organizations and integrates the results into the U.S. SSUP. It assumes these three organizations or functions are independently managed. In this concept, the planners are the implementors.

Partner Utilization Planning is accomplished in each partner's resource allocation/user selection process and integrated by the Multilateral Utilization Planning Panel (MUPP) into the U.S. SSUP. The U.S. SSUP is reviewed and approved by the Multilateral Coordination Board (MCB) and forwarded to NASA and the international partners for implementation.

The Manifesting Subpanel recommends that the SSP adopt a Centralized Utilization Planning approach during station design, development, test, and evaluation (DDT&E) and evolve into a more Distributed Utilization Planning process as operations mature. The early years of station development will be a learning time, not only for the Station operators and users, but for the planners as well. Considerable time and effort will be needed to structure the analyses which are required and determine the level of detail that is appropriate to support Utilization Planning.

As operations and operations planning become more routine, the operations organizations become more involved in the Utilization Planning process. As this occurs, and organizational responsibilities and interfaces become clearer, a distributed process becomes more attractive. The subpanel recommends that the Space Station Program establish a goal to evolve to a more Distributed Utilization Planning process.

The Utilization Planning process must be flexible in the early stages of the Program. It should build in a means of evaluation that will allow it to be responsive to the changing needs of the Space Station and the manner in which NASA elects to carry out its responsibilities.

Additional conclusions and recommendations of the Manifesting Subpanel are the following:

o the U.S. SSUP should be the top-level planning document for the SSP, its users, operators, and transportation suppliers,

o the SSUP should provide the information needed

   -- by the users and their sponsors to plan, budget, and coordinate their use of the station,

   -- by the Space Station Program to direct tactical operations planning,

   -- by the transportation (e.g., NSTS, ELV's) and logistics organizations to plan support,

o the Utilization Planning process should be responsive to management, users, and station operators,

o the U.S. SSUP should be developed, maintained, and controlled by NASA taking into account its commitments to the international partners,

o Utilization Planning should be accomplished at NASA Headquarters with the participation of the user community, station operators, and transportation organizations, and international partners,

o a centralized UPO should be established at NASA Headquarters as soon as possible with initial emphasis on

   -- developing the overall planning process,
   -- planning the transition from DDT&E to operations,
   -- station assembly phase planning, and
   -- development of the NSTS interface,

o   NASA should transition to a Distributed Utilization
    Planning approach as Station operations mature,

o   the Space Station Program should consider Utilization
    Planning in a multi-national after the planning process
    is established and station operations are routine.

5.1   Introduction

The objective of the Space Station Manifesting Subpanel was to
develop an operational concept for manifesting the Space
Station which: 1) defines manifesting, 2) describes the Space
Station manifesting process, and 3) recommends an
organizational structure for each phase of the Space Station
Program (SSP) from DDT&E through mature operations.

Manifesting is a term from the Space Shuttle Program that
refers to the assignment of payloads to flights. In this
sense, the definition of the word manifest is a list of cargo
carried by a vessel. However, the Space Station manifest is
more than a list of cargo, for it not only assigns payloads to
the Station, but also must consider the Station operation
requirements and the transportation services to and from the
Station - all as a function of time. With these additional
considerations, the Space Station manifest is a Utilization
Plan rather than a list of cargo.

In order to properly address manifesting for the Space Station,
a working definition of Utilization Planning is needed.
Several definitions were suggested and reviewed by the
subpanel. While some were quite different, they all had the
following elements in common:

o   the SSUP should be an integrated schedule of
    transportation to and from the Station and cover Station
    assembly activities, Station operations, and user
    operations,

o   the SSUP should reflect the integration of user and
    Station requirements,

o   the SSUP will be constrained by Station and
    transportation capabilities,

o   the SSUP will be limited to a specific time period or
    planning horizon.

The subpanel adopted the following definition. Space Station
Utilization Planning is the integration of user and station
operations requirements within the available station and
transportation (both launch and return) capabilities over a
specific planning horizon.

Section 5-2 provides a generic description of the Utilization
Planning process. It describes the activities that must be
accomplished in developing an SSUP regardless of the
organization that is responsible for the planning.

Section 5-3 presents three organizational concepts for
Utilization Planning. These concepts represent the practical
alternatives available to the SSP.

A summary of this report and the Manifesting Subpanel's
recommendations are presented in Section 5-4.

Appendix G provides an overview of the manifesting subpanel and
includes biographies of the members and a chronology of the
subpanel's activities.

The subpanel also investigated Utilization Planning in other NASA programs. These programs included the National Space Transportation System (NSTS), the Tracking and Data Relay Satellite System (TDRSS), the Deep Space Network (DSN), and the Spacelab program. Summaries of these programs' manifesting processes are contained in Appendix H.

Appendix I. is a White Paper which describes a Centralized Space Station Utilization Planning concept.

5.2 Utilization Planning Description

This section describes the elements and activities involved in the Utilization Planning process. The process can be visualized as a system, with inputs and an output, that maps user and Station requirements into a schedule of activities consistent with Station and transportation capabilities. Figure 5-3 illustrates the process.

5.2.1 Inputs

Inputs will be provided by SSP Management, the user selection and resource allocation process, users, Station operations, ground operations and the transportation system. The following paragraphs describe the types of information provided by these organizations.

Space Station Program Management

SSP management provides guidance and direction to Utilization Planning in the form of goals, objectives, and policies. These provide the framework around which the planning is accomplished. The planning process must be responsive to changes in the SSP goals and objectives that may take place overtime.
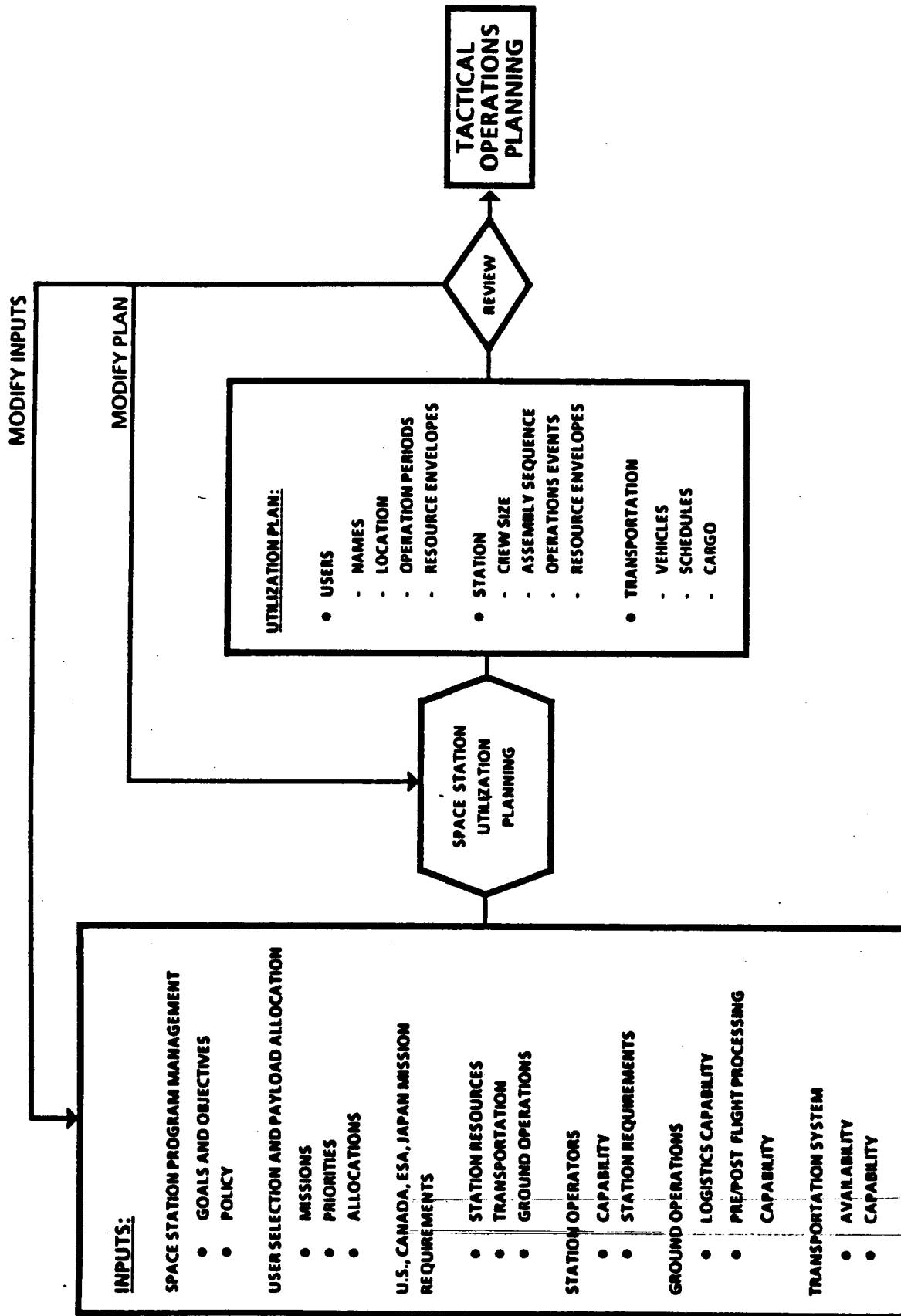
Figure 5-3. Utilization Planning Process

User Selection and Resource Allocation

The output of the User Selection and Resource Allocation
Process is a primary input to the Utilization Planning Process.
It identifies payloads selected for the Station and provides
information about their priorities and resource allocations.
The international partners' inputs are expected to be
utilization plans for their respective users and Station
components. U.S. users will be selected by the U.S. Space
Station User Board (SSUB). Utilization Planning uses the
priority information as a guide for scheduling the payloads.
The priority information will assist in resolving conflicts
associated with scheduling one payload relative to another that
may occur in the development of the Utilization Plan.

The format and content of this input is expected to be in the
form of proposed utilization plans and user data forms similar
to the NSTS Form 100-Request for Flight Assignment.

The information contained in this initial definition of
requirements must be sufficient for Utilization Planning to
schedule the user. In addition to identifying the user, the
priority, and the resource allocation, it will include the
basic information described under User Requirements below.

User Requirements

The users specify their support requirements within the
resource envelopes allocated to them. The planning information
provided in the user selection/resource allocation process will
suffice for initial manifesting but must be augmented for more
detailed analyses. Additional, more detailed data, will be

required for payload engineering, accommodation, integration, safety, training, and other analyses as well. It is expected that a central comprehensive data base, similar to the current Mission Requirements Data Base (MRDB), will be maintained in the Technical and Management Information System (TMIS) for these purposes. Utilization Planning will define its specific informational needs for entry into this data base and utilize it for compatibility and feasibility analyses. The exact set of information required of the users will depend upon the type of payload (e.g., rack mounted, free flying, attached) support required, and the activities to be accomplished. Servicing, logistics, Extravehicular Activity (EVA), reconfiguration, particular crew skills, and other special needs may not be required of all payloads, but must be specified when needed. In general, the following data is needed by Utilization Planning for each user/payload selected for the Station.

- o Payload description
  - -- Activities
  - -- Equipment

- o Schedule parameters
  - -- Time period on Station
  - -- Operations requirements
  - -- Duty cycle

- o Facility requirements
  - -- Internal pressurized volume
  - -- External attach points
  - -- Pointing requirements
  - -- Microgravity requirements

- o Power and thermal requirements

- o Crew requirements
  - -- Hours Intravehicular Activity (IVA) and EVA
  - -- Skills

- o Communication and data requirements

o Transportation requirements
   -- Weight
   -- Volume
   -- Carrier requirements

o Logistics requirements
   -- Orbital Replacement Units (ORU's)
   -- Payload resupply
   -- Payload reconfiguration

o Servicing Requirements

o Orbital Maneuvering Vehicle (OMV) requirements

Station Operations

The Station operators provide the following types of
requirements information to Utilization Planning:

o Station activities to be scheduled:
   -- Assembly
   -- Major maintenance
   -- Reconfiguration
   -- Reboost and attitude adjustment
   -- Servicing

o Facility requirements
   -- Internal pressurized volume
   -- External requirements

o Power and thermal requirements

o Crew requirements
   -- Hours (IVA and EVA)
   -- Skills

o Communication and data requirements

o Transportation requirements
   -- Volume
   -- Weight
   -- Schedule

o   Logistics requirements:
    -- Crew resupply
    -- Reboost propellant
    -- Orbital Replacement Units (ORU's)
    -- Station subsystems resupply

o   OMV requirements

In addition to Station requirements, the operations
organization provides the following capabilities information to
Utilization Planning:

o   Resource availability profiles
    -- Power and thermal
    -- Crew
    -- Internal pressurized volume
    -- Payload Attachment Equipment (PAE)
    -- Communication and data
    -- Microgravity environment
    -- OMV
    -- MSC

o   Station configuration profiles
    -- Center of Gravity (CG)
    -- Altitude
    -- Attitude
    -- Space Station Program Elements (SSPE)
    -- Systems status

Ground Operations

Ground Operations are comprised of the pre- and post-flight
processing facilities and the SSP logistics system. Ground
Operations provides information on the capabilities of the
processing facilities and logistics system to support the SSP
including the following.

o   Logistics carriers

o   Special payload carriers

o   ORUs and spares

o   Station components

o   Crew and station supplies

o   Payload ground processing requirements

Transportation System

The NSTS is the only transportation system baselined to support
the SSP at this time. It is anticipated, however, that
additional vehicles, both manned and unmanned, will transport
payloads to and from the Station in the future.

The NSTS provides information to Utilization Planning as to the
availability of the Shuttle to support the Station's needs.
The NSTS information is in the form of a flight assignment
schedule or transportation manifest which defines and schedules
all Shuttle flights to and from the Station and specifies the
launch and return capability envelopes.

Development of the SSP transportation manifest will be an
iterative process. After integrating user operations and
station operations to develop the transportation requirements,
Utilization Planning proposes specific payloads for each flight
in the NSTS provided SSP transportation manifest. The NSTS
will itegrate the Space Station requirements with other Shuttle
requirements including ground processing and flight performance
capabilities to develop an approved transportation manifest for
the SSP.

Typical information provided by the NSTS to Utilization
Planning includes:

        o   Proposed flight assignments for the SSP
        o   Launch dates
        o   Launch vehicle configuration
            -- Payload launch capability
            -- Payload return capability
        o   Flight performance margins

Typical information provided by Utilization Planning to the
NSTS includes:

o Launch window requirements
o Flight duration
o Crew requirements
o Altitude
o Payload characteristics
  -- CG
  -- Weight
  -- Length
  -- Volume
  -- Carriers
  -- Special interfaces
  -- Late payload access
  -- Secondary payload requirements

o Platform launch windows
o Remote Manipulator System (RMS) requirements
o Consumable requirements
o OMV requirements

As other launch vehicles, both manned and unmanned, become available to support the Station, the responsibilities of the transportation system will expand to include them. This enhanced Transportation Support System (TSS) will be responsible for:

o Managing all NASA launch vehicle program support for the SSP.

o Brokering all non-NASA launch vehicle support for U.S. SSP users, and

o Coordinating/integrating all non-NASA launch vehicle support for the SSP.

It is anticipated that the TSS will be the single organizational contact for all SSP transportation requirements as well as the ground operations interface with the transportation system.

5.2.2 Output

The output from Utilization Planning is a single Space Station
Utilization Plan (SSUP) which covers approximately five years.
In the time period, approximately two to five years in the
future, the SSUP serves as a strategic plan of the expected use
of the Station. This portion of the SSUP is of primary
importance for long range planning, user mission development,
resource allocation, and marketing. In the near term, approxi-
mately the first two years, the SSUP is the control document
which provides direction to tactical operations planning.

The SSUP contains information about user operations, Station
operations, logistics, and transportation including:

- o Launch vehicles
  - -- NSTS flight designation
  - -- Launch/return dates
  - -- Payload assignments (to and from orbit)

- o User/Payload requirements
  - -- Payload designators
  - -- Operations schedules
  - -- Station Locations
  - -- Resource allocations/envelopes

- o Station requirements
  - -- Assembly sequence
  - -- Significant events such as reboost, major
         maintenance, EVA's
  - -- Resource requirements/envelopes

- o OMV activities
  - -- Operations schedules
  - -- Servicing requirements

- o Unused Capabilities

Figure 5-4 illustrates the typical information to be contained
in an SSUP.

		YEAR 3											
		J	F	M	A	M	J	J	A	S	O	N	D

ETR FLIGHTS:

MB	=	ASSEMBLY	
OF	=	PAYLOAD OUTFITTING	
L	=	LOGISTICS	
P	=	PLATFORM	

```
                        ^           ^           ^           ^
                       MB11        MB12        MB13        MB14
            ^           ^           ^           ^
            L2          L3          L4          L5
```

EXTERNAL ATTACHED:	LOCATION	
SAAX 030	K	FIXED
TDMX 2072	K	FIXED
TDMX 4003	K	FIXED
TDMX 2011	K	FIXED
TDMX 2132	K	FIXED
TDMX 2441	K	FIXED
TDMX 2442	K	FIXED
TDMX 2443	K	FIXED
TDMX 4005	K	FIXED
SAAX 207A	UB	POINT
SAAX 207C	UB	POINT
SAAX 207E	UB	POINT
T-001	EF	
T-005A	EF	
T-009	EF	
C-001	EF	
SAAX 112	K	FIXED

MMPF LAB:

- YEAR 2 MMPF EQUIPMENT
- TS 216 FLUIDS PHYSICS
- TS 220 LATEX REACTOR
- TS 207 SMALL BIDGMAN

LIFE SCIENCES LAB:

- YEAR 2 LIFE SCIENCES EQUIPMENT
- TS 153 RHESUS UNIT

LSRF FACILITIES:

- YEAR 2 LSRF EQUIPMENT
- TS 101B ,C CALCIUM HOMEOSTASIS; B,C
- TS 102B CARDIOVASCULAR; B
- TS 103B,C MUSCLE PHYSIOLOGY; B,C
- TS 105A,B EXERCISE; A,B
- TS 106B ENDOCRINOLOGY; B
- TS 107B ,C BEHAVIORAL RESEARCH; B,C
- TS 108B HEMATOLOGY; B
- TS 109AB,C IMMUNOLOGY; A,B,C
- TS 110AB,C NEUROSCIENCE; A,B,C
- TS 112A-E PULMONARY PHYSIOLOGY; A-E
- TS 113A ,B MICROBIOLOGY; A,B
- TS 111A ,B PHARMACOKINETICS; A,B

Unscheduled crew time (hrs/day)	30.4	26.9	28.9	28.7
Unscheduled power (kW)	53.2	51.0	50.9	49.3

L = Launch   R = Return   ═══ = Operating Period   ▬ ▬ ▬ = Checkout Period   • • • • • = On Station-Non Operating Period

Figure 5-4 Example of One Year's Activity of the SSUP

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5.2.3 Utilization Planning Process

The Utilization Planning Process converts the inputs into an
integrated Space Station Utilization Plan (SSUP). It balances
user and Station operations requirements with the capabilities
of the Space Station and the transportation system to produce a
single integrated, operationally feasible plan of activities.
The plan must also be consistent with and reflect the intent of
SSP management's policies and guidelines.

Utilization Planning is a continuing process with revisions
made over time as activities are completed and payloads
returned from the Station, as newly selected users are mani-
fested, as Station capabilities evolve, and as contingencies
arise. This dynamic process, while complex, is fairly
straightforward. An integral part of the process is to conduct
feasibility analyses and compatibility assessments of Station
requirements and capabilities. These activities make the
process iterative. Initial inputs are merged into a candidate
plan and analyses are performed to determine feasibility.
Modifications are made to the plan and/or inputs until a
feasible and acceptable plan is achieved. It is expected that
computer tools will be extensively employed for the
"bookkeeping" involved in tracking and balancing resources.
Expert systems will also be used to insure the planners do not
violate groundrules and guidelines during the scheduling
process.

The following assumptions were used in developing the
Utilization Planning process.

o The planning process schedules all payload assignments and defines each payload complement on vehicles going to and from the Station. Payloads include all user equipment and materials, station components (assembly and growth), station and user logistics, other cargo elements (such as the OMV), and the associated carriers.

o The planning process schedules all payload assignments and defines each payload complement on the OMV.

o The planning process schedules major station operations events, such as transportation vehicle visits, OMV deployments and retrievals, assembly milestones, reboosts, etc.

o The planning process schedules users who are selected by the international partners and the U.S. SSUB.

o Users are selected by each partner consistent with the level of resources allocated to the partners by the Multilateral Coordination Board (MCB).

o The international partners will independently select their users and prepare Utilization Plans within their allocated resources.

o Users are selected by each of the U.S. sponsors consistent with the level of resources allocated to the sponsor by the U.S. SSUB.

o The U.S. SSUB and the partners each specify the order of priority of their selected users with some flexibility allowed to ensure efficient utilization.

o The planning process assigns all users to the element(s) in which they will be located and schedules the time period they will be on the Station.

The Utilization Planning process involves a set of planning activities, conducted in parallel by the partners, that are integrated into the total Station plan. It has two distinct phases: development of the initial baseline SSUP and follow-on continuous replanning. Figure 5-5 illustrates the flow of the process for development of the initial baseline SSUP. It is an
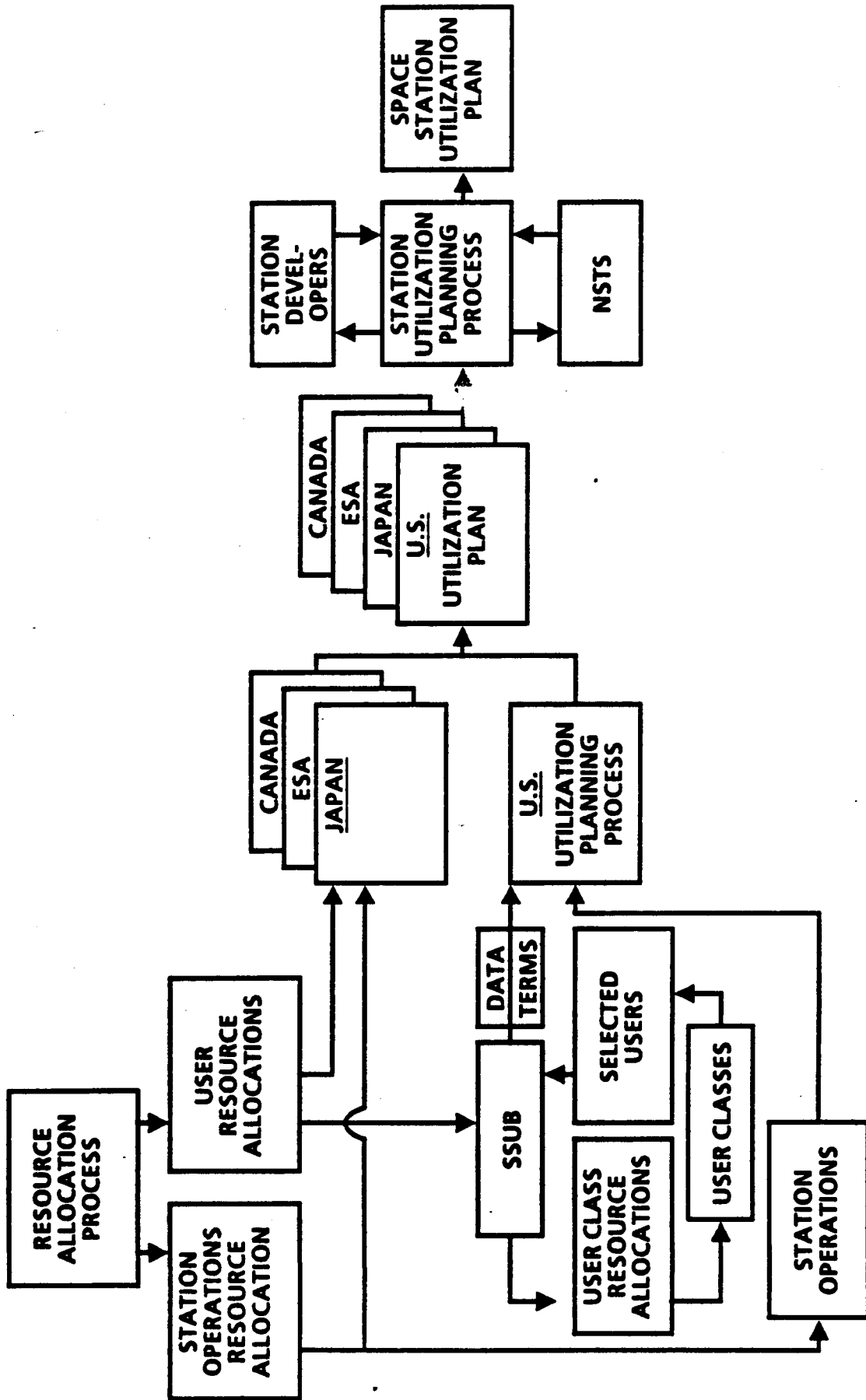
Figure 5-5. Initial SSUP Development Flow

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iterative activity, but can be viewed as commencing with the division of the total Station resources into those required to operate the Station's systems and those available for users. Each of these is further subdivided among the partners.

The partners will establish their own internal processes for developing their utilization plans. These will include both user activities and systems operations. The U.S. process interfaces with the U.S. SSUB, which selects users and the Station system operators who plan U.S. Station operations.

The integration of these two U.S. activities is the proposed U.S. Utilization Plan. Similar proposed utilization plans are developed by the international partners and are the initial input to the Space Station Utilization Planning process. The separate partner plans include detailed schedules of all activities desired to be accomplished over a five to six year period of time. They also are within the resources allocated to each partner.

The Utilization Planning process integrates the four partner plans by mission increment (time between launch vehicle visits to the Station). Assessments are performed, as needed, to ensure compatibility among the separate activities and feasibility with overall Station capabilities. As part of this process, the planners coordinate transportation needs with the NSTS and capabilities with the Station developers and operators. For conflicts which are identified, the planners develop alternatives within each partner's resource allocation to resolve them. Mission Increment Plans (MIP) are then integrated into a unified U.S. SSUP. Alternatives for any additional conflicts are also developed. The result at this point is a preliminary SSUP with identified changes to each

partner's proposed utilization plan. An iterative review/revision process with the partners results in a recommended plan which is presented to Space Station management for approval and baselining.

Development of the initial baseline plan will be a lengthy process with much interaction between the planners, the international partner's organizations, the U.S. SSUB, the Station developers, operators, and the NSTS. During this time the Utilization Planning process procedures will be developed and groundrules, guidelines, templates, and resource envelopes defined. Once the initial SSUP is baselined, SSP activities will become focused on a common plan and tactical operations planning can be initiated.

Baselining of the first SSUP initiates the second phase of the Utilization Planning process. This is illustrated in Figure 5-6. The major characteristics of the second phase are that the partners are working to their own utilization plans, which are subsets of the SSUP, and the Utilization Planning process is revising, as opposed to developing, plans. Changes which affect the plan will come from a number of sources; the users, the Station developers and operators, and the NSTS. The partners will also revise and update their lists of selected users. Bartering/trading of resources is also anticipated to occur. The Utilization Planning process will assess the current SSUP, propose necessary revisions, and coordinate a recommended revised plan. Coordination will include the NSTS and Station developers as well as the partners' utilization planning organizations. The time and effort required to accomplish the replanning will vary according to type of change that is required. Feasibility and compatibility analyses of
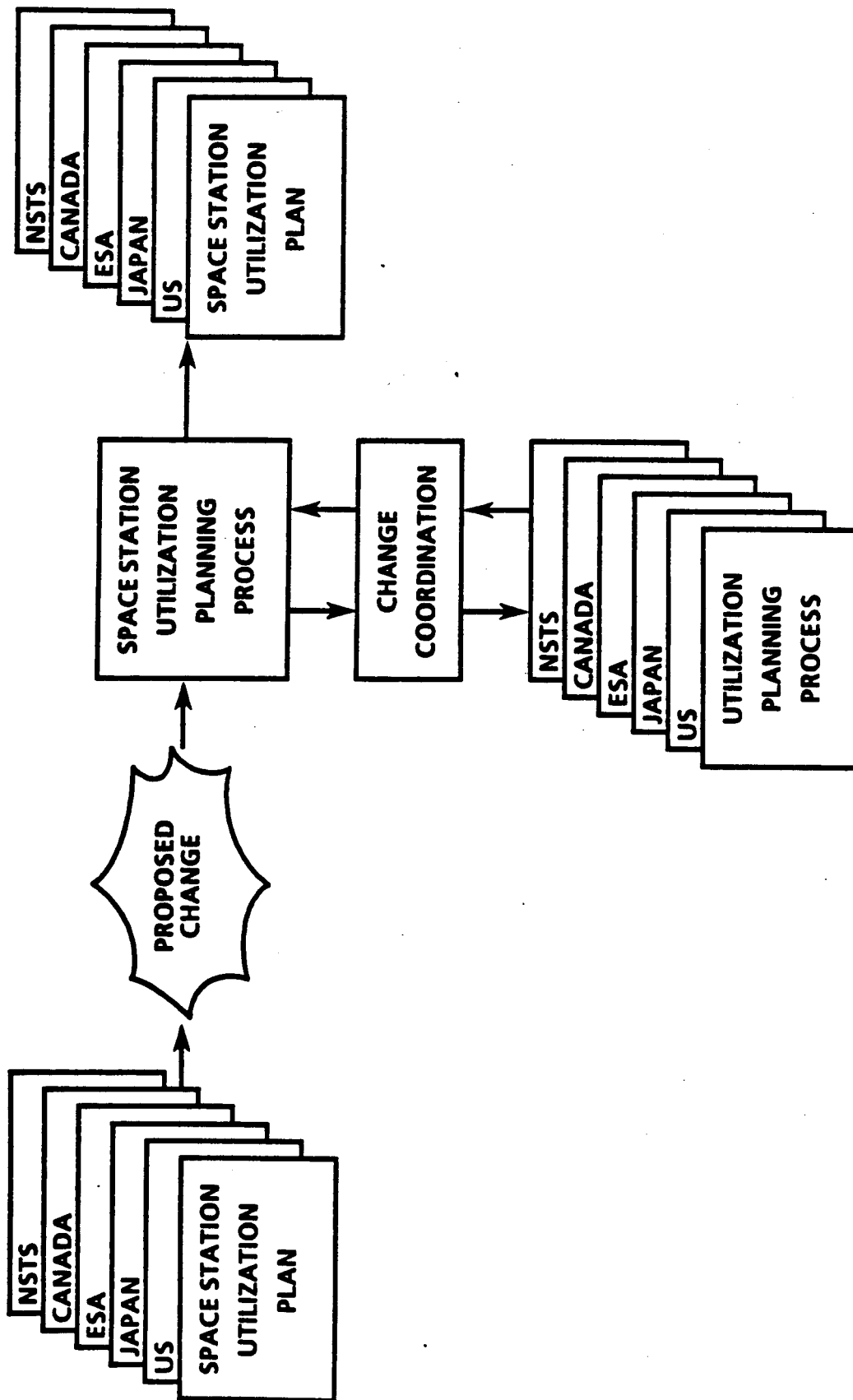
5-23

Figure 5-6. SSUP Replanning Flow

various levels of detail may be required. What-if assessments
of alternative plan changes may also be necessary before
agreement is reached among all involved organizations. Many
changes are expected to be routine and will be incorporated in
periodic, planned updates of the SSUP - approximately on a
quarterly basis. Other changes may be of a more severe nature,
either a major impact to the SSUP or time critical, and will
require a more intense replanning effort.

As Utilization Planning includes a diversity of activities to
be conducted over several years and is an on-going process, it
is instructive to look at it as a function of time. The
planning horizon consists of two distinct time periods --
strategic and tactical.

Strategic Time Period

Planning in the strategic time period, roughly two to five
years in the future, is primarily for coordinating the
long-range planning and budgetary process of program
participants. The level of detail of the information available
to the planners is usually much less than they have for the
near future.

During the strategic time period, Station and payload hardware
are being developed and operating plans and NSTS manifests are
being formulated. Planning is based on projected capabilities
and requirements. As we move closer in time to launch,
hardware development nears completion, schedules become more
firm, and the actual payload requirements and Station
capabilities become better known. It is during the strategic
time period that Utilization Planning has the greatest
flexibility to make adjustments and to accommodate changing

payload requirements. Planning can be responsive to trades and barters of resources between classes of U.S. users or the international partners, to development schedule changes, and revised lists of selected users and/or their priorities. Feasibility assessments which are performed as a part of Utilization Planning during the strategic time period are not comprehensive, but designed to identify any major areas of incompatibility. It is foreseen that changes in the SSUP for the strategic time period will be geared to individual mission and system changes and incorporated on a routine basis.

Tactical Time Period

The utilization plans which were developed in the strategic time peroid and have now moved into the tactical time period, become the controlling document for tactical operations planning. User requirements are well defined and trading or bartering of resources among users is restricted. The Station configuration and support capabilities are well understood and the NSTS integration process has been initiated. During this time period, changes to the SSUP are the result primarily of contingency events taking place on the station or during the integration process. Figure 5-7 illustrates the flow of activities that take place during the tactical time period.

Contingencies that occur during execution will be handled by user and station operations organizations. Some contingencies, however, may also impact later activities and schedules. The SSUP will then be revised and impact assessments performed until new, feasible, acceptable plans are developed. If only minor modifications are needed, the process to incorporate the changes is straightforward; however, changes in the tactical time period can only be made to the extent that the operations organizations can support them before execution.
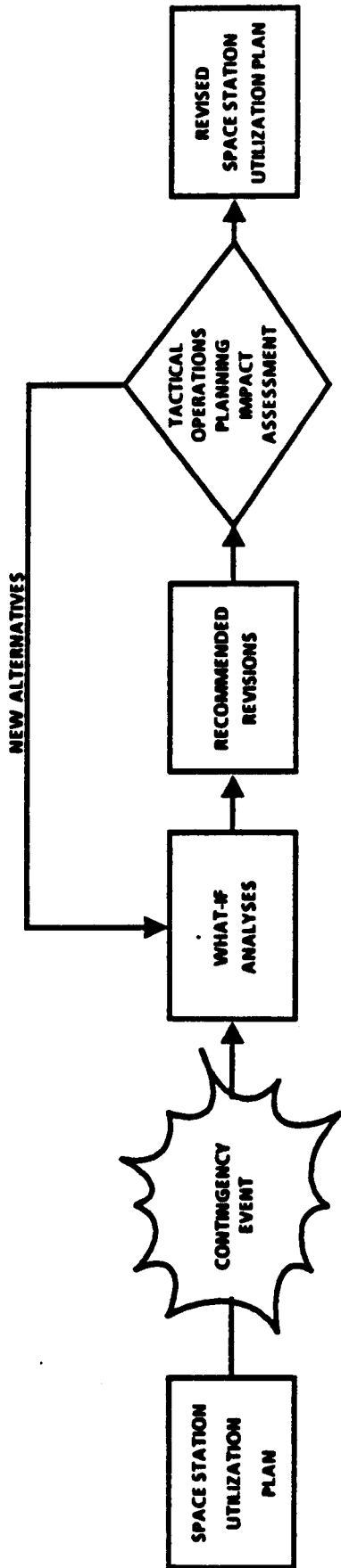
Figure 5-7. Additional Utilization Planning Functions During Tactical Time Period

5.3 UTILIZATION PLANNING ORGANIZATIONAL CONCEPTS

This section describes several operations concepts for
Utilization Planning with emphasis on the organizational
functions, structures, and interfaces that are involved. The
concepts were developed from options discribed in several of
the documents that were reviewed and alternatives suggested by
subpanel members during the course of its deliberations.

There are two general approaches to planning: centralized and
distributed. In the centralized concept, there is a dedicated
planning group which is responsible for preparing plans for the
organization. The plans are passed to the operational elements
for execution. This can be viewed as a top-down planning
approach. The planning group can be located at a number of
places within the organization, for example, in a NASA
Headquarters office or a NASA field center's line organization,
or be part of an international body. Distributed planning is a
bottoms-up approach. Various organizational components prepare
plans, coordinate them with each other, obtain approval from
management, and execute them. In this approach, there must be
some mechanism for integrating the plans before they are
executed, however, this effort usually requires less dedicated
personnel than the centralized approach. There are also
several ways to distribute the planning; for example, among the
partners, by SSPE (labs, platforms, truss, etc.), or among the
major program functional interests, i.e., the users, station
operators, and transportation logistics organizations.

Three operations concepts have been developed in detail and are
described in this Section. Each discusses the functions and
interfaces of a Utilization Planning Office (UPO) relative to
the SSP organization, how the planning process is accomplished,
and the features and benefits of the concept.

5.3.1 Centralized Utilization Planning (Centralized NASA Planning with International Participation)

The Centralized Utilization Planning concept is a variation of the NSTS manifesting process. The UPO is a line organization at NASA Headquarters which coordinates analysis support provided by the centers and international partners through working groups similar to the NSTS Flight Assignment Working Group (FAWG). The UPO differs frc~ the NSTS manifesting organization in that it is an office independent of user, space, and ground operations and has user and station operations representatives co-located in the office. The Centralized Utilization Planning Concept is envisioned for the DDT&E and initial operational phase of the SSP.

1. Organizational Functions

In the Centralized Utilization Planning Concept, the UPO is a NASA Headquarters line organization reporting to Space Station Management as shown in Figure 5-8. The Office is staffed by NASA personnel. Representatives from the operations organizations, and the international partners are co-located in the office to participate in the development of the Utilization Plan and provide a liaison with their organizations. International representatives are also co-located in the UPO to represent the interests of the partners in management of the utilization planning process. The UPO is responsible for development of the SSUP and the integration of the four partner plans Figure 5-9 depicts the functions of the Office which are described below.
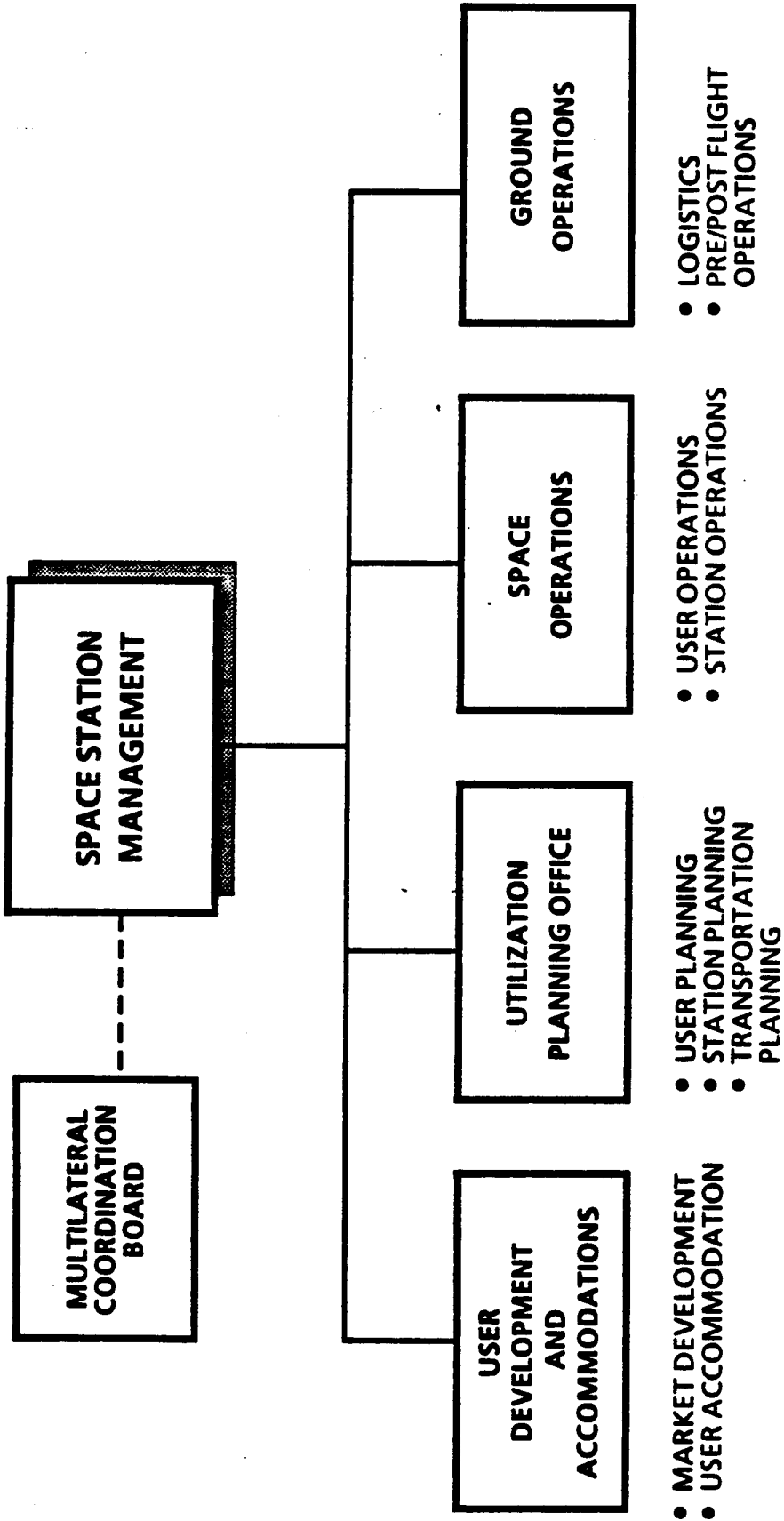
Figure 5-8. Space Station Program Organization (Centralized Concept)

UTILIZATION PLANNING OFFICE

REPRESENTATIVES (U.S., CANADA, ESA, JAPAN)
- SUPPORT PLAN DEVELOPMENT
- PROVIDE LIAISON

USER PLANNING
- MISSION ASSIGNMENTS
- DIRECT FEASIBILITY ANALYSES
- INTEGRATE USER PLANNING

STATION PLANNING
- INTERFACE WITH SUSTAINING ENGINEERING
- INTERFACE WITH SPACE OPERATIONS
- INTEGRATE SYSTEM PLANNING

TRANSPORTATION PLANNING
- NEGOTIATE STS TRANSPORTATION
- DEFINE PAYLOAD FLIGHT ASSIGNMENTS
- DIRECT PRE/POST FLIGHT ANALYSES
- INTEGRATE TRANSPORTATION PLANNING

ANALYSIS
- SUPPORT USER SELECTION PROCESS
- TREND ANALYSES
- POLICY EVOLUTION
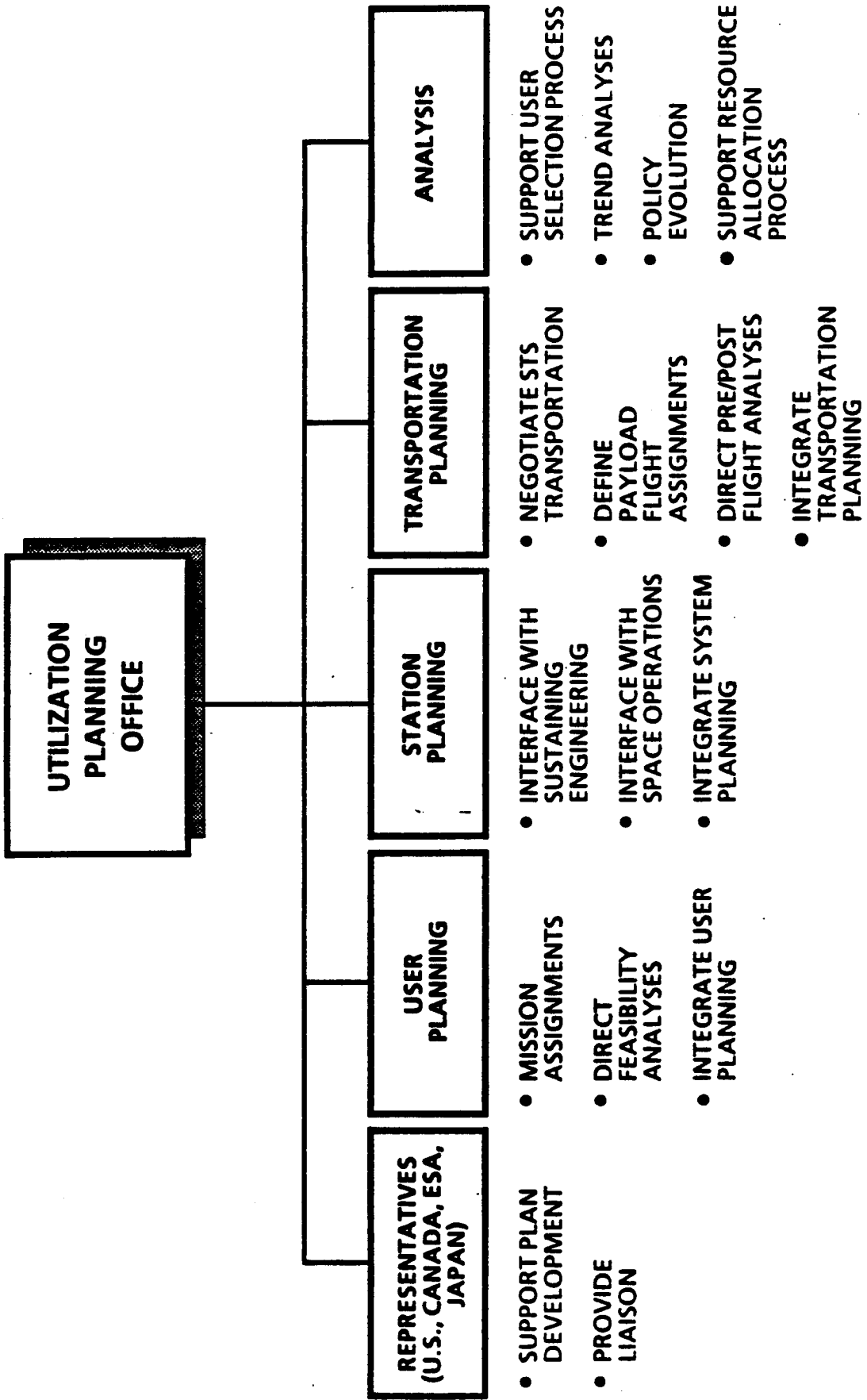- SUPPORT RESOURCE ALLOCATION PROCESS

Figure 5-9. Utilization Planning Office Functions (Centralized Concept)

User Planning

User Planning is responsible for making payload assignments for both the U.S. and international partners. A payload assignment identifies the Space Station element, operational period, and associated resources for the payload. This function requires interfacing with the U.S. and international partners' utilization planning processes. The U.S. groups include the U.S. SSUB, the NASA sponsors, other government agencies, commercial enterprises, and the Space Station User Working Group (SSUWG). A representative from user operations assists User Planning in directing the feasibility analyses and compatibility assessments necessary to support payload assignments.

Station Planning

Station Planning works with sustaining engineering and the space operations organizations to develop plans for the assembly of the Station, the system operations required for maintenance of the Station, and support of payload operations.

Transportation Planning

Transportation Planning integrates the U.S. and international partners' transportation requirements and negotiates with the NSTS for flight assignments on the NSTS manifest which provide the necessary transportation capability. Transportation Planning also defines the payload flight assignments for the SSP and directs pre- and post-flight operations analyses required to support the SSP transportation manifest.

Analyses

The UPO also has a responsibility to perform analyses in support of the user selection and resource allocation process and to provide Space Station Management with visibility into how the goals and objectives of the SSP are being met. It conducts assessments of Station utilization, performs trend analyses, identifies unused capabilities, evaluates policies, and conducts studies to assist in long range planning. The group also provides the forecasts of available resources to the MCB for use in the resource allocation process.

2. The Utilization Planning Process

The UPO manages the Utilization Planning process through the Space Station Utilization Planning Working Group (SSUPWG). The SSUPWG is chaired by the UPO. Membership includes representatives from each partner's user and space operations organizations and U.S. ground operations as shown in Figure 5-10. The user community participates in the SSUPWG as advisors. The UPO prepares an integrated SSUP which is given to the international partners and U.S. operations organizations for feasibility and compatibility evaluations. The SSUPWG will review the compatibility assessments and feasibility analyses and identify issues. The SSUP is modified as required to resolve conflicts. The UPO also participates in the FAWG to coordinate SSP flight assigments.

3. Features and Benefits

The Centralized Utilization Planning concept provides a focused development of the SSUP that is responsive to SSP management. Centralized development results in plans that maximize use of SSP resources and capabilities.
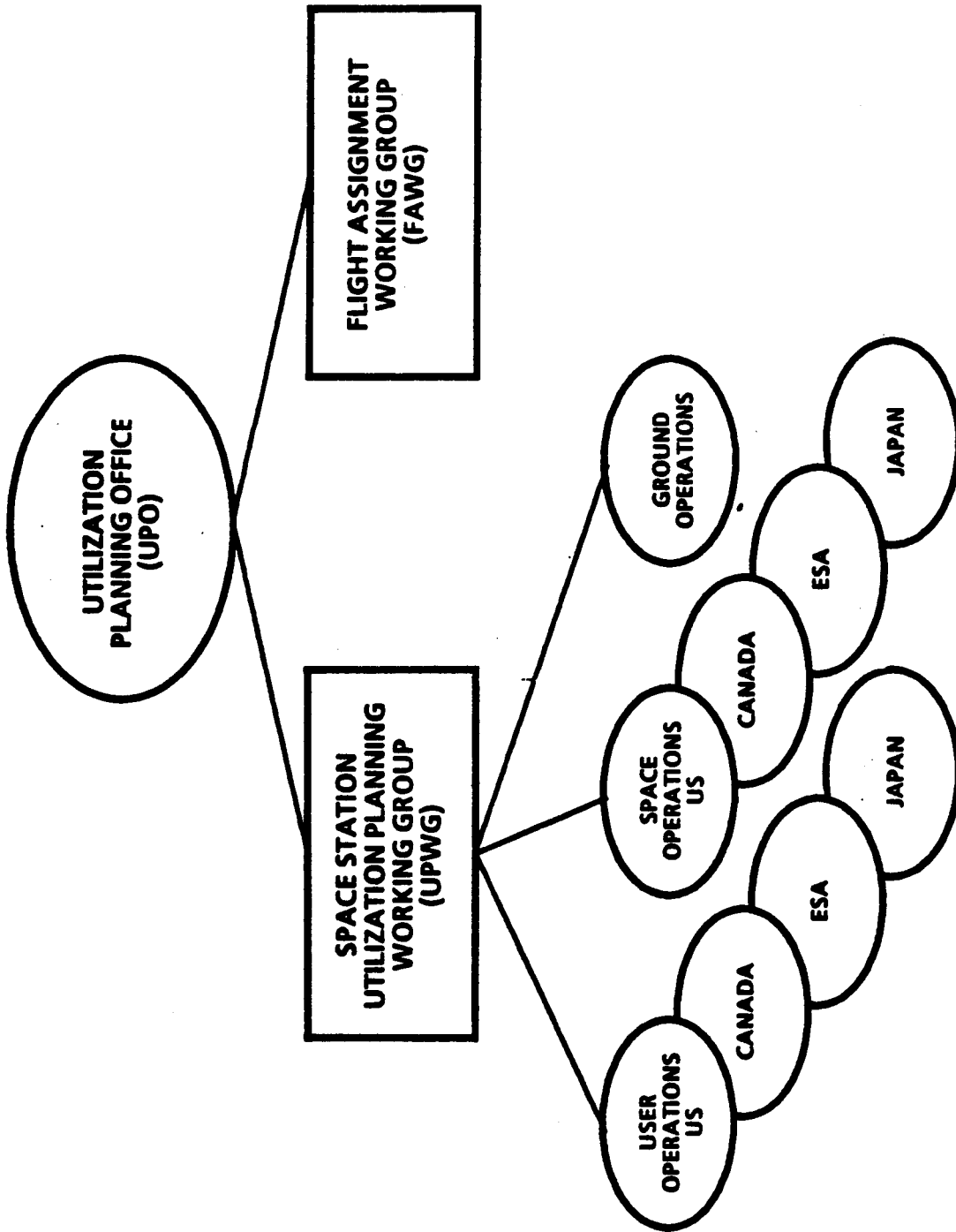
Centralized Utilization Planning Interfaces
Figure 5-10

A dedicated planning organization will focus the development of the guidelines and procedures required in Utilization Planning. This is very important in the early stages of the program.

Establishing the UPO, as a line organization, at NASA Headquarters facilitates the interfaces with organizations outside the SSP such as the international partners and Codes E, I, R, and M. A Headquarters line organization can also respond quickly to management questions about the limitations, constraints, and capabilities of the SSP. As a separate office, the UPO can better reflect the goals, objectives, and policies of the SSP and minimize bias toward the users, operators, engineering, or transportation organizations.

The development of an integrated plan by the UPO depends on data and analytic support from other organizations such as the user community, the international partners, the SSP operations organizations, and the NSTS. This can be a difficult challenge. The Office must manage a large number of interfaces with supporting organizations over which it does not have direct line authority. Data acquisition is accomplished through networks such as the Technical and Management Information System (TMIS) and other data bases not under the control of the UPO. Representatives from the international partners and the operations organizations are co-located in the UPO to help overcome these problems. While a centralized Headquarters UPO is more responsive to management, it tends to be less responsive to the users.

5.3.2 Distributed Utilization Planning (NASA Line Organization Planning and Centralized Integration with International Participation)

In Distributed Utilization Planning, planning functions such as mission assignments and transportation planning are accomplished by U.S. operational line organizations in conjunction with the international partners. The role of the UPO is focused on management of the planning process and integration of the total SSUP. The UPO controls the distributed planning through the Space Station Utilization Planning Panel (SSUPP). It is recommended that the Distributed Utilization Planning be implemented after initial on-orbit operations have been established.

1. Organizational Functions

In the Distributed Utilization Planning concept, the UPO is a NASA Headquarters staff organization reporting to the Space Station Management as shown in Figure 5-11. The Office is staffed by NASA personnel. Representatives from the international partners are co-located in the Office to represent the interest of the international partners in the management of the Utilization Planning process.

The UPO is responsible for coordinating the planning activities of several U.S. line organizations and the international partners in order to produce a single integrated SSUP. User, station, and transportation planning is accomplished by the U.S. operational line organizations in conjunction with the international partners. Figure 5-12 depicts the functions of the Distributed UPO. The UPO is responsible for communicating the SSP goals, objectives, and policies to all organizations
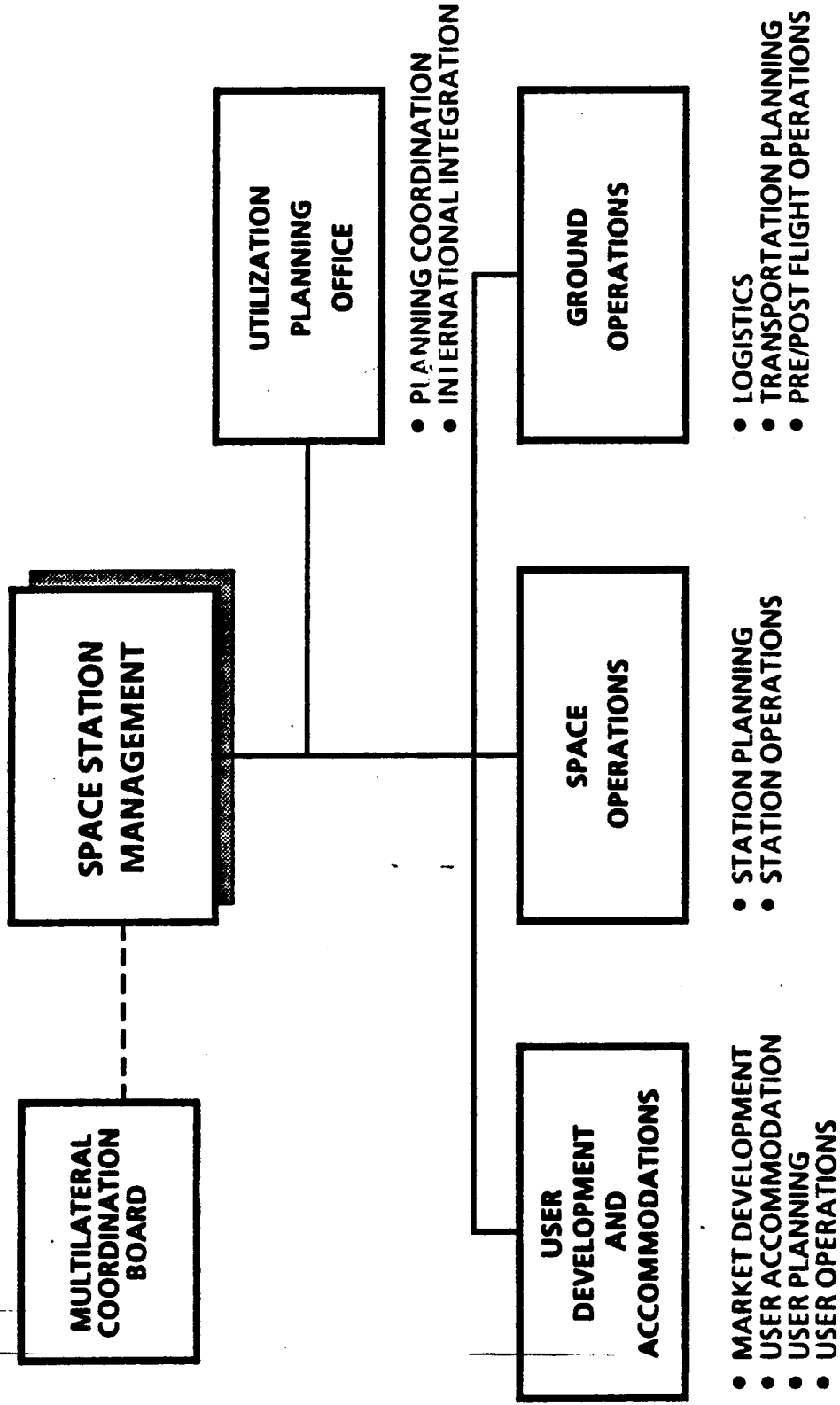
Figure 5-11. Space Station Program Organization (Distributed Concept)

MULTILATERAL COORDINATION BOARD

SPACE STATION MANAGEMENT

UTILIZATION PLANNING OFFICE
- PLANNING COORDINATION
- INTERNATIONAL INTEGRATION

GROUND OPERATIONS
- LOGISTICS
- TRANSPORTATION PLANNING
- PRE/POST FLIGHT OPERATIONS

SPACE OPERATIONS
- STATION PLANNING
- STATION OPERATIONS

USER DEVELOPMENT AND ACCOMMODATIONS
- MARKET DEVELOPMENT
- USER ACCOMMODATION
- USER PLANNING
- USER OPERATIONS

Figure 5-12. Utilization Planning Office Functions (Distributed Concept)

UTILIZATION PLANNING OFFICE (UPO)

REPRESENTATIVES (CANADA, ESA, JAPAN)
- REPRESENT PARTNER INTEREST

COORDINATION
- ESTABLISH ENVELOPES AND GUIDELINES
- INTEGRATE PLANNING
- ARBITRATE CONFLICTS

ANALYSIS
- SUPPORT USER SELECTION PROCESS
- TREND ANALYSES
- POLICY EVOLUTION

involved in the planning process. The office is also
responsible for directing analyses to support the user
selection process, for providing Space Station management
visibility into how the program is achieving its goals and
objectives, and for providing forecasts of available resources
to the MCB for use in the resource allocation process.

2. The Utilization Planning Process

The Space Station Utilization Planning Panel (SSUPP) is the
forum used to manage the Distributed Utilization Planning. The
SSUPP is chaired by the UPO and supported by the user, space,
and ground operations organizations as shown in Figure 5-13.
Planning activities of the individual organizations are
completed within an established set of envelopes and guidelines
provided by the UPO. The operations organizations provide the
UPO with the information required to produce an integrated SSUP
which is then presented to the SSUPP for review. The SSUP is
modified as required to resolve conflicts. The ability to
integrate user, station, and transportation planning is
dependent on the flexibility and trade-offs incorporated into
the planning by each organization.

The Multilateral User Planning Working Group (MUPWG) and the
Flight Assignment Working Group (FAWG) are shown on Figure 5-13
to reflect the integration responsibilities of the operations
organization involved in the planning process. User operations
integrates the payload assignments of the U.S. and
international partners through the MUPWG. Each of the partners
is responsible for their own user planning to the maximum
extent possible. It is important to note that user planning is
integrated outside the SSUPP, thus, the user operations
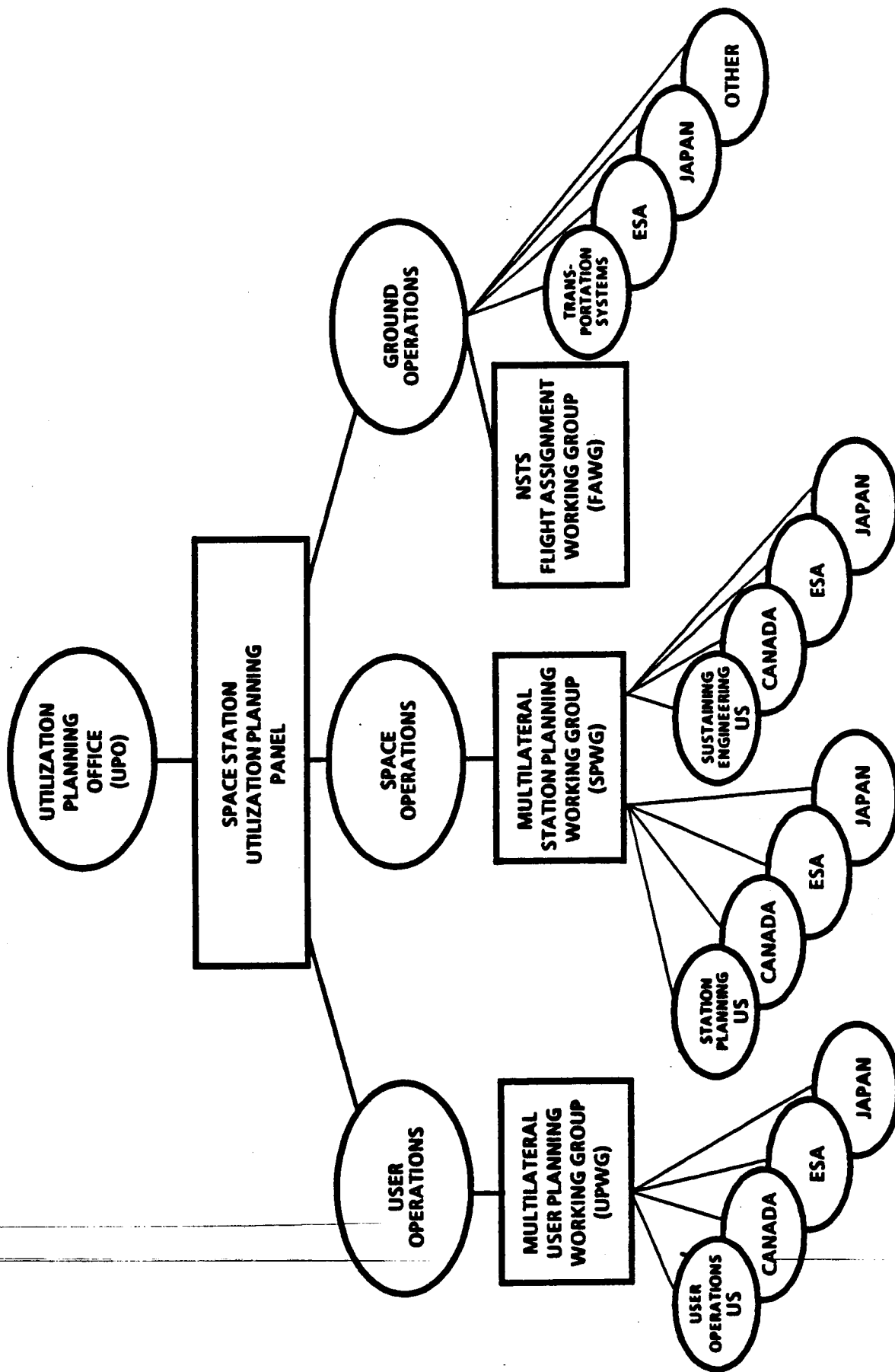organization must represent all users at the SSUPP. Similarly,

Figure 5-13. Distributed Utilization Planning Interfaces

the space and ground operations organizations are responsible
for integrating the requirements of all station elements and
transportation systems, respectively. Ground operations will
eventually be involved in the planning of multiple
transportation systems as they are added to the program.

3. Features and Benefits

In the Distributed Utilization Planning Concept, the UPO
focuses its attention on the integration and management of
planning activities. The actual development of the U.S. plan
has been delegated to U.S. operational organization. The UPO
is responsible for overall integration of the SSUP between the
user, station operations, and transportation system organiza-
tions and international partners. However, integration of
planning activities are done in a multilateral forums such as
the MUPWG. The SSUPWG and SSUPP in the Distributed Utilization
Planning concept provide the users, the station operators, and
the international partners several points of appeal in the
planning process before needing to contact Space Station
Management or the MCB.

Distributed Utilization planning reduces the number of
interfaces that must be managed by the UPO.

Several improvements are realized as a result of locating
planning activities in the organizations that will eventually
execute the plan. For example, by locating user planning in
the user operations organization, the flow of information from
new and current users to the planning process is improved. The
users recognize the user operations organization as a single
point of contact. The quality of work life is improved by
allowing the operations organization to develop the plan they
will eventually have to execute.

5-41

C-3

Distributing development of the SSUP into three separate
organizations can result is less efficient utilization of the
Space Station resources. The concept assumes that envelopes
and guidelines for user, station, and transportation planning
have been established. This approach makes it more difficult
to ensure the complete use of all resource margins. Delegation
of the planning activities also makes the coordination and
integration of the Utilization Plan more difficult. In
addition, quick response to what-if analyses will be difficult
to obtain.

5.3.3 Partner Utilization Planning (Independent Partner Planning and International Integration)

The Partner Utilization Planning concept is designed to allow
independent Utilization Planning by each of the partners.
Integration of the partners' planning activities is the
responsibility of a Multilateral Utilization Planning Panel
(MUPP). Distributed Utilization Planning would evolve into
partner Utilization Planning as Space Station operations mature
and become routine.

1. Organizational Functions

The Multilateral Utilization Planning Panel, shown in
Figure 5-14, reports to the MCB and is composed of
representatives from each partner. The Panel is chaired by the
U.S. representative who is the manager of the NASA UPO. The
MUPP is responsible for overall coordination and integration of
the partners' planning activities to produce the SSUP. The
Panel also provides forecasts of available resources to the MCB
for use in the resource allocation process.

5-42
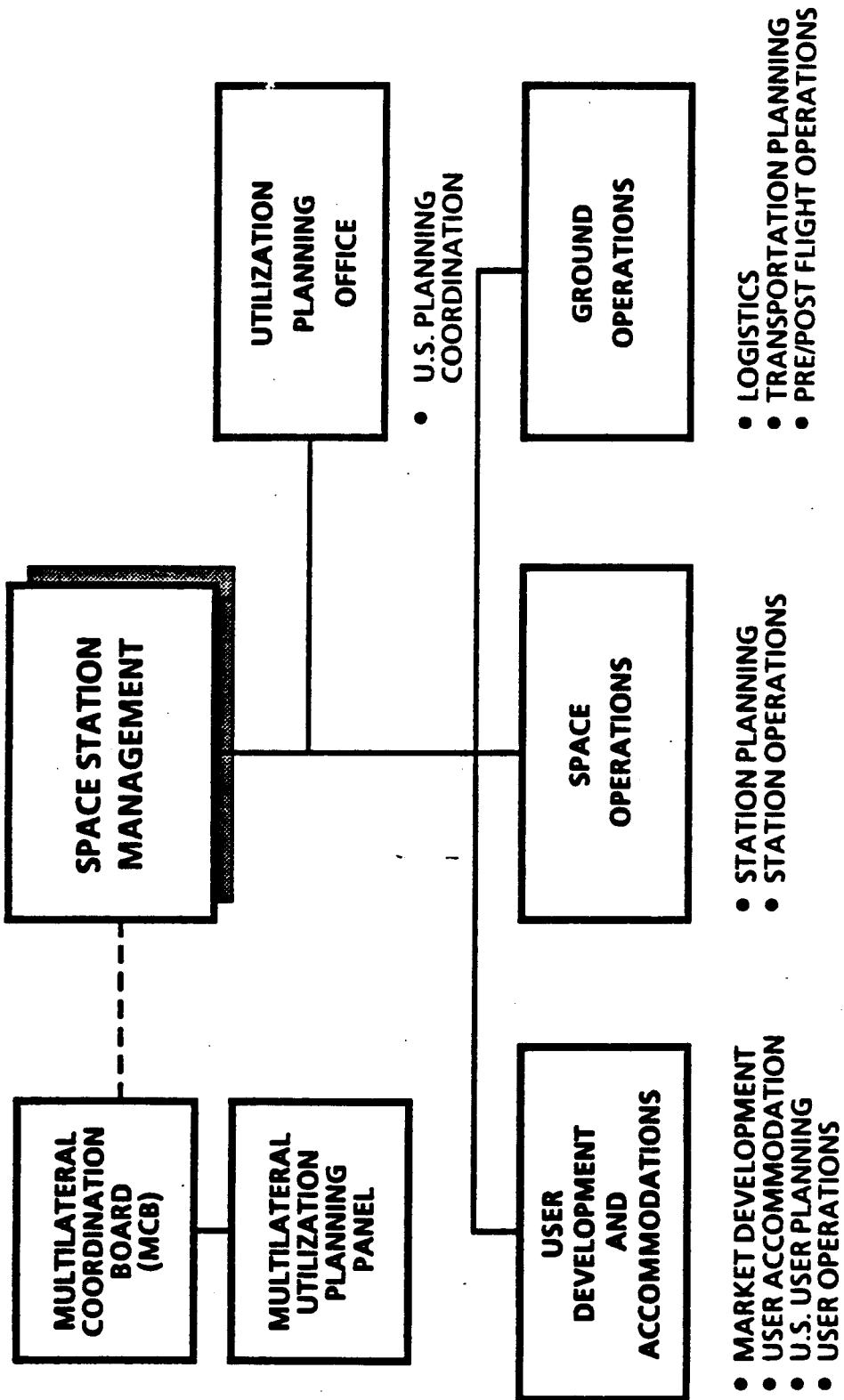
Figure 5-14. Space Station Program Organization (Partner Concept)

MULTILATERAL COORDINATION BOARD (MCB)

MULTILATERAL UTILIZATION PLANNING PANEL

SPACE STATION MANAGEMENT

UTILIZATION PLANNING OFFICE

- U.S. PLANNING COORDINATION

USER DEVELOPMENT AND ACCOMMODATIONS

- MARKET DEVELOPMENT
- USER ACCOMMODATION
- U.S. USER PLANNING
- USER OPERATIONS

SPACE OPERATIONS

- STATION PLANNING
- STATION OPERATIONS

GROUND OPERATIONS

- LOGISTICS
- TRANSPORTATION PLANNING
- PRE/POST FLIGHT OPERATIONS

The NASA UPO is responsible for coordinating the development of the U.S. Utilization Plan. Representatives from the international partners are no longer co-located in the Office. The functions of the NASA UPO in the Partner concept are depicted in Figure 5-15. The NASA Office is responsible for coordinating U.S. user, station, and transportation planning activities in conjunction with the comparable planning organizations of the international partners. The UPO also supports the U.S. user selection process and provides NASA management visibility into how the SSP is achieving its goals and objectives.

2. The Utilization Planning Process

Each partners' plans are completed within a set of envelopes and guidelines established by the MUPP. Integration of the plans is accomplished through working groups. These interfaces are depicted in Figure 5-16. The panel arbitrates any conflicts that cannot be resolved in the working groups. The MUPP could grow out of the Space Station Utilization Planning Panel established by NASA in the Distributed concept. The working groups in the Distributed concept have previously been established as multilateral working groups. Figure 5-17 shows in more detail the relationship between NASA and the multilateral planning organizations.

3. Features and Benefits

The Partner Utilization Planning Concept accomplishes the international partners' desires for independent planning. Each of the partners develop their own plans with coordination and integration accomplished in an international forum. This concept requires that each partner have detailed knowledge of station and transportation capabilities and constraints. It
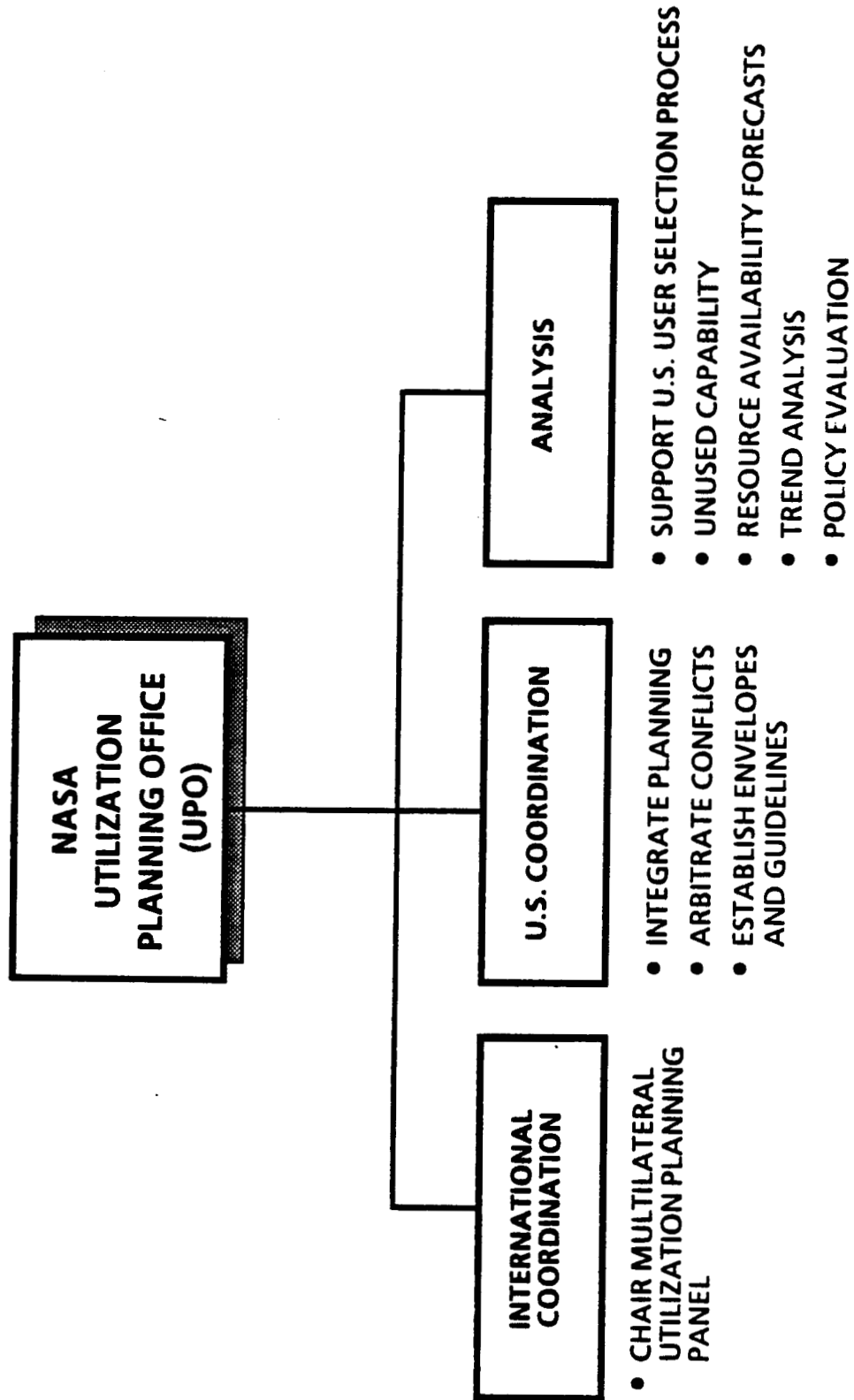
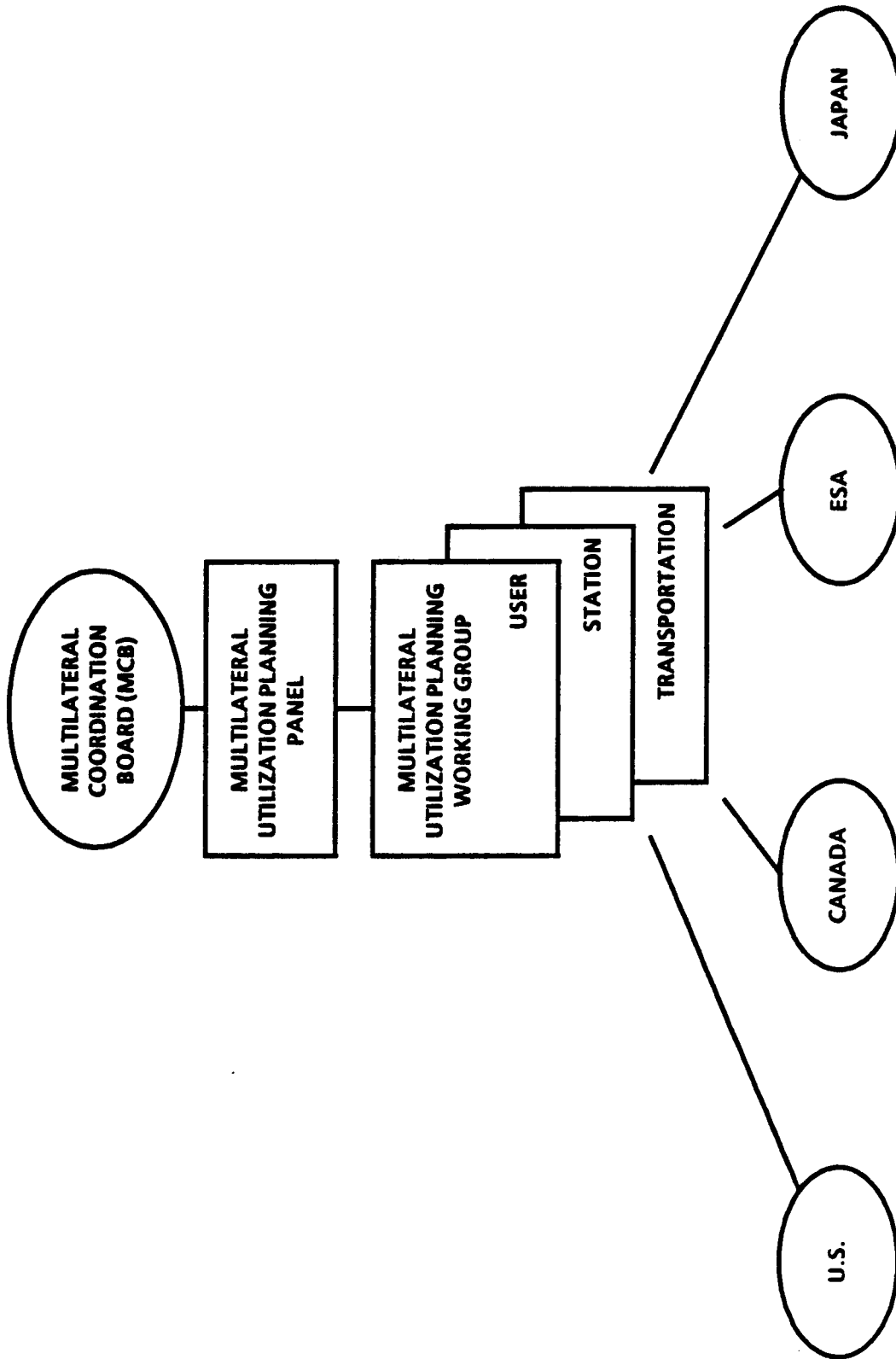**Figure 5-15. Utilization Planning Office Functions (Partner Concept)**

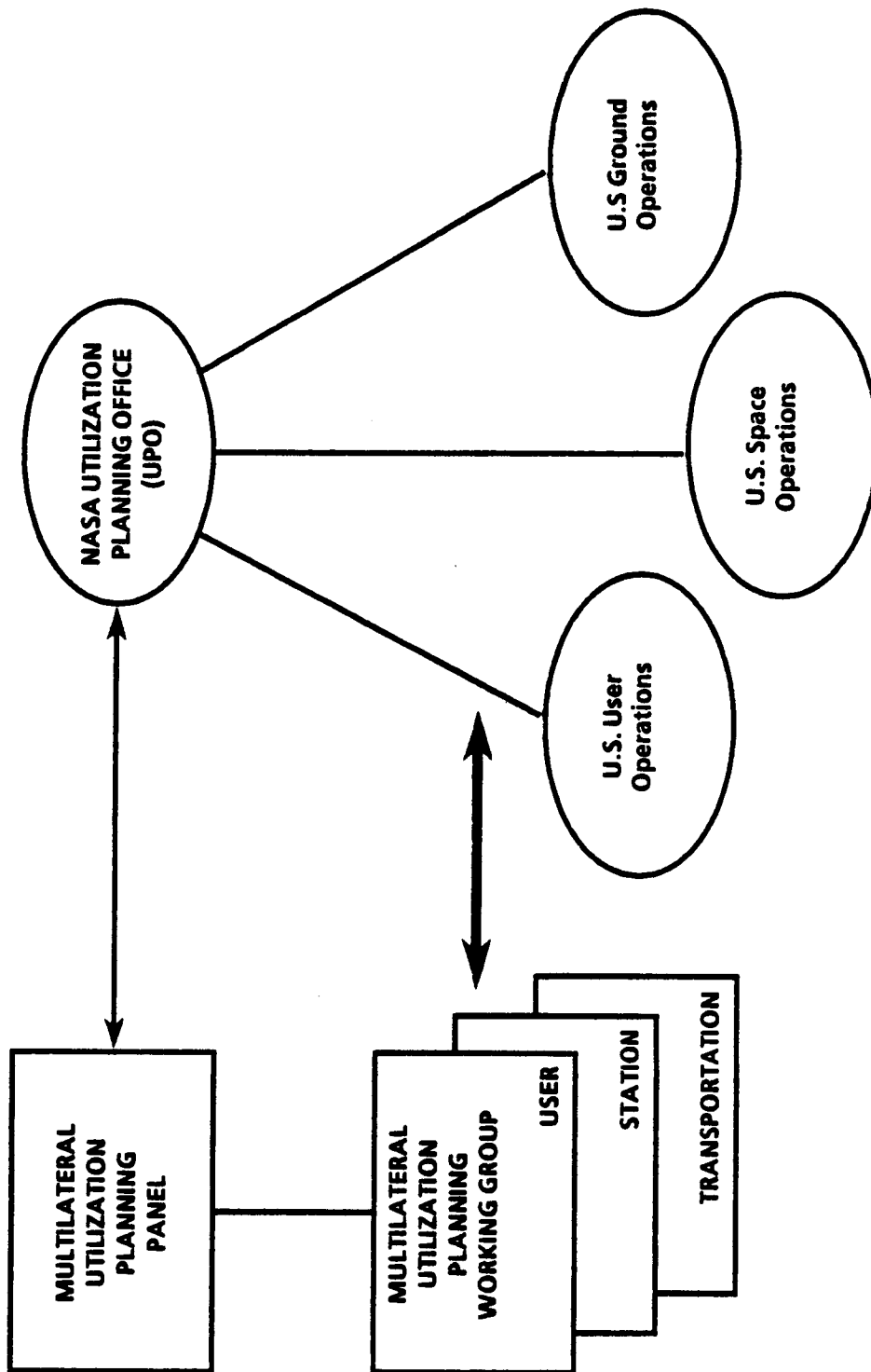Figure 5-16. Utilization Planning Interfaces (Partner Concept)

Figure 5-17. Relationship Between NASA and Multilateral Planning Organizations for Partner Concept

will be difficult to obtain a coordinated, quick response to contingency events which require replanning.

5.4 MANIFESTING SUMMARY AND RECOMMENDATIONS

The manifesting subpanel's operations concept is based on the following assumptions:

o   The Space Station needs a long-range (5 year), top-level Space Station Utilization Plan (SSUP) which defines where the program is going and what it hopes to accomplish. Users, Station builders, the NSTS and other transportation suppliers, and Station operators need long-range commitments in order to plan, budget, and coordinate their activities.

o   The partners will independently select their users and prepare utilization plans within their allocated resources.

o   The individual utilization plans must be integrated to ensure compatibility of operations, safety of the Station and crew, and efficient use of Station's limited resources.

o   The U.S. as the principal partner in the Station (70 to 80%) and NASA, as its agent, will have the lead role for coordination, development, integration and control of the SSUP.

o   The SSUP is the Program control document that:

   --   Schedules all users to the Station, including element assignments, resource envelopes, and logistics support,

   --   Schedules all major on-orbit Station activities, including assembly, maintenance, and reboost, and

   --   Manifests all Station transportation support.

These assumptions provide the framework for the manifesting concept. From them the subpanel concluded that the SSP requires an organization, the Utilization Planning Office (UPO), that has responsibility for:

o   Developing the U.S. Utilization Plan,

o   Obtaining NSTS and other launch support for the
    Station, and

o   Integrating the four partners' utilization plans into
    the top-level, long-range SSUP in a manner that is
    responsive to SSP management.

The SSUP defines what activities are to be accomplished on the
Station and when they are to be done. It is the baseline for
the Tactical Operations Plan (TOP). The TOP defines how the
SSUP will be implemented and provides the next level of
detailed planning information. TOP is the operations control
document and baseline plan for the Mission Increment Plans
(MIP's). The MIP's specify how the TOP is to be executed and
provide the additional level of detail needed for execution.
Operations manages the TOP and MIP's within the direction
provided by the SSUP. Problems or conflicts that arise between
the SSUP and TOP are brought to Program management for
resolution. Figure 5-18 depicts the relationships between
these three levels of planning.

The UPO will develop, maintain, and control the SSUP. In the
process, the UPO interfaces with all levels of organization
within the SSP. Compatibility analyses, coordinated with
Operations and the NSTS, will be conducted to assist in the
resource allocation and user selection process. The U.S.
Utilization Plan will be developed which reflects U.S. plans
and requirements. In addition, the UPO will gather Station
capabilities and operations requirements, launch support
capabilities, and integrate them with SSP goals and policies to
provide resource availability forecasts for resource
allocation. Figure 5-19 illustrates this SSUP process flow.

SPACE STATION UTILIZATION PLAN (SSUP)

- User/payload assignments
- NSTS flight assignments
- Assembly sequence
- Resource balancing per increment
- Resource allocation balancing per year

TACTICAL OPERATIONS PLAN (TOP)

- Payload integration/ops planning
- NSTS flight planning
- Systems operations planning
- Crew assignments
- Ground ops/logistics planning

MISSION INCREMENT PLAN (MIP)

- Payload operations timelines
- Systems operations timelines
- Pre/post flight operations timelines
- Crew activity plans
- Day-to-day replanning

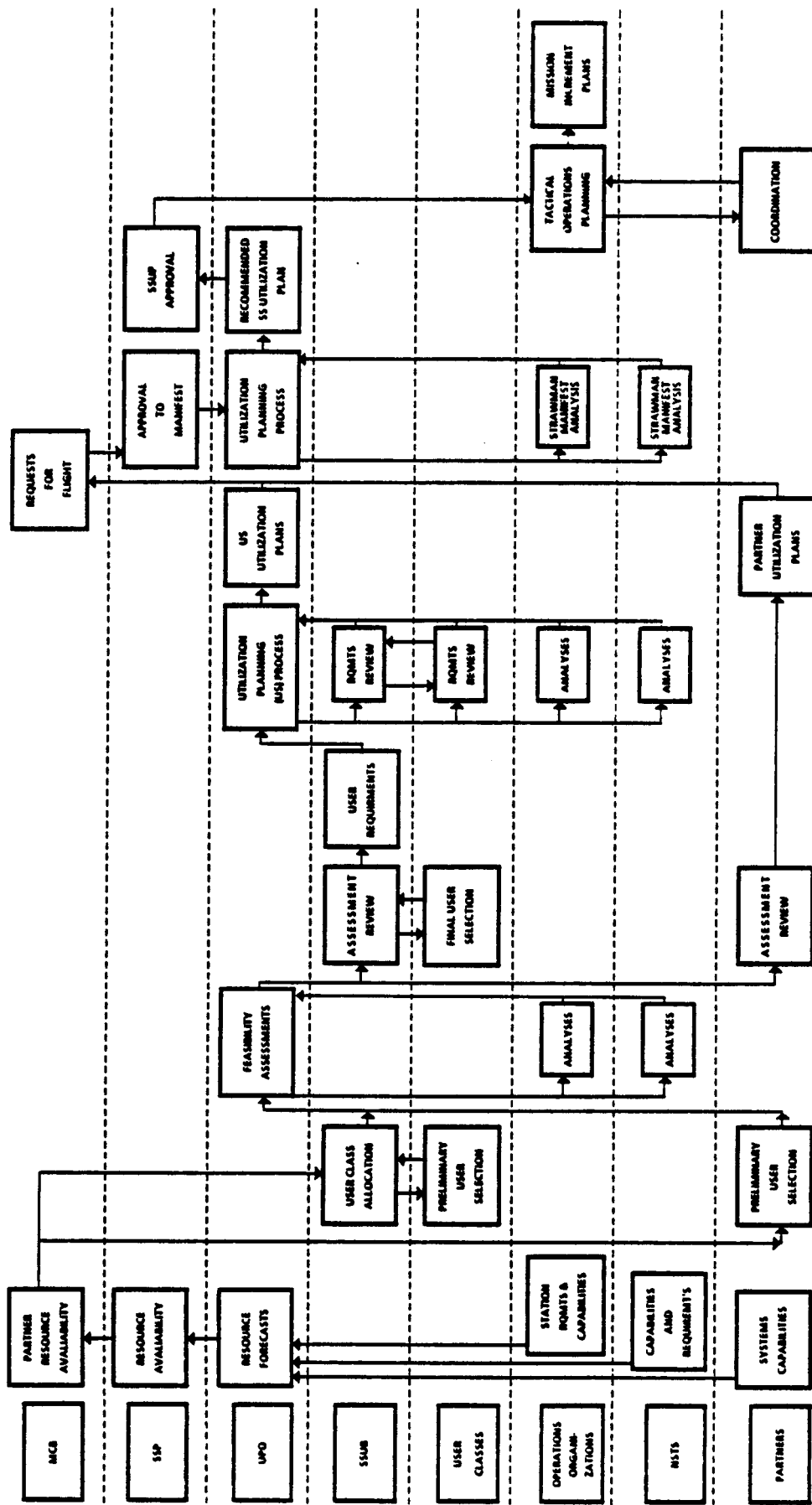Figure 5-18. Plan Hierarchy

Figure 5-19. Utilization Planning Flow

The UPO will also be responsible for developing, early in the DDT&E phase of the program, the procedures, tools, interfaces, and methodology needed to implement the utilization planning process that is described in Section 5-2.

The significance of the SSUP as the Program's long-range plan, the need to be responsive to SSP management, and the many working interfaces external to the SSP and NASA led the subpanel to conclude that the UPO should be located at NASA Headquarters and report to SSP management. Also, to ensure impartiality with respect to scheduling user and station system requirements, the subpanel concluded that the UPO should be a separate office and not part of either the User Development and Accommodations Office or the Operations Office.

Several organizational concepts for the Utilization Planning process were evaluated by the subpanel. Three are described in detail in Section 5-3. They represent the range of alternatives which the subpanel believes are available to the SSP. The major differences between them are:

o   The role of the NASA UPO in the process,

o   The international partners level of involvement in the process and where they interface, and

o   Which SSP orgainzation(s) are responsible for Utilization Planning and where integration of the international utilization plans is accomplished.

The subpanel's organizational recommendations for the operations concept are illustrated in Figure 5-20. They envision an evolving organizational structure with the appropriate realigning of responsibilities for Utilization Planning and integration. Three phases are proposed.

- **From DDT&E through initial operations**
- **Space OPS includes user and station**
- **UPO does all utilization planning**
  - -- Tech support of OPS organization
  - -- Co-located partner representatives
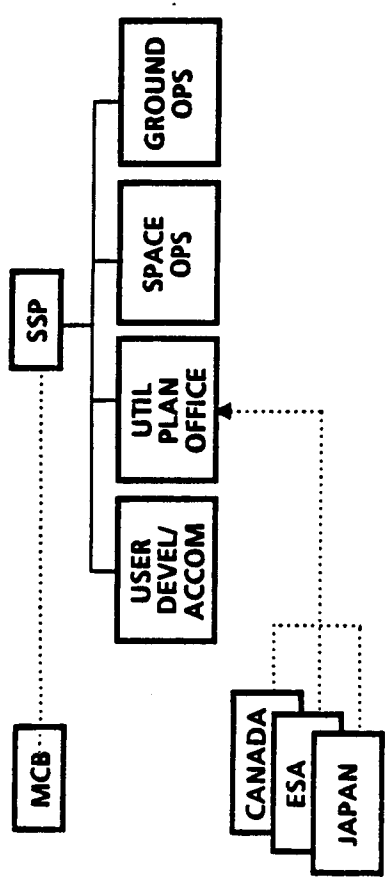
- **MATURE OPERATIONS**
- **USER ACTIVITIES IN ONE ORGANIZATION**
- **OPS ORGANIZATIONS PLAN OWN ACTIVITIES**
- **UPO COORDINATES/INTEGRATES PLANNING**
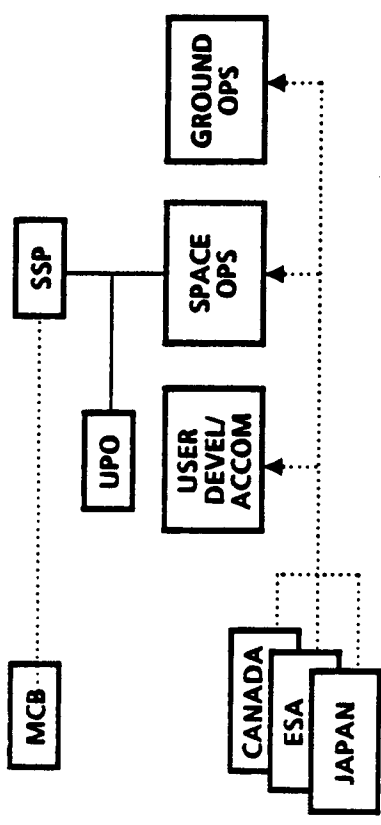
- **ROUTINE OPERATIONS**
- **UPO COORDINATES/INTEGRATES U.S. PLANNING**
- **UPP COORDINATES/INTEGRATES PARTNER PLANS**
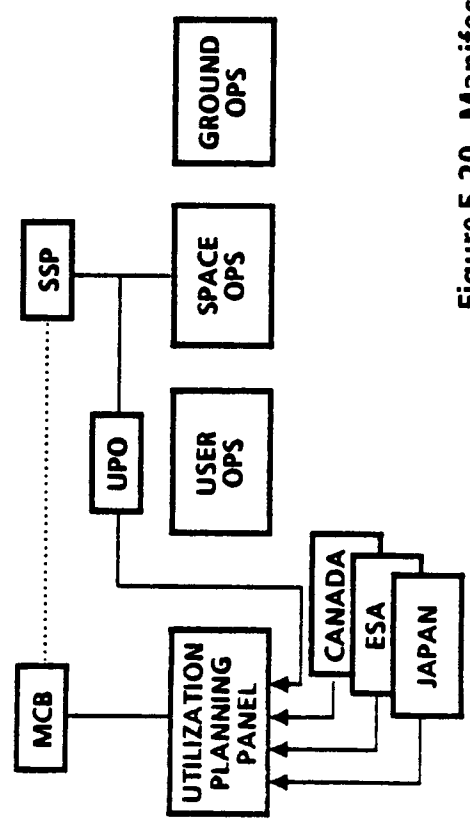
Figure 5-20. Manifesting Organizational Concept

During Station DDT&E and initial operations, the Centralized
Utilization Planning concept should be adopted. It is recom-
mended that the concept be implemented as soon as possible.
Figure 5-21 depicts this approach and the interfaces involved.
The subpanel believes this concept is most appropriate during
the early stages of the program for the following reasons:

o   Assembly, checkout, and verification of Station
    components are primarily NASA's responsibility:

    -- Considering that the U.S. is providing the Station
        structure, habitation facility, a lab module, the
        nodes, distributed support systems, and major
        integration function;

    -- To ensure the safety of the crews and Station
        during this critical phase, and

    -- The reliance on and coordination that is necessary
        with the NSTS during this time period.

o   Only NASA has the experience that is required to plan
    and implement such a large, manned space program,

o   Commitments to and interfaces with the partners and
    U.S. organizations outside the SSP and NASA can only be
    executed at the Headquarters level, and

o   The concept is consistent with current NASA policies
    that focus program management at Headquarters.

The Centralized approach, with the independent, dedicated staff
of the UPO, will allow focusing resources on the difficult task
of determining what Utilization Planning actually entails and
how it should be done. The Centralized UPO will enable the
orderly development of procedures, guidelines, groundrules, and
computer tools during the startup of the Program.

As operations mature, experience is gained and the planning
process becomes well understood, many aspects of planning can
be delegated from the centralized UPO to the operational line
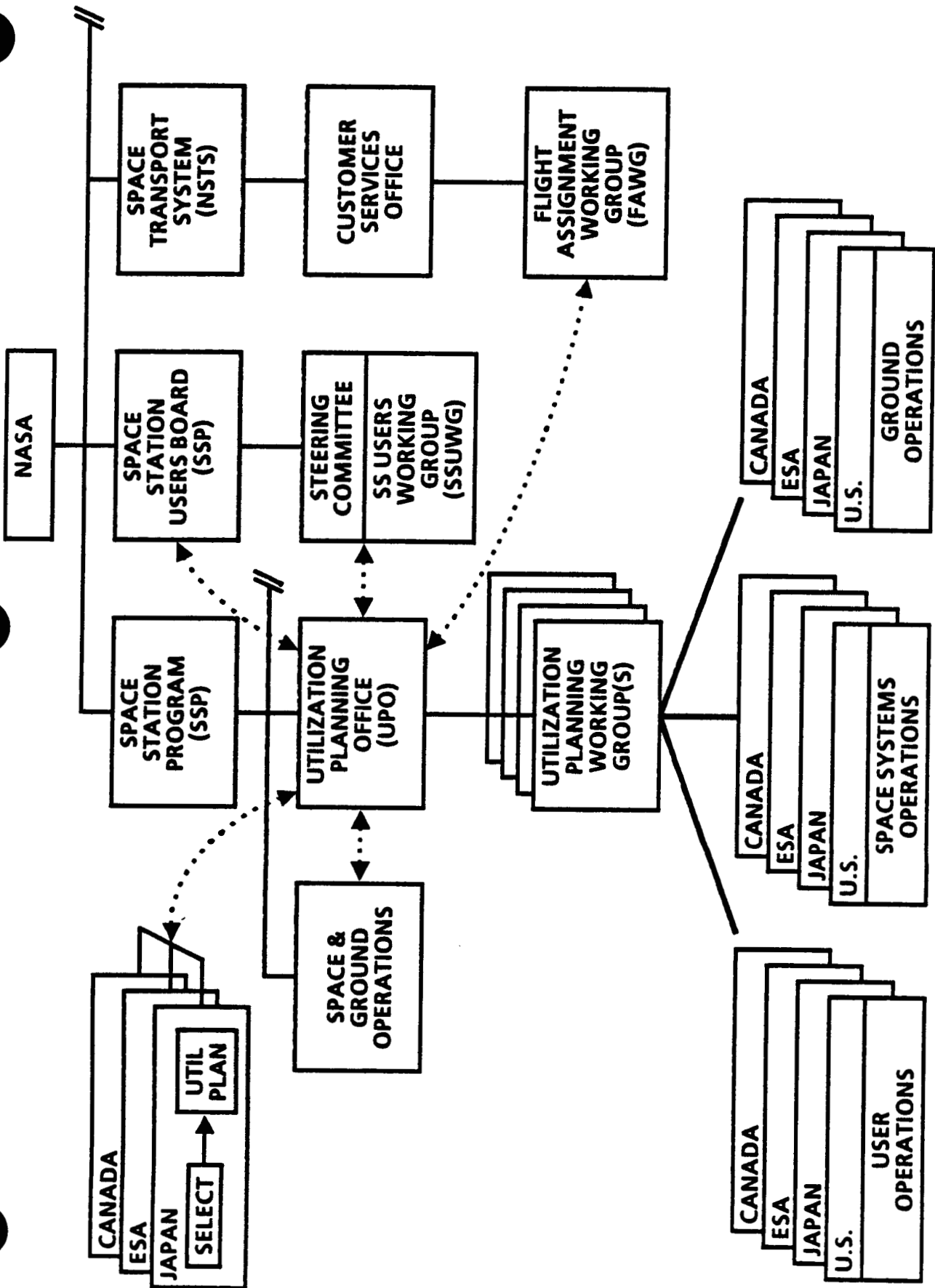
Figure 5-21. Centralized Utilization Planning

organizations. The subpanel recommends that at this time the Program transition to the Distributed Utilization Planning approach. With delegation of responsibility to the operations organizations, the staff of the UPO can be reduced accordingly. The Distributed approach has the following benefits:

o   the number of UPO planning and coordination interfaces in reduced,

o   the planners have improved accessibility of data,

o   the operations implementers are responsible for developing their own plans, and

o   it avoids duplication of effort between the UPO and the line organizations

Finally, when an established, mature Station is in place and operations are routine, the subpanel recommends that the SSP respond to the partners desire for autonomous planning and evolve to the Partner Utilization Planning concept. At this stage of the Program, the major uncertainties of how to operate the Station, especially those activities involving safety, will have been resolved. We believe that NASA can then delegate the more routine aspects of planning and still ensure the safety of operations. However, this approach can only be accommodated after the partners have gained the necessary operational experience and the SSP is confident that the planning process is well understood.

In summary, the subpanel's recommendations to the SSOTF are:

o   the SSUP should be the top-level planning document for the SSP, its users, operators, and transportation suppliers.

o   the SSUP should provide the information needed

    -- by the users and their sponsors to plan, budget,
        and coordinate their use of the Station.

    -- by the Space Station Program to direct tactical
        operations planning,

    -- by the transportation (e.g., NSTS, ELV's) and
        logistics organizations to plan support,

o   the Utilization Planning process should be responsive
    to management, users, and Station operations,

o   the SSUP should be developed, maintained, and
    controlled by NASA taking into account its commitments
    to the international partners,

o   Utilization planning should be accomplished at NASA
    Headquarters with the participation of the U.S. user
    community, station operators, and transportation
    organizations, and international partners,

o   a centralized UPO should be established at NASA
    Headquarters as soon as possible with initial emphasis
    on

    -- developing the overall planning process,

    -- planning the transition from DDT&E to operations,

    -- station assembly phase planning, and

    -- development of the NSTS interface,

o   NASA should transition to a Distributed Utilization
    Planning approach as Station operations mature.

o   the Space Station Program should consider Utilization
    Planning in a multinational forum after the planning
    process is established and Station operations are
    routine.

APPENDICES

APPENDIX
TECHNICAL DISCIPLINES & POTENTIAL APPLICATIONS

OCP-1011

MPS

BIOTECHNOLOGY
- CELL CULTURING
- MACROMOLECULE CRYSTALLIZATION
- BIORHEOLOGY
- ELECTROKINETICS
- NON-ELECTROKINETICS

COMBUSTION SCIENCE
- LIQUID POOL BURNING
- SMOLDERING
- GAS PHASE COMBUSTION
- FIRE SAFETY
- HIGH PRESSURE VAPORIZATION & COMBUSTION
- COMBUSTION OF LARGE SOLIDS
- COMBUSTION OF DROPLETS & PARTICLES

ELECTRONIC RESEARCH
- DIRECTIONAL SOLIDIFICATION
- VAPOR GROWTH
- SOLVENT GROWTH
- EPITAXY
- SEMICONDUCTOR CRYSTALS
- NON-SEMICONDUCTOR CRYSTALS
- POLYCRYSTALLINE MATERIAL PRECIPITATES
- AMORPHOUS MATERIALS

FLUIDS & TRANSPORT
- CONVECTION & DIFFUSION TRANSFER
- MULTIPHASE MIXTURES
- DROPLET PHYSICS & CHEMISTRY
- THERMOPHYSICAL PROPS. OF CORROSIVE & REACTIVE FLUIDS
- SYNTHETIC CHEMISTRY
- SUPERFLUID HELIUM BEHAVIOR
- CAPILLARY PROCESS

GLASSES & CERAMICS
- OPTICAL DEVICES
- ULTRAPURE MATERIALS
- FIBERS
- FIRING & HOMO-GENIZATION
- COMPOSITES
- MACROBALLOONS
- CONTAINERLESS HIGH TEMP. GAS PHASE REACTION
- EXOTIC GLASSES OR CERAMICS W/ UNIQUE PROPS.
- SLIP CAST MATERIALS
- FOAMS
- SPACE STRUCTURES

METALS & ALLOYS
- COARSENING & STABILITY OF TWO-PHASE MIXTURES
- SOLIDIFICATION OF TWO-PHASE MELTS
- ALLOY SEGREGATION
- SCALING LAWS
- CONVECTIVE INTERACTIONS
- THERMOPHYSICAL PROPERTIES
- DEPOSITION OF METALS FROM IONIC SOLUTIONS

A-1

OCP-1012

APPENDIX
TECHNICAL DISCIPLINES & POTENTIAL APPLICATIONS

EARTH SCIENCE & APPLICATIONS

EARTH/OCEAN OBSERVATIONS SYSTEMS*

- SYNTHETIC APERTURE RADAR
- SCATTEROMETER
- AUTOMATED DATA COLLEC. & LOCATION SYS.
- ALTIMETER
- MSS OCEAN COLOR IMAGING SYSTEM
- EARTH OBSERVING SYSTEM
- NAVY REMOTE OCEAN SENSING SYSTEM

* POLAR PLATFORMS

A-2

APPENDIX
TECHNICAL DISCIPLINES & POTENTIAL APPLICATIONS

ASTROPHYSICS

ASTRONOMY
- PLANETARY SCIENCE
- RADIO ASTRONOMY
- INFRARED ASTRONOMY

PLASMA PHYSICS
- ACTIVE PLASMA EXPERIMENTS
- ATMOSPHERIC
- PLASMA ENVIRON. WITHIN SPACE STAT. COMPLEX
- ELECTRO-DYNAMICS TETHER

SOLAR & COSMIC RAY PHYSICS
- SOLAR OPTICAL TELESCOPE STUDIES
- CO-OBSERVING SOT INSTRUMENTS
- PINHOLE OCCULTER FACILITY
- COSMIC RAY NUCLEI EXPERIMENTS
- SUPER-CONDUCTING MAGNET FAC.
- COSMIC DUST COLLECTOR/ANALYZER
- EARTH RADIATION STUDIES
- SOLAR CONCEN-TRATOR/THERMAL GENERATOR

APPENDIX
TECHNICAL DISCIPLINES & POTENTIAL APPLICATIONS

AUTOMATION & ROBOTICS

INDUSTRIAL SERVICING
- STRUCTURAL ASSEMBLY
- TELEPRESENCE
- SPACE CRAFT SERVICING & REPAIR
- REMOTE MANIPULATION
- SATELLITE REPAIR
- ADVANCED CONTROL CONCEPTS

DESIGN/ OPERATIONS
- MOBILITY
- DEXTROUS MANIPULATIONS
- SUPERVISED/ AUTONOMOUS OPERATIONS
- MAN/MACHINE INTERFACES
- BERTHING/ DOCKING MECHS & CONTROLS

APPENDIX
TECHNICAL DISCIPLINES & POTENTIAL APPLICATIONS

COMMUNICATIONS

COMMUNICATIONS SYSTEMS

- DEEP-SPACE OPTICAL COMMUNICATIONS
- COMPUTER/ DATA SYSTEM
- INFORMATION SYSTEMS
- OPTICAL TERMINAL ON SPACE CRAFT
- TELEMETRY TECHNOLOGIES

APPENDIX
TECHNICAL DISCIPLINES & POTENTIAL APPLICATIONS

LIFE SCIENCES

HUMAN FACTORS
- LIFE SUPPORT SYSTEM RESEARCH
- EFFECTS OF SPACE FLIGHT RESEARCH
- MEDICAL EXPERIMENTS TECHNOLOGIES
- MANNED SYSTEM EXPERIMENTS (SPACE ADAPTATION SYNDROME, MUSCULAR STRENGTH/ ENDURANCE, BONE DEMINERALIZATION)
- CREW OPERATIONS PRODUCTIVITY

PHYTOLOGY
- GROWTH & CULTURE UNIT
- PLANT PHYSIOLOGY & DEVELOPMENT
- CELSS - FOOD & WASTE PROCESSING
- PLANT STRUCTURE/ GROWTH
- CLOSED LOOP ECOSYSTEM STUDIES

ANIMAL SCIENCE
- MAMMALIAN PHYSIOLOGY & DEVELOPMENT
- AUTOMATED HAB. & GROWTH UNIT DESIGN
- GROWTH & DEVELOPMENT MECHANISMS
- STRUCTURE & MUSCULATURE RESEARCH
- MULTIPLE GENER- ATION STUDIES (LONG-TERM)

BIOMEDICAL
- DEVELOPMENT OF BIOPOLYMERS
- SEPARATION & PURIFICATION OF BIOLOGICAL MATERIALS
- ADVANCED BIOMEDICAL INSTRUMENTS
- SPACE MEDICINE RESEARCH

APPENDIX B

IDENTIFICATION OF POTENTIAL USERS ACCORDING TO
TECHNICAL DISCIPLINE - BIBLIOGRAPHY

Atkins, Harry L., 1986. "Commercial Advocacy Group: External
   Advocacy", Commercial Materials Processing in Space
   Group Presentation, NASA/MSFC in-house Document.

Atkins, Harry L., 1986. "NASA's Microgravity Materials Science:
   A Commercial Perspective from Within NASA", Presented to
   NASA's Microgravity Materials Science Assessment Task
   Force, NASA/MSFC in-house Document.

BDM Corporation, The, 1985. "OSSA Space Station Servicing
   Data Book", NASA/HQ Code E In-House Document.

Booz, Allen & Hamilton, Inc., 1986. "Space Station Commercial
   User Development - Phase II", Prepared for NASA Office
   of Space Station, Contract NASW-3775.

Center for Space Policy, Inc., 1986. "Impact of Customer
   Utilization Requirements on Space Station Design &
   Operations, Briefing to the Space Station Operations
   Task Force, November 13, 1986. Results of Contract
   #NAS 9-17386.

Center for Space Policy, Inc., 1986. "Space Station Design
   Decisions: Customer Needs, Utilization Requirements,
   and the Implications of International Participation",
   Final Working Paper-Volume I, NASA/JSC Space Station
   Program Office, Contract # NAS9-17386.

Coopers and Lybrand/Grumman Aerospace, 1985. "Commercial Users
   Development Contract Phase II - Final Report", Prepared
   for NASA Space Station Commercial Advocacy Group,
   NASW-3776.

Duns Marketing Service, 1986. "Standard Industrial Codes,
   Million Dollar Directory", Cross Reference Volume.

ECON, Inc., 1984. "Marketing the Use of the Space Environment
   for the Processing of Biological and Pharmaceutical
   Materials", Prepared for NASA/HQ, Contract NASW-3339.

Jet Propulsion Laboratory, 1986. "Space Station Requirements Analysis Program", California Institute of Technology, Pasadena, California.

Lyman, Peter and Carl Shelley, 1986. "Objectives and Status of the Space Station Operations Task Force", Briefing to the Space Station Oversight Committee, NASA/HQ.

Office of Aeronautics and Space Technology, 1986. "Planning Guide for In-Space Technology Experiments Using the National Space Station Complex", NASA/HQ In-House Document, Washington, D.C.

Office of Space Science and Applications-Space Station Planning Group, 1985. "OSSA Mission Plan for the IOC Time Frame of the Space Station Complex", OSSA NASA/HQ, Washington, D.C.

Teledyne Brown Engineering and Boeing Aerospace Company, 1986. "Microgravity and Materials Processing Facility Study Data Release", Volume I-User Requirements Development, NASA Contract # NAS8-36122.

Wyle Laboratories, 1985. "Top-Level Requirements for Microgravity Science and Applications Research on Space Station", Final Report, Sponsored by NASA/MSFC and NASA/LeRC under the Microgravity Science and Applications Division/Code EN, Contract #NAS8-36117.

APPENDIX C

Subject: Synopsis of Previous NASA Marketing Activities
By

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The Channel Group

Introduction

Throughout its history, the National Aeronautics and Space
Administration (NASA) has disseminated the results of its
programs and activities to a variety of constituencies.
Perhaps first and foremost has been its publicizing of space
endeavors to the American people, and the world at large.
Past success has enabled NASA to propose more challenging space
ventures to Congress and the Executive Branch of the Federal
government. Programs have been advocated based on their
importance to the country in terms of science, technology,
defense and national prestige.

Traditionally, NASA has advocated programs based on the needs
of various user groups -- scientists in government and
academic, technologists in government agencies and its
supporting aerospace and electronics industries, and to a
lesser extent users in private industry. These scientists and
technologists have formed the traditional constituencies NASA
supports in its budget and programmatic requests, and who in
turn support NASA.

The private sector as a significantly larger participant in
NASA programs, and as a potential constituency, began to emerge
in the Space Transportation System (STS) Program. Early

industrial interest was also a foundation for arguing the commercial need for a Space Station (SS).

The development and sustenance of NASA's major constituencies is largely a function of its outreach and user development activities. This paper examines the history of NASA's marketing activities aimed at developing commercial users of space. A short history of marketing activities is presented first. Second, the perceptions of some of the key players in NASA's marketing activities are summarized. Finally, the implications of this heritage for the Space Station are analyzed.

NASA Commercial Marketing Activities

Throughout its history, the aerospace industry has been intimately involved in NASA's programs. Although the industry's relationship has largely been as a contractor to provide NASA equipment and services, technology with potential commercial applications has been transferred to the aerospace industry as a result. This diffusion process continues. Of interest here are programs specifically aimed at encouraging non-aerospace industrial firms to use space and its attributes to develop or improve products and services.

In 1978, the Materials Processing in Space (MPS) office at Marshall Space Flight Center (MSFC) undertook a corporate search program to match company product lines to research and development programs which could benefit from space-based research. The discriminators used to select companies included:

(1)   the research and development orientation of the company,

(2)   the existence of an entrepreneurial element within the
      company,

(3)   known diversification plans,

(4)   whether NASA personnel knew someone in the company who
      could be contacted as a potential advocate for space-based
      research,

(5)   whether the company had adequate cash reserves to fund a
      long term research program, and

(6)   whether the company was interested in materials that were
      not near their theoretical limits of capabilities.

The resulting list of companies was used to initiate
discussions between NASA scientists and the private firms.
Many of these initial contacts form the basis of commercial
user programs today.

Active development of commercial users may be considered to
have begun in 1979 when McDonnell Douglas Astronautics Corpora-
tion (MDAC) approached NASA with a proposal. In the years
prior to 1979, MDAC had been receiving funding through NASA
science and technology programs to better understand continuous
flow electrophoresis, a process for efficiently separating and
increasing the purity of biological materials. MDAC had
invested corporate funds in expanding the scope of the original
NASA sponsored activity. The research and development had
proceeded to a point where MDAC felt a possibility existed for
a viable business based on the increased separation efficiency
and purity achievable in space. MDAC, in conjunction with its
partner Johnson & Johnson, Inc., had also identified a market
which could be penetrated with space-processed pharmaceuticals.
MDAC needed to verify the expected process efficiency by flying
on the Shuttle, and obtain enough product to begin the process
to gain U.S. Food and Drug Administration (FDA) approval. MDAC

was willing to undertake the research and develop the equipment to be used in space, but wanted NASA to underwrite the costs of getting to space until the existence of a viable business could ascertained with some degree of confidence. MDAC felt it was in the national interest to encourage innovative space ventures, and on that basis asked NASA to share the risk of the venture by underwriting the cost of Shuttle flights.

NASA had no policies or procedures for undertaking such a venture as proposed by MDAC. The NASA Administrator decided ventures of this type should be encouraged consistent with the National Aeronautics and Space Act of 1958 ("Space Act"). The Administrator convened a panel and directed them to develop appropriate policies for his approval. "Guidelines CROSSTALK - XVI Regarding Early Usage of Space for Industrial Purposes" were signed by NASA Administrator Robert A. Frosch on June 25, 1979. "Guidelines Regarding Joint Endeavors with United States Domestic Concerns in Materials Processing in Space" were also approved. The first Joint Endeavor Agreement (JEA) was signed with MDAC in January 1980.

This first JEA was seen by some as the precursor of significant non-aerospace business involvement in space. Just as MDAC had enlisted the participation of Johnson and Johnson in its pharmaceutical program, some in NASA believed that if non-aerospace industry was made aware of the advantages of space, and more particularly the tremendous research and development capabilities resident in NASA, more concerns would soon step forward with other proposals.

Since the Administrator and other senior managers had decided that encouraging commercial ventures was in NASA's long-term interest, they felt NASA should initiate an active program to

inform non-aerospace industry of the possibilities afforded by
space-based research and development. They also wished to
enhance contacts between private industry and all NASA
programs. Even though the JEA with MDAC had been signed, there
was at this time little interest within NASA program offices to
encourage other ventures of this type, either in materials or
other disciplines.

The NASA Office of Technology Utilization and Industry Affairs
created the Corporate Associates Program. Under a contract
with the American Institute of Aeronautics and Astronautics
(AIAA), non-aerospace Fortune 500 executives were invited to
participate in one and two day seminars at NASA field centers.
While these seminars presented NASA's overall research and
development capabilities, participants were exposed to a few
hours of technical results derived from experiments on the
Shuttle. In a period of eighteen months, over 160 companies
were represented at one or more seminars.

The stated interests of these companies were categorized,
leading to more focused seminars over the next year. Seminars
were held at Lyndon B. Johnson Space Center (JSC) focusing on
biological sciences, at Lewis Research Center (LeRC) on
ceramics, at Langley Research Center (LaRC) on materials, and
at Goddard Space Flight Center (GSFC) on computer and
electronic technology. While no specific program can be
attributed to these seminars, they have increased the
interaction between NASA and industrial scientists. This
program continues today.

In 1981, GTI and Microgravity Research Associates, Inc. (MRA)
both approached NASA for Joint Endeavor Agreements. GTI
intended to develop a furnace for materials experimentation

both on the ground and on the Shuttle. Its business case was based on selling experiment time in a shared facility. GTI was forced to withdraw from further negotiations for lack of funding.

MRA proposed the development of furnaces for manufacturing gallium arsenide crystals in space using an electroepitaxy process. MRA's business plan anticipates a large market for space-produced crystals over a considerable time period. After a protracted negotiating and approval period, a JEA with MRA was signed.

In mid 1982, NASA began to plan for a Space Station which would become operational in the mid 1990's. Based on the perceived interest of commercial firms in using NASA facilities, including the Shuttle, for research, development and production of goods and services, it was believed a large latent demand existed for commercial use of the Space Station. As a result the Phase A Space Station Needs, Architecture, Attributes and Operations (SSNAAO) study, contractors were required to solicit potential commercial users of the Space Station to discover the types of projects to be proposed and requirements which would be levied on the Space Station. The eight SSNAAO contractors reported about 160 contacts with potential commercial users of the Space Station. Some of these contacts were definite projects such as MDAC and MRA who were contacted by almost all of the contractors. Most of the contacts represented concepts to be explored. The SSNAAO studies were the first "shotgun" approach to industry about the potential of business in space and yielded about one hundred concepts and organizations to be pursued.

To advocate and articulate industrial requirements, a
Commercial Working Group (CWG) was created within the Mission
Requirements Working Group (MRWG) of the NASA Space Station
Operations Task Force (SSOTF). In addition to determining
requirements, the CWG was also charged with identifying,
encouraging and supporting commercial firms who, by undertaking
early experimentation, would become users on the Space Station
at its Initial Operating Capability (IOC) and beyond. The
purpose of this development assignment was to help build a
constituency among potential commercial users who, it was
hoped, would argue forcefully to Congress and the
Administration that NASA should be chartered to build, launch
and operate a Space Station.

In 1983, the CWG issued a request for proposal (RFP) for
private firms to act as an intermediary in attracting and
encouraging private firms to consider the use of space as part
of their ongoing lines of business. This RFP attracted con-
siderable attention from a variety of firms, though aerospace
firms were specifically excluded from responding. A
competitive selection process resulted in contracts being
awarded to Coopers & Lybrand ("C&L"), an international
accountancy and management consulting firm, and Booz, Allen &
Hamilton ("BA&H"), a multifaceted consulting firm. C&L was
supported by Grumman Aerospace Corporation, and BA&H by
McDonnell Douglas Aerospace Corporation, to provide technical
aerospace expertise and a familiarity with NASA programs when
approaches were made to non-aerospace corporations. These
initial one year contracts were extended several times, and
finally concluded at the end of 1985.

Critical to this user development activity was the business
basis on which it was undertaken. The names of potential user

contacts were held confidential by the contractors so that discussions of opportunities could be undertaken on a business to business basis. Technical and management support was provided by NASA only as specifically requested by the contractors.

The SSNAAO private sector contact lists were the starting points for the two contractors. Each contractor was given half the list, fifty each, to pursue. The contractors were also encouraged to contact others not on the lists. It was intended that C&L and BA&H would follow up the initial SSNAAO contacts and help convert concepts to active programs by providing appropriate assistance. The net results of these contracts were that BA&H successfully encouraged 22 firms to pursue Space Station activities, and C&L encouraged 30 firms.

While the Space Station CWG-sponsored user development contracts were the most visible to those outside NASA, other program offices were undertaking similar activities. Although C&L and BA&H were to operate in the four general areas of materials processing (Earth and ocean observations, advanced communication, and industrial services), most of the activity focused on materials processing, both crystal growth and biological processing. Most of the other program office activities were also focused on materials processing. Of particular interest were programs sponsored by the Materials Processing in Space (MPS) Office, the STS Customer Service Office, and the Office of Technology Utilization and Industry Affairs.

The Office of Technology Utilization and Industry Affairs sponsored a study of "User Requirements for the Commercialization of Space" by EcoSystems International, Inc. The goal of

the study was to "...assess non-aerospace industry perceptions of and interests in pursuing commercial operations in near-Earth orbit." [p.1] To accomplish this goal, two activities were undertaken:

o The status, results and potential of the art of Material Processing in Space (MPS) were synthesized with a view to commercial processes which would be significantly facilitated or improved in an Earth-orbit space environment.

o Queries of selected U.S. non-aerospace industries were completed which identify opportunities for NASA to gain industrial involvement in space-based applications of materials processing. [p.1]

In addition to compiling the experimental data obtained in the NASA MPS Program, EcoSystems visited 16 potential MPS users, some of whom were being assisted by either BA&H or C&L.

o Most R&D managers were aware of NASA's space commercialization activity and interested in its potential. They were handicapped, however, by limitation of available time to analyze, in depth, the application of MPS technology to their industry's requirements. Nevertheless, they evidenced a willingness to enter into further discussion directed toward areas of specific technological interest to their industries. [p. 4]

The MPS Program Office was at this time continuing its own outreach program through traditional science, that is, peer group, activities. The MPS Program focused on developing a ground-based infrastructure to support materials research by supporting the materials research activities at Marshall Space Flight Center (MSFC), and expanding the activities of Lewis Research Center (LeRC). The objective was to encourage commercial use of drop tubes, towers, aircraft, and sounding rockets to more fully understand the fundamental physical

processes of interest as a precursor to Shuttle, and eventually
Space Station, experimentation.

NASA uses two mechanisms to involve industry in materials
processing research not immediately involving Shuttle flight
experimentation.

Under a Technical Exchange Agreement (TEA), a company and NASA
agree to exchange technical information and cooperate in the
conduct and analysis of ground-based research programs. The
private company funds its own participation and derives direct
access to and results from NASA facilities and research. NASA
benefits from the support and expertise of the private
company's industrial research capabilities.

An Industrial Guest Investigator (IGI) agreement allows a
company scientist to collaborate, at company expense, with a
NASA-sponsored principal investigator (PI) on an MPS
experiment. Once NASA and the company agree on the scientific
contribution to be made to the objectives of the experiment,
the IGI becomes a member of the investigation team.

As the Shuttle moved from construction to roll-out, to first
flight, and to operational status, the STS Customer Service
Office was engaged in developing commercial users for the
Shuttle. While a considerable part of the effort was to sell
launch services to commercial communications satellite
operators, attempts were being made to leverage the MDAC
Electrophoresis in Space (EOS) flight program into other
similar activities.

It was perhaps at this time that questions of appropriate
terminology were first raised. Up to this point, outreach

activities were called "user development" based on NASA's
traditional role with scientists and technologists. Since part
of the justification for the Shuttle was the revenue it would
generate for the government, NASA became engaged in "marketing"
the Shuttle. As with any transportation system, NASA wanted to
fully use the Shuttle's launch capacity. Issues such as
pricing and competitive position, issues normally associated
with a business venture, began to be used to describe some of
NASA's activities.

This change of terminology is of more than academic interest.
It reflected and engendered a fundamental change in the way
NASA operates or, as some would say, "does business." The
Shuttle is NASA's first operational (rather than research and
development) system. The Space Station will also be an
operational system. NASA has struggled to integrate an
operational system, the Shuttle, into its programmatic research
and development organizational structure. Debate continues on
the success achieved to date. The Space Station itself will
undergo a similar process. The difficulties will be further
compounded in the Space Station era because a portion of
Shuttle operations will be required to support and work in
concert with Space Station operations.

Does NASA develop users or does it market or both? Should it
do either or both? Tentative answers to these questions have
been developed, as is here demonstrated. However, with the
Shuttle Challenger accident, these questions are being
reexamined. A discussion of these issues must be deferred
until later. It is sufficient here to be sensitized to these
issues and the far reaching implications for NASA and,
specifically, the Space Station Program.

About the time the Space Station CWG contracts were being
initiated, the STS Office announced its intention to fund a
Shuttle marketing contractor. In addition to providing a
worldwide marketing presence, the contractor would be chartered
to develop users for the Shuttle in much the same way C&L and
BA&H had been chartered. A RFP was drafted, but never
released.

It was now clear that NASA had at least four program offices,
supported by the NASA field centers, engaged in developing
commercial users and marketing. In many cases, all of the
programs were talking to the same firms at the same time.

Since each program had its own unique objectives to be served
by involving the commercial firm, the prospective industrial
user was often confused by the multiplicity of contacts and
seeming lack of cohesiveness in scope and presentation.

To address this problem, which was being communicated by
industry to the new NASA Administrator James M. Beggs,
Mr. Beggs initiated two activities meant to integrate NASA's
approach to industry and provide a focused program. The
Administrator requested that the National Academy of Public
Administration (NAPA) investigate "sectors in the commercial
utilization of the space environment and the requirements of a
policy framework conducive to business ventures based on space
technologies." [p. v]

The NAPA panel made a number of recommendations to encourage
business ventures in space, which are summarized in its report
"Encouraging Business Ventures in Space Technologies," 1983.
[p. x - xiii]

At the same time, the Administrator convened an internal NASA Commercialization Task Force (CTF) to make recommendations on how NASA should handle its involvement with potential commercial users. All NASA program offices and field centers with an interest in commercial use of space were represented on this task force.

The Commercialization Task Force produced a policy statement and an implementation plan. The policy was approved by the Administrator in December 1984. One of the essential elements of the plan was the creation of a new program office to deal specifically with questions of the commercialization of space.

The new Office of Commercial Space was to act as a single focus for all industrial users of NASA resources.

One of the first responsibilities of the Office of Commercial Space was to recompete the follow-on user development activity to the C&L and BA&H efforts. It was intended that the newly selected contractor would serve as a single unifying outreach and user development organization for all of the NASA programs concerned with business use of space. Boeing Aerospace Services Corporation was selected as the NASA user development contractor in late 1986.

Perceptions of NASA Marketing Activities

Part of this study was to compare and contrast perceptions of the effectiveness of NASA's marketing and commercial user development activities. The approach taken was to interview NASA personnel involved with marketing and user development, and commercial users who have interacted with NASA, and ask them similar questions. It was hoped this would provide

insight into the effectiveness of NASA activities. The
questions asked included, but were not limited to, the
following:

(1) What product or service is NASA marketing? How is the
     product or service defined?

(2) How are initial commercial contacts determined? Are
     market segmentation techniques utilized?

(3) What information is transmitted to the potential user, by
     whom, and in what manner?

(4) If interest is expressed, what procedures are utilized for
     continuing support and development? Who is responsible
     for continuing user support?

(5) What successes have been achieved? What made these
     successes?

(6) What failures have occurred? Why?

(7) Recommendations for improvements. The interviews were
     informal and subjective opinions elicited. Their value
     is derived from the long involvement of the persons inter-
     viewed in a number of NASA user development activities.
     A list of the persons interviewed is appended here, but
     comments are summarized below without attribution.

What Does NASA Market?

First, all of the respondents agreed that NASA does in fact
engage in marketing. However, not everyone agrees that NASA
should be marketing to potential commercial users of space.

There is a somewhat surprising consensus among both NASA and
private sector personnel on what it is that NASA markets. The
respondents generally agree that NASA markets (1) access to
space and (2) its image as a first rate research and
development organization with particular expertise in the space
environment. The respondents believe NASA does and should

provide an infrastructure of high risk, long term, critical technology beyond that reasonable for industry to provide.

Some of the respondents segmented NASA's marketing activities. To the nation as a whole, and even the entire world, NASA markets the image of the people of the United States, its technology, and its political system. To Congress and the Administration, NASA markets the ability to leverage scientific knowledge and technology into a domestic perception of well being. To the aerospace industry it markets the opportunity to participate in high technology systems to meet national requirements. To the non-aerospace industry, NASA markets the opportunity for economic benefit in terrestrial markets.

How Does NASA Determine Initial Contacts?

In its traditional science and technology programs, NASA develops users through government procurements, formalized science solicitation programs, and unfocused, generalized NASA representation on scientific panels, interagency working groups, and forums. NASA has also established industrial advisory boards to provide input into programmatic activities.

The CWG contractors, C&L and BA&H, segmented the potential markets in determining those companies to be approached first to propose space-based ventures. The discriminators they used were fundamentally the same as those used by MSFC.

Several respondents felt that being a NASA contractor, and connected into the "old boy" network, was essential to achieving success in early commercial space ventures.

What Information Does NASA Provide?

NASA is viewed as providing excellent primary investigator information in the form of scientific papers and program documentation. NASA also creates useful "slicks," glossy brochures, after a program has been approved by Congress. Most of the respondents felt NASA does not have or provide documents useful to corporate mid-level managers who must advocate and defend space-based research programs.

When making initial presentations to private firms, the designated NASA program managers make superficial presentations. Companies must themselves contact the appropriate NASA scientist to obtain more detailed information, both technical and managerial. Once the company gets inside the NASA system, it is difficult to get answers to questions raised by company officials who must approve space-based research programs. This appears to be a communications problem -- private industry to government and vice versa.

What Continuing Support is Provided?

Both NASA and industry respondents agree that NASA does not provide continuing customer service. The commercial user is handed off to a committee, then bounced from place to place. Different faces come to every meeting, but no one has any authority to reach an agreement. Everything is handled on an ad hoc basis. The user finds himself cycling through the system a number of times. NASA should undertake a continuing science research program to build the confidence base for potential commercial users.

What Successes have been Achieved and Why?

MDAC is considered a success because it had a deep
understanding of NASA before it proposed its JEA. The company
has the resources to undertake long-term research activities
and knows the risks, and the head of the corporation took a
personal interest in the program. NASA also has a vested
interest in assuring MDAC's success. A project completed by 3M
is considered a success based on its visibility with the
Administration and Congress, who both have a large wish for it
to succeed. The path to success requires matching corporate
cultures to the NASA culture in terms of research and
development time horizons and organizational size.

What Failures have Occurred and Why?

The reasons given for failures, which are defined as failure to
reach agreements for JEAs or the protracted time period it may
take, run the gamut of the litanies that have been identified
in the various studies discussed above. They include:

   o Lack of company staying power to survive

   o No long term contracts

   o No continuous funding

   o NASA bureaucracy

   o Lack of planning horizons both in companies and within
      NASA

   o Layers inserted between the user and flight support
      personnel

   o Political failures in misjudging the influence of third
      parties in the world space culture

   o Unwillingness of industry to make high risk investment
      based on the limited science base

   o Inability of NASA to guarantee access to space

o The long time required to get into space after agreement is signed

o NASA documentation and flight requirements

o NASA "turf battles"

o Conflicting interpretations of NASA requirements

o NASA lack of credibility - budgets do not support marketing programs

o Lack of program continuity and consistency

o Inertia of the NASA system inhibits change

o Small firms' lack of political leverage

o Terms and conditions of NASA agreements

o Budget allocations within NASA to support commercial users

o Negotiation style and duration

RECOMMENDATIONS

In addition to dealing with the issues enumerated above, two themes emerge from the respondents. First, NASA must centralize its marketing activities in an organization which supports the commercial user from the initial development of the concept for space-based research to production facilities on the Space Station. This organization should be staffed with knowledgeable and dedicated NASA advocates. The personnel should have a background in private industry and understand its needs and how it operates. Essential to success is that this organization have not only the responsibility, but also the authority, to reach enforceable agreements between NASA and industry. It would be desirable for this organization to be given a profit incentive. As soon as a customer is identified,

he must be supported by a single point advocate within this organization.

Second, NASA must continually expand the science base which could support future commercial ventures. Commercial ventures should not be viewed as competitive with NASA science and technology programs, but rather as a complement and enhancement to them. Without an expanding NASA program, future commercial ventures will be limited. Further, NASA must assure industry that space and opportunity will be available on a continuing basis. NASA assets should be viewed as national facilities to support industrial ventures.

Implications of Previous NASA Marketing for the Space Station

The question of user development and marketing is one that must be addressed to NASA as a whole. Only in this context can questions of commercial user development and marketing for the Space Station be addressed.

It is commonly acknowledged that user development is an evolutionary process supported by a continuing NASA science and technology program. In materials processing for example, ground based research and development in drop tubes and towers leads to aircraft flights then Shuttle experiments and ultimately to the Space Station for both expanded R & D and production. For remote sensing systems, sensor and applications development can be initiated on aircraft and Shuttle flights. Further research and continuing data acquisition can proceed on Space Station platforms. Thus, for the foreseeable future, the Space Station is the logical end objective of this evolutionary program.

Today, there are no commercial users manifested for accommodation on the Space Station at IOC. Further, unless steps are taken today to develop commercial users by starting them along the evolutionary path, there will not be any users at IOC.

The two major themes that emerged from the respondent's comments provide guidance to NASA in developing commercial users and marketing. The centralized marketing organization should provide a single point-of-contact for industry in dealing with NASA. This office would be responsible for integrating the appropriate customer service support for various NASA program offices and field centers.

The Space Station Program may adopt one of two approaches in supporting commercial users. Since the Space Station is the logical end objective for commercial users, it could take the lead responsibility for this single point marketing organization with the support of other programs. Or, the Space Station Program can provide a customer service function for payloads destined for Space Station to support the centralized marketing function located elsewhere within NASA. For either option to succeed, the Space Station Program must ensure that outreach programs attract potential commercial users and start them on the path toward the Space Station. Without active involvement by the Space Station Program, there will be no commercial users on the Space Station.

It is essential that NASA demonstrate it commitment to a continuing, robust science and technology program which supports commercial endeavors. While the centralized marketing organization certainly must provide input to this program, the program itself should exist within the context of traditional NASA science and technology programs. To industry, the most

demonstrable evidence of NASA's commitment to this program will
be an adequate program budget.

In presenting the need for a Space Station to the President,
NASA argued that significant interest existed in industry for
the development of new products and services in space which
would be economically advantageous to the nation. The force of
this argument led the President to commit to a space policy
which envisioned business in space in the Space Station era.
He gave NASA the responsibility for encouraging the commercial
use of space. Much has been accomplished in that direction;
even more is required to assure success.

INTERVIEWS

Timothy M. Alexander, Space Development Services

Joseph P. Allen, Harry L. Atkins, Marshall Space Flight Center

John J. Egan, Center for Space and Technology

Jerry Freibaum, NASA Headquarters

Stan Goldberg, NASA Headquarters

Richard D. Halpern, NASA Headquarters

George Knouse, NASA Headquarters

Holmes S. Moore, Center for Space and Technology

Pete M.P. Norris, Eosat

Frank Penaranda, NASA Headquarters

Jon Michael Smith, NASA Headquarters

Edward J. Stanton, Rockwell International

Charles D. Walker, McDonnell Douglas Astronautics Company

APPENDIX D

SUMMARY OF EXISTING NASA AGREEMENTS
TO PROVIDE LAUNCHES AND SERVICES

Space Shuttle Launch and Associated Services Agreement Provides
launch and associated services to commercial and foreign
customers on a reimbursable basis. Launches are provided at a
fixed price plus escalation from a base pricing year for
standard services. Standard services are paid by the customer
prior to the launch. Optional services are available to the
customer on a fixed price, fixed rate or government cost
(actual incurred cost to the government) basis and are paid
prior to the performance of the services by NASA. The majority
of the document consists of standard terms and conditions with
negotiated customer unique provisions included in Article I.
An outline of the document is included below:

Preamble
Article I   Description of Customer Unique Provisions
Article II   Description of Services to be furnished by NASA
Article III   Responsibilities, Coordination and Documentation
Article IV   Scheduling Policy and Requirements
Article V   Allocation of Certain Risks
Article VI   Financial Arrangements
Article VII   Termination of Services
Article VIII   Assignment of Rights to Services
Article IX   Use of United States Government-Owned Equipment
Article X   Exchange of Documents and Information
Article XI   Handling of Customer Provided Data and Data
                 Derived From the Payload
Article XII   Patent and Data Rights
Article XIII   Assistance with Third Party Claims
Article XIV   Availability of Appropriations
Article XV   Services Consistent with United States'
                 Obligations, Law, and Published Policy
Article XVI   United States Government Offices Not to Benefit
Article XVII   Applicable Law
Article XVIII   Disputes
Article XIX   Registration of Customer Payloads

Space System Development Agreement (SSDA)

Modified Launch Service Agreement (LSA)

Similar to the basic LSA, the SSDA provides launch and
associated services to commercial customers on a delayed
reimbursable basis for those customers that offer an important
and unique use of space not yet available. The customer agrees
to pay NASA for launch and associated services after the launch
has occurred and the customer has begun to receive revenues
resulting from the launch. Shuttle services will be paid to
NASA out of the customer's revenue after the launch has been
completed. An outline of the document is included below:

Joint Endeavor Agreement (JEA)

A JEA is a cooperative agreement in which NASA and the private sector share common objectives and risk. JEA's were primarily conceived to encourage private ventures in space and to demonstrate the usefulness of space technology to meet commercial needs on earth. After a JEA is negotiated and signed by NASA and a company, the company develops the appropriate hardware to perform a selected space experiment or technology demonstration in orbit aboard the Shuttle at its own expense. NASA provides the flight opportunity at no cost to the company except for certain optional services outside of the scope of services normally available to JEA experiments. Also, the company is allowed to retain certain proprietary rights as a result of the JEA, particularly non-patentable information that yields a competitive edge in the eventual commercial marketing of any product which may result. NASA does require certain data to evaluate the significance of the results of the JEA and stipulates that any promising technologies be applied commercially within a reasonable amount of time or the results published. NASA also retains "march in" rights to provide the resulting proprietary data from the JEA to the public domain. An outline of the document is included below:

Small Self-Contained Payload (SSCP) Launch Services Agreement

SSCP launch service agreements provide conformance between NASA
and the customer to fly SSCP experiments (Get Away Specials) on
the Shuttle. The Getaway Special (GAS) Program provides
inexpensive access to the space environment on Shuttle flights
for a wide variety of users. Users can fly experiments in

self-contained canisters located in the payload bay of the
Orbiter on a space available basis for a fixed price of $3,000
to $10,000 per payload. The two-page GAS Launch Agreement
includes basic customer experiment, financial and scheduling
provisions necessary for agreement between NASA and the
customer for flight of the GAS payload. An important aspect of
this agreement is the absence of a NASA requirement for the GAS
customer to indemnify the government against third party
liability claims. This allows access to the GAS Program for
the widest and most diverse customer base possible, including
schools and individuals. An outline of this short document is
included below:

        Article I   User Unique Provisions
        Article II   Effective Date of Agreement
        Addendum I   Supplementary User Provisions

Memorandum of Understanding

A Memorandum of Understanding (MOU) is a binding document
between NASA and foreign government for a cooperative program.
There is no exchange of funds between NASA and the other
government under the terms and conditions of the MOU and no
further agreements are required. In a typical MOU, NASA may
provide free Shuttle launch services for a foreign spacecraft
program which involved cooperation with the U.S. or for which
NASA was interested in sharing the data. The main feature of
the document is the description of responsibilities of the
parties.

This MOU is not to be confused with an MOU signed between NASA
and a foreign government as a precursor to a reimbursable
Shuttle Launch Agreement. This particular MOU states the basic

intent of the parties to fly a particular payload on the
Shuttle with the detailed terms and conditions to be negotiated
in an anticipated Launch Agreement between the parties. The
MOU is signed before the LSA can be executed and is accompanied
by an exchange of diplomatic notes between the U.S. and the
other country.

An outline of a typical MOU is included below:

Preamble
Article I   Purpose
Article II   General Description of the Program
Article III   Scientific Uses of the Spacecraft
Article IV   Data Acquisition and Analysis
Article V   NASA Responsibilities
Article VI   Foreign Government User Responsibilities
Article VII   Program and Project Management
Article VIII   Integration and Flight Readiness
Article IX   Standards, Specifications and Language
Article X   Rights in Technical Data
Article XI   Rights in and Distribution of Data Derived from
                 Operation of Spacecraft and Experiments
Article XII   Public Information
Article XIII   Customs Clearance
Article XIV   Funding Arrangements
Article XV   Liability
Article XVI   Limits of Obligation
Article XVII   Duration
Article XVIII   Amendments
Article XIX   Entry into Force

Technical Exchange Agreement (TEA)

NASA and the company agree to fund its respective participation
in the program. NASA gains expertise of the company's private
research capabilities, and allows the company access to NASA
research and facilities. NASA facilities such as wind tunnels,
micro-gravity drop tubes and aircraft flights are available for
commercial use through TEA's. An outline of a typical TEA is
included below:

D-6

Article I	Purpose, Scope and Consideration
Article II	Responsibilities
Article III	Data
Article IV	Property Rights in Inventions
Article V	Term of Agreement

Industrial Guest Investigator Agreement

An agreement for an Industrial Guest Investigator (IGI) provides the terms for a scientist from private industry to cooperate with a NASA-sponsored principal investigator on a space research project. The IGI collaborates with NASA at his company's expense. The scientist becomes a member of the investigation team and brings the private company's expertise and insight into the research project.

DOD Memorandum of Agreement

NASA provides reimbursable Shuttle flights to the DOD under an umbrella Memorandum of Agreement between NASA and the DOD with unique pricing and terms and conditions resulting form the DOD's participation and investment in the Shuttle program.

Memorandum of Understanding between NASA and other U.S. Government Agencies

NASA provides launches and other services to other U.S. Government agencies under the terms and conditions of specific MOU's outlining the responsibilities of each agency and any reimbursement provisions required.

APPENDIX E

USER SELECTION PROCESS

The selection of U. S. users comes under the purview of the Space Station User Board (SSUB). Selection is the responsibility of the entities participating on Space Station. NASA's OSSA, OAST, and OCP, along with DoD, NOAA, commercial reimbursable and other entities, each select its own users. Selection does not begin until each agency has been allocated its share of Space Station resources, for a given increment of time (say one year). The selection process and the roles and responsibilities of the management elements of Space Station are described as follows.

AGENCY SELECTION PROCESS

Each agency receives an allocation of resources which it uses to accomplish its overall program objectives. The actual allocation mix of resources which each receives may force that user class to revise its program goals and near- term planning. When the revised program is completed, each agency can begin its selection process.

AOS AND SALES ANNOUNCEMENTS

Within NASA, OSSA and OAST send out Announcements of Opportunity (AOs) to all potential users. OCP advertises for commercial companies to bid for use of Space Station resources. The Space Station Market Development office market to commercial reimbursable users and provides all user communities with general information on Space Station capabilities and operation.

OSSA, OAST, and OCP provide more detailed information on payload capabilities and Space Station resources available to its users.

USER LETTERS OF INTENT

In response to AOs, users send letters of intent (LOIs) to the office which has sent out the AO. The NASA offices respond to LOIs by sending out to each interested user a detailed proposal instruction package. Users, following the instructions, submit proposals them to the relevant office.

PROPOSAL EVALUATION

Proposals received by each office prior to some cutoff date are reviewed and evaluated by the office.

1. Each office must review its proposals and compile a list of resource requirements needed to support each proposal. These requirements may be given to the Space Station Utilization Planning office for a technical feasibility analysis which will flag proposals which are technically difficult, outside the capabilities of the Space Station, or impossible to manifest during the required time period.

2. Each office must evaluate its proposal for scientific and/or technical merit. OSSA has traditionally conducted peer group evaluations to rate proposals on scientific value. OAST and OCP will conduct evaluation processes according to their needs. Commercial reimbursable users may be evaluated on the basis of the best financial offer and/or resources required.

USER/PAYLOAD SELECTION

1. Each NASA office selects its complement of users and user
    payloads for a given increment of time. This selection is
    based on three primary considerations: technical feasi-
    bility as determined by the Space Station Utilization
    Planning office, scientific and technical value as deter-
    mined by peer group evaluation or other evaluation process,
    and user and payload requirements and compatibility with
    existing manifest timelines.

2. Commercial reimbursable users may be selected on the
    basis of best financial offer and/or resource requirements.

3. DoD selects its users (payloads, missions) according to
    national defense priorities.

USER PRIORITY ASSIGNMENTS

OSSA and OAST may assign priorities or scheduling categories to
users based on peer group rankings, recommendations, and
observational-related time windows. An example of a time
window is the observation of a comet or other time-critical
event. User priorities or categories are very useful to the
functions of utilization planning (manifesting) and conflict
resolution.

PRELIMINARY PROGRAM REQUIREMENTS ANALYSIS

User requirements and categories for selected payloads are
compiled by the User Accommodation office. These requirements
are submitted to the Utilization Planning office by the UOP for
compatibility analysis and assessment. This office flags any

problems in the area of resource availability and manifesting compatibility. These problems are iterated and trade analyses are conducted by the Utilization Planning office with guidance by the SSUWG Steering Committee until an acceptable preliminary (strawman) manifest and resource requirement timeline for operations is produced. This preliminary utilization plan forms the basis for each user office's Preliminary User Program Plan.

FINAL USER PROGRAM SELECTION APPROVAL

The preliminary utilization plans which include resource requirements proposed, selected user programs, and a preliminary manifest are presented to the UOP for final approval. This board reviews the plan, resolves conflicts between users and user groups, and approves the plan for implementation. Each user office can now inform all of its users that they have been officially accepted by the Space Station and proceed to get each user under contract to begin the end to end process of user payload development, integration, operation, data analysis, data publication, and archiving.

APPENDIX F

CONTACTS FOR PAYLOAD SELECTION AND RESOURCE ALLOCATION

John Egan, President, The Egan Group

Dr. Joe Allen, Executive Vice President,
Space Industries Inc.

Dr. Chris Podsiadly, Director, Science Research Laboratory;
Director, NASA/3-M Project, 3-M Company

Bob Pace, Executive Vice President, Microgravity Research
Associates, Incorporated

Charlie Walker, Special Assistant to the President on Space
Station, McDonnell Douglas Astronautics Company

Charles Williams, President,
Earth Observations Satellite Company

Dr. Donald York, University of Chicago

Michael Devirian, NASA Headquarters, Code EI

Lynwood Clark, NASA, Langley Research Center

Rick Chappell, NASA, George C. Marshall Space Flight Center

Owen Garriott, Consultant

Bill Lenoir, Booz-Allen-Hamilton

APPENDIX G

MANIFESTING SUBPANEL

The members of the Manifesting Subpanel were:

o   Robert Everline   Consultant/TADCORPS
o   Bryant Keith   NASA Headquarters, Code M
o   Carolyn Kimball   NASA Headquarters, Code S
o   Deborah Kessler Langan   NASA Johnson Space Center
o   John Mitchell   NASA Johnson Space Center
o   Richard Ott   NASA Headquarters, Code M
o   Thomas Overton   NASA Kennedy Space Center
o   David Porter   Jet Propulsion Laboratory

Mr. Raymond Sizemore of the NASA Lewis Research Center also participated as a OTF member-at-large in many of the Subpanel's meetings.

The subpanel was formed in October 1986 and worked as a group through February 1987. During this time they reviewed existing literature, attended background briefings, and sought the advice and opinions of individuals outside the Space Station Operations Task Force. Commencing in December a series of subpanel meetings was held to discuss issues and policies; formulate and evaluate concepts; prepare and review drafts of the final report; participate in critiques with other panel members; and review the panel's findings with the Task Force. A summary of panel activities is provided in Figure G-1.

Biographies of the subpanel members follow.

ROBERT EVERLINE is a consultant with several aerospace companies. He is based in Webster, Texas, and specializes in marketing, management, and integration of space systems. He has over 28 years aerospace experience in operations, planning, and analysis with NASA and industry. Mr. Everline was a member of the original Langley Space Task Group and worked on most major U.S. manned space programs, including Mercury, Gemini, Skylab, and the Space Shuttle, while with NASA. He retired from the NASA in 1983 as Manager, Space Shuttle Flight Manifest Office at the NASA Johnson Space Center, Houston, Texas. Mr. Everline has a B.S. in Electrical Engineering from West Virginia University.

BRYANT KEITH is responsible for supporting NSTS Manifest Development at NASA Headquarters. In that capacity, he develops NSTS manifests based on payload requirements in coordination with the Flight Assignment Working Group (FAWG). Mr. Keith manages the computer based scheduling activities for the Office of Space Flight. Prior to coming to NASA Headquarters in 1983, he was employed at the Kennedy Space Center. Mr. Keith has a B.S. Degree from Georgia Tech.

CAROLYN KIMBALL is a Requirements Analyst in the Utilization Division of the Office of Space Station at NASA Headquarters in Washington, D.C. She is currently managing utilization policy studies for user systems including manifesting, resource monitoring, and user operations policy. Her previous experience at NASA has been in the development and analysis of technology requirements for the Space Station.

DEBORAH KESSLER LANGAN is an Aerospace Engineer in the Mission
Operations Directorate at the NASA Johnson Space Center in
Houston, Texas where she is involved in rendezvous mission design
and analysis. Her previous experience with NASA includes analysis
of Space Station user requirements and mission planning and
integration for the Space Shuttle program. Prior to joining NASA,
Ms. Langan was a member of the engineering staff for the Marketing
Division of Exxon Company USA. Ms. Langan has a B.S. in
Mechanical Engineering from the University of Maryland and an M.S.
in Electrical Engineering from the University of Houston.

JOHN MITCHELL is a Technical Manager in the Space Station
Program Office at the NASA Johnson Space Center in Houston,
Texas where he is responsible for the synthesis of user require-
ments. He has over 25 years experience in civilian and military
aerospace programs—the last 18 with NASA. His previous experi-
ence includes: missile guidance systems, flight safety, and data
engineering; remote sensing operations, applications, and systems;
and Shuttle flight manifesting. Mr. Mitchell has a B.S. in
Physics and Mathematics from Northern Illinois University and an
MBA from the University of Houston (Clear Lake).

RICHARD OTT is the Branch Chief in the Office of Space Flight
at NASA Headquarters, Washington, D.C. for NASA Utilization.
His Branch is responsible for the development of the Shuttle
Manifest and the User interface for NASA and other U.S. Govern-
ment payloads. In addition, his responsibilities include the
scheduling and integration coordination of Getaway Specials,
mid deck, Commercial hitchhikers, Student Non Scientific, and
Space Flight Participant Payload Programs. Mr. Ott has a B.S.
in Aerospace Engineering from Virginia Polytechnic Institute
and a M.S. in Space Science and Applied Physics from Catholic
University of America.

TOM OVERTON is a lead Operations Engineer in the Mission Planning Office at the NASA Kennedy Space Center, Florida. He is the KSC Shuttle representative to the Space Shuttle Flight Assignment Working Group where he is responsible for the development of the KSC integrated multiflow processing schedules and the STS Program Manifest. He is a graduate of Florida Technological University with a B.S. degree in Electrical Engineering. His work experience includes 21 years at KSC with ten years as an Operations Engineer on the Apollo Program and eleven years in Shuttle Operations.

DAVID PORTER is a Senior Economist at the Jet Propulsion Laboratory in Pasadena, California. He is currently involved in the NASA Space Station program developing and analyzing utilization policies. He has a PhD in Experimental Economics and an M.S. in Mathematics from the University of Arizona. His previous experience includes the analysis of the rate structure for the electric power and telecommunications industry, the experimental design of computerized market exchanges, and nonparametric statistical analysis of controlled experiment data.

1986

SEPTEMBER			OCTOBER				NOVEMBER					DECEMBER			
15	22	29	6	13	20	27	3	10	17	24	1	8	15	22	29

NASA HQS — SSOTF KICKOFF METING

NASA HQS — PANEL 3 KICKOFF MEETING

MSFC — PANEL 1 SPACELAB BRIEFINGS

KSC — MANIFESTING MEETING W/FAWG

JSC — PANEL 1 OPERATIONS BRIEFINGS

NASA HQS — PANEL 3 MEETINGS

NASA HQS — ESA MEETINGS

NASA HQS — CANADS/JAPAN MTG

JSC — MANIFESTING MEETING

1987

JANUARY				FEBRUARY				MARCH					APRIL	
5	12	19	26	2	9	16	23	2	9	16	23	30	6	13	20

KSC — PANEL 3 MEETING & INDUSTRY BRIEFINGS

ARC — PANEL 3 REPORT WRITING

KSC — PANEL 3 REPORT EDITING

KSC — CANADA/ESA/JAPAN MEETINGS

KSC — PANEL 3 REPORT TO SSOTF

KSC — PANEL 1 REPORT TO SSOFT

KSC — PANEL 1 REPORT CONCLUSION

KSC — PANEL 2 REPORT TO SSOTF

STANFORD U. — TFSUSS BRIEFING

KSC — PANEL 4 REPORT

Figure G-1. Manifesting Subpanel Activities

APPENDIX H

UTILIZATION PLANNING IN OTHER NASA PROGRAMS

As a part of its activity, the subpanel investigated how
Utilization Planning was done in other NASA programs. The
purpose of these investigations was to develop a better
understanding of the planning process, in general, as well as
in specific situations, and to use the experiences gained in
these programs to develop recommendations for the SSOTF. The
programs investigated were the National Space Transportation
System (NSTS), the Tracking and Data Relay Satellite System
(TDRSS), the Deep Space Network (DSN), and the Spacelab Program.
In addition, an outside consultant, who has been involved in
the planning processes of all these programs except Spacelab,
and is currently developing a prototype expert system for Space
Station Utilization Planning, provided valuable insight into
the various scheduling processes and lessons learned from them.
It should be noted that what we refer to as Utilization
Planning, the NSTS calls the flight assignment process or
manifesting, and the other programs call scheduling.

A.   NSTS

The following is a description of the current process used by
the NSTS to manifest the Shuttle. It is intended to provide a
broad overview and reference for comparison with the Space
Station Utilization Planning process.

The NSTS process begins with the submittal of a Form 100. This
is a "Request for Flight Assignment" and when signed by an
approving authority constitutes a "ticket" to fly on the
Shuttle. Form 100's which are submitted by the NASA Payload

Program Offices, require the signature of the respective Associate Administrator and indicate that the payload is a funded project or program. Commercial payloads require the signature of an official authorized to commit the company funds and an accompanying earnest money check for $100,000.00 (which is non-refundable). Joint Endeavor Agreements (JEA) require the signature of the NASA Associate Administrator of the Office of Commercial Programs (OCP). The form contains basic descriptive information of the payload that includes desired launch date, weight, dimensions, C.G., type of payload (deployable, attached, retrieval), and type of carrier (e.g. PAM-D, PAM-D II, IUS, Spacelab). This initial information is sufficient for the NSTS To manifest the payload. An approved form initiates a number of actions within the NSTS program.

o   The payload is assigned a booking date as of the date it is received. The payload is added to an NSTS queue list established within each payload priority clarification (DOD, commercial, NASA science, etc.) which establishes its priority with regard to other payloads.

o   The Flight Assignment Working Group (FAWG) is authorized to include the payload in its manifesting activities which ultimately leads to an assignment in the NSTS manifest. This system prevents including payloads on the manifest which have not been approved for flight.

o   Authorization is also issued to JSC and KSC to initiate the payload integration process which includes preparation of the Payload Integration Plan (PIP) and PIP Annexes.

The FAWG is the focal point of the NSTS manifesting effort. It is chartered by NASA Headquarters and chaired by Johnson Space Center. Weekly telecons, quarterly meetings, and frequent informal discussions allow FAWG members to exchange the information necessary to provide an updated preliminary NSTS manifest on a periodic basis.

FAWG Membership

o NASA Headquarters identifies the payload requirements, provides payload priorities, and oversees the implementation of the NSTS program goals, requirements and objectives.

o The Johnson Space Center (JSC) chairs the FAWG meetings/telecons and assesses the orbiter configuration, crew size, mission duration, altitude, inclination, payload distribution in the orbiter, and orbiter performance.

o The Kennedy Space Center (KSC) (NSTS) provides and assesses working manifests and assigns orbital vehicle sequence, launch dates, flight rate capabilities based on optimized ground flow processing assessments and facility limitations. KSC establishes significant milestone data such as payload delivery/installation dates and major transportation flight hardware delivery/processing dates (ET, Orbiter, SRB's).

o KSC (Payloads) provides payload ground processing capability assessments and Aerospace Service Equipment (ASE) ground turnaround processing limitations.

o The Marshall Space Flight Center (MSFC) represents specific scientific payload interests, provides mission specific requirements to the FAWG, and Spacelab carrier information and constraints. MSFC also provides major flight hardware production/delivery schedule compatibility analyses to support the manifest, e.g., ET, SRB, and SSME modification and delivery schedules.

o Space Division (DOD) represents the DOD interests and assesses working and preliminary manifests for compliance with DOD requirements.

o Vandenberg Air Force Base (VAFB) provides processing assessments for Vandenberg Launch Site (VLS) flights.

o GSFC represents specific scientific payload interests.

o NASA Headquarters Office of Space Science and Application (OSSA) represents the NASA science and applications payload community.

FAWG Products

   o   The <u>Working Manifest</u> is an initial manifest usually
       provided by NASA Headquarters to KSC and JSC for
       assessment. The working manifest includes preliminary
       orbiter assignments, launch dates, crew size, mission
       duration, and payload assignments. Several iterations
       of the working manifest may occur between NASA
       Headquarters, JSC, and KSC during the process of
       establishing a preliminary manifest.

   o   The <u>Preliminary Manifest</u> is a manifest that has been
       assessed by the FAWG to a sufficient level of detail
       that it may be used for preliminary planning purposes
       by all NASA Centers. The preliminary manifest is
       distributed to the FAWG members via computer and to
       general distribution by a preliminary manifest report
       produced by KSC. Near term milestones established by
       the preliminary manifest are submitted to Level II for
       formal approval, inclusion in the "Flight Definition
       and Requirements Directive", and implementation.

   o   The <u>Baseline Manifest</u> is a manifest that has been
       reviewed and approved by NASA Headquarters Management.
       When the preliminary manifest has been reviewed by all
       members of the FAWG, it is presented to management for
       approval. After approval, it becomes a new baseline
       manifest, is reproduced in booklet form, and released
       to general distribution. The FAWG goal is to provide a
       baseline manifest quarterly, however, past experience
       has resulted in the release of a new baseline
       approximately every six months.

Additional supporting data that is needed to manifest the NSTS
is obtained from several sources.

   o   Status of the Shuttle fleet is contained in the
       Baseline Accounting and Resource System (BARS). This
       computerized data base includes information on the
       performance capability, weight, C.G., and configuration
       of all the NSTS elements.

   o   Programmatic and strategic milestones that guide the
       direction of the Program, such as the flight rate,
       fleet size, and production/delivery schedules of
       orbiters, are developed by NASA Headquarters and
       documented in the Flight Definition and Requirements
       Directive (FDRD).

o   Payload data is maintained and updated in several
     documents. Generic carrier data is documented in the
     carrier Interface Control Document (ICD) and payload
     specific data in the Payload Integration Plan (PIP) and
     the PIP Annexes.

Much of the information used in developing the manifest has
become standardized. For example, payloads with PAM-D upper
stages are fairly routine as the weight, C.G., dimensions, and
allowable payload bay locations are known from the generic ICD
and experience. The basic unknowns with these payloads are the
compatibilities with other payloads and specific launch and
deploy windows.

Revisions or changes to the manifest begin with NASA
Headquarters issuing a working manifest to the KSC and JSC FAWG
members for assessment. It primarily identifies the payload
requirements and the order in which they are to be flown but
also includes proposed orbiter assignments, launch dates, crew
size, and mission duration. Much of the working manifest is
based on the previous manifest but it incorporates payload
requirement (delays, additions, deletions) and priority
changes, as well as changes in the Shuttle program support.

KSC is responsible for specific orbiter assignments and launch
dates. These are determined through computer analysis of an
optimized on-line or vehicle ground flow which is modified to
include constraints and limitations imposed by the specified
mission circumstances. The outputs of the on-line assessments,
particularly the launch dates, serve as inputs to the off-line
or cargo processing ground flow. This is another computer
assessment that starts with the launch date and backs up
through the cargo processing requirements to establish
milestones for payload delivery, assembly, checkout,

verification, and installation in the orbiter. Both the on-line and off-line analyses identify any problems with the working manifest.

JSC assesses the payload and orbiter configurations, crew size, inclination, altitude, flight duration, payload locations in the bay, composite system C.G., performance margins, landing weights, and unused capabilities. A computer program, called Shuttle Payload Integrated Cargo Evaluation (SPICE), is used in these analyses. Based on these analyses, JSC will identify all constraints, limitations, and any residual problems with the working manifest.

A preliminary manifest is then developed and assessed in detail by the entire FAWG. Issues are identified and impact assessments developed. The preliminary manifest, along with issues and impacts, is then reviewed with NASA Headquarters management and the payload program offices. Any unresolved issues are identified, actions assigned and upon closeout of the actions, a new baseline manifest is approved and distributed.

B. Spacelab

This section describes the process by which instruments are manifested for a Spacelab mission and become one payload for the Shuttle. It also briefly discusses aspects of Spacelab mission coordination, implementation, and operations. The main sources of information for this study come from the STS Investigators' Guide, conversations with the Office of Space Science and Application (OSSA) personnel, and discussions with Spacelab mission scientists. The purpose is to provide an overview of the information, interfaces, and planning required in Spacelab Utilization Planning.

1. Instrument Manifesting

Spacelab offers a variety of services to potential users. In addition to the use of low gravitational fields in low Earth orbit, instruments can make use of crew (payload specialists), electric power, payload environmental control, data processing and acquisition, instrument pointing, etc. The manifesting process attempts to fit the requirements of instruments into the capabilities of the Shuttle and Spacelab subsystems. The planning of Spacelab/Shuttle utilization by instruments and operating subsystems is a complicated procedure.

First, instrument requirements are given to the NASA Payload Engineering Division (Code EM) where tentative payload groups are studied for compatibility, i.e., experiment interfaces, use of common facilities, and resource utilization.[1] We have learned from our conversations with Code EM personnel that the manifesting process is an iterative procedure. In general, Code EM receives information from payload designers about instrument requirements and develops tentative payload groups. Payload Engineering then relays this information to the pertinent field centers (mission management centers) where initial flight accommodation studies are performed on the tentative payload groups. After Code EM analyzes the results, it reviews the results with NASA management. Then NASA management transmits information about its preferences

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[1] The STS Investigators' Guide states that "In general, for a given flight or series of flights, the tentatively selected experiments are grouped by discipline to provide maximum scientific data return from the various research areas, minimum interface among experiments, and maximum feasible use of common facilities, sensors, and data processing equipment."

(relative benefits over the payloads and payload groups).
Information about how instruments fit together and about queue
position is transmitted to sponsors, payload designers, and
investigators.   Payload designers and investigators then
reevaluate their designs to determine the feasibility of
changing their requirements and, therefore, changing the
payload assignment. Finally, results of mission studies are
evaluated and a decision is reached on mission funding.
Figures H-1 and H-2 provide a flow of this process which is
taken from the STS Investigators' Guide.

2.   Spacelab Mission Coordination and Implementation

Many events can occur between the manifesting/funding of a
Spacelab mission and the post-flight operations which may
adversely affect the resource allocation of the mission.
Before actual operation of a mission, planning must be
undertaken to both integrate the instruments of a mission into
the Spacelab and NSTS operations and to schedule/coordinate the
use of available resources to satisfy instrument requirements.
This function is directed by a Payload Mission Manger (PMM) who
is responsible for implementing the particular mission.   The
PMM is responsible for brokering the elements required to
implement a Spacelab mission. Figure H-3 shows the interface
of the user, PMM, and elements to be brokered.   The actual
mission plan, coordination of requirements, and the resolution
of resource scheduling conflicts is provided through a
committee mechanism (Investigator Working Group - IWG)
consisting of the users and chaired by a NASA Mission
Scientist.   The IWG develops a mission plan and recommendation
to be implemented by the PMM.   If there are any changes such as
new instruments entering the mission, a change in instrument or
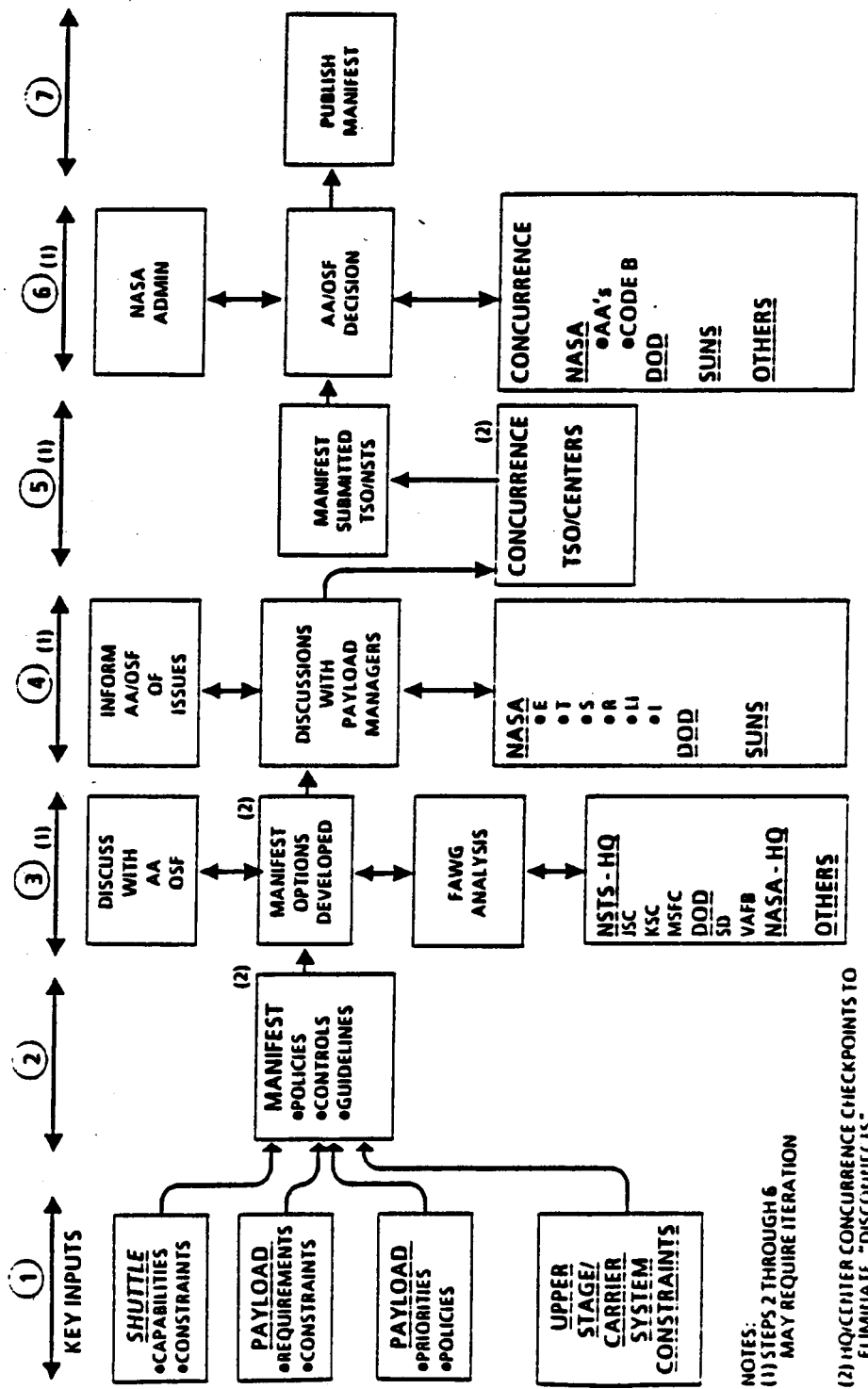system requirements, or the deletion of instruments on a

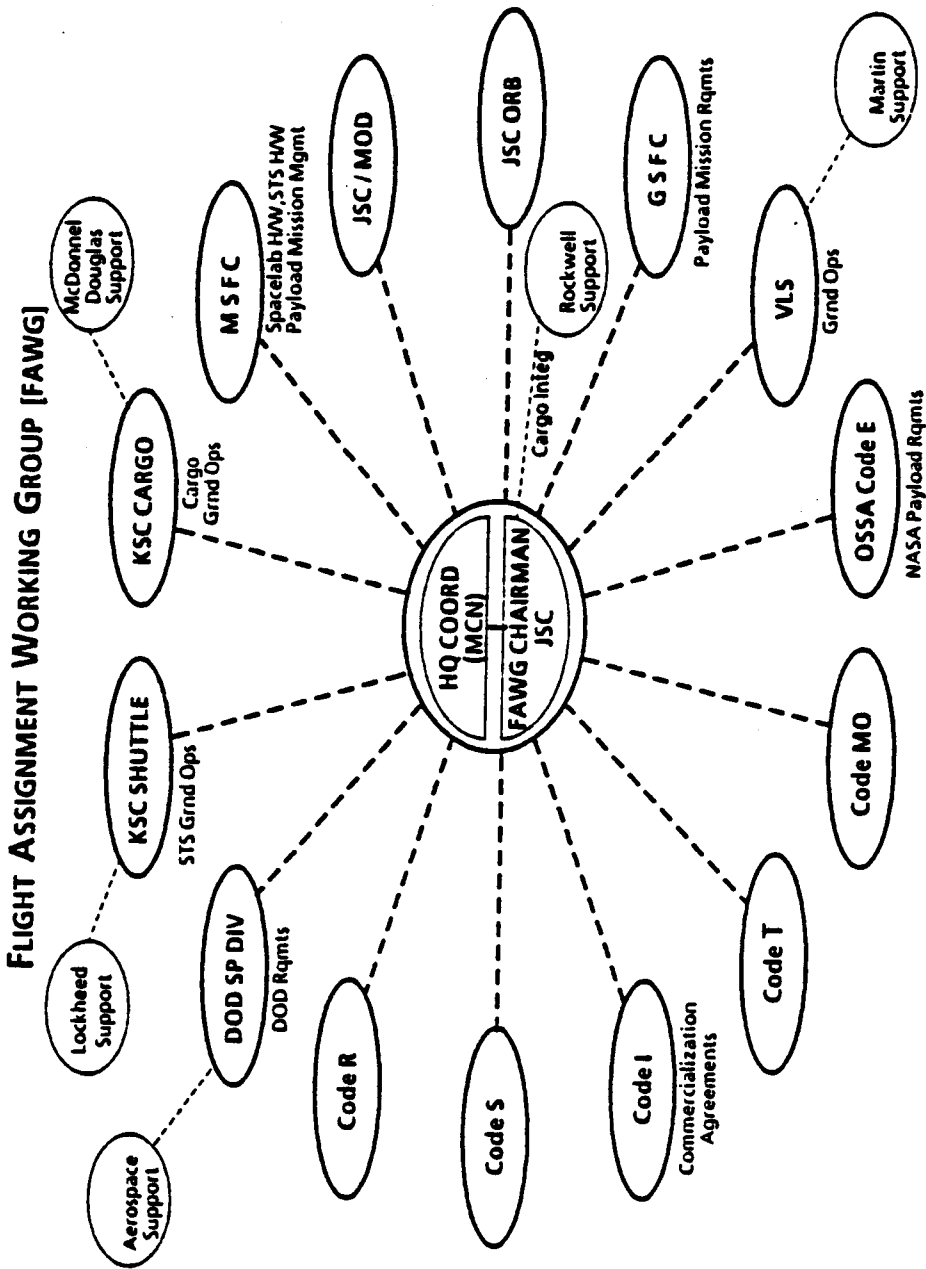**Figure H-1. Manifesting Process An Overview**

FLIGHT ASSIGNMENT WORKING GROUP [FAWG]

Figure H-2. Manifesting Discussions

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                    ┌──────────────────────────┐
                    │       PRINCIPAL          │
                    │   INVESTIGATORS          │
                    │        (PI)              │
                    ├──────────────────────────┤
                    │  ● EXPERIMENT            │
                    │    - DEFINITION          │
                    │    - REQUIREMENTS        │
                    │    - DATA OR OTHER PRODUCTS │
                    │                          │
                    │  ● SCIENTIFIC SUPPORT    │
                    └──────────────────────────┘
```

PRINCIPAL INVESTIGATORS (PI)

- EXPERIMENT
  - DEFINITION
  - REQUIREMENTS
  - DATA OR OTHER PRODUCTS

- SCIENTIFIC SUPPORT

EXPERIMENT PAYLOAD ELEMENT DEVELOPERS (EPED)

- DESIGN, DEVELOPMENT, DELIVERY OF INSTRUMENTS OR EXPERIMENT FACILITIES, HARDWARE AND SOFTWARE

- INTEGRATION/OPERATIONS SUPPORT FOR EQUIPMENT HARDWARE AND SOFTWARE

PAYLOAD MISSION MANAGER (PMM)

- INTEGRATED PAYLOAD DEFINITION

- PAYLOAD ELEMENT PHYSICAL INTEGRATION

- INTEGRATED PAYLOAD ELEMENT COMPATIBILITY AND SAFETY

- INTEGRATED PAYLOAD FLIGHT PLANNING AND OPERATIONS

- INTEGRATION INTERFACE MANAGEMENT

MISSION PECULIAR EQUIPMENT (MPE) PAYLOAD ELEMENT DEVELOPERS (MPED)

PAYLOAD ELEMENT UNIQUE INTERFACING HARDWARE/SOFTWARE

- CABLES
- STRUCTURES
- BRACKETS, ETC.
- CONTROL EQUIPMENT/SOFTWARE
- ETC.

GROUND DATA PROCESSING FACILITY MANAGER

- SPACELAB DATA PROCESSING FACILITY

- HUNTSVILLE OPERATIONS SUPPORT CENTER

- PAYLOAD OPERATIONS CONTROL CENTER

HOST CARRIER PROGRAM MANAGER

- PAYLOAD-TO-CARRIER INTERFACE COMPATIBILITY

- FUNCTIONAL CHECKOUT

- FLIGHT ANOMALY RESOLUTION

- FLIGHT READINESS VERIFICATION

STS PAYLOAD INTEGRATION MANAGER

- SHUTTLE/PAYLOAD COMPATIBILITY AND SAFETY CERTIFICATION

- FUNCTIONAL CHECKOUT

- FLIGHT OPERATIONS

LAUNCH SITE SUPPORT MANAGER

- INTERFACE COMPATIBILITY AND SAFETY VERIFICATION
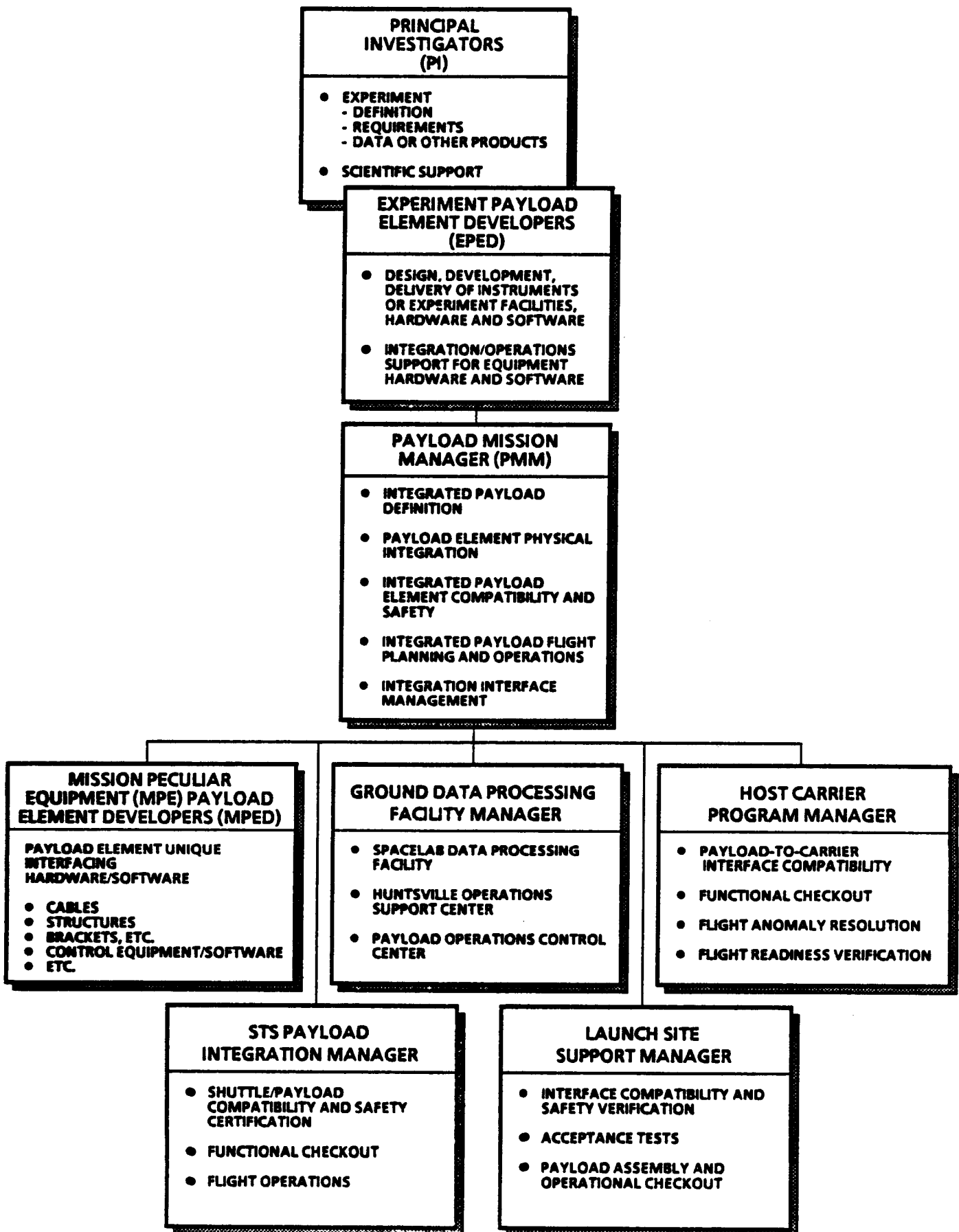
- ACCEPTANCE TESTS

- PAYLOAD ASSEMBLY AND OPERATIONAL CHECKOUT

Figure H-3

mission so that a conflict arises, the IWG attempts to resolve the conflict. The actual structure and procedures of the IWG are developed by the Mission Scientist for each mission. In general, the IWG tends to work by consensus and bilateral arrangements between the parties in conflict, with the final recommendation coming from the Mission Scientist. Users can appeal the outcome of the IWG by going directly to their sponsors and attempting to receive priority through the NASA Program Manager. The payload integration process is described by the flow provided in Figure H-4. As an overview of the process presented to this point, Figure H-5 provides a simple flow of information and decision-making requirements needed to implement/plan a mission after manifesting and prior to operations.

3. Spacelab Mission Operations

After a mission has been planned and integrated and the available resources are scheduled and "timelined" (see Figure H-6 for the mission design flow) many situations can still arise that will disrupt the planned schedule of resources and, thus, require a replanning of the timeline.[2] In general, provisions have to be made by NASA to handle a) the probability that planned resources will be less than anticipated, b) the probability that an individual payload may malfunction and, therefore, either require far more resources for repair or release unused resources, and c) the use of resources to expand an experiment due to "unique" opportunities. The analog of the

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[2] A complaint from the science payload users and crew of Spacelab has been the micro managing of resources through the timeline.
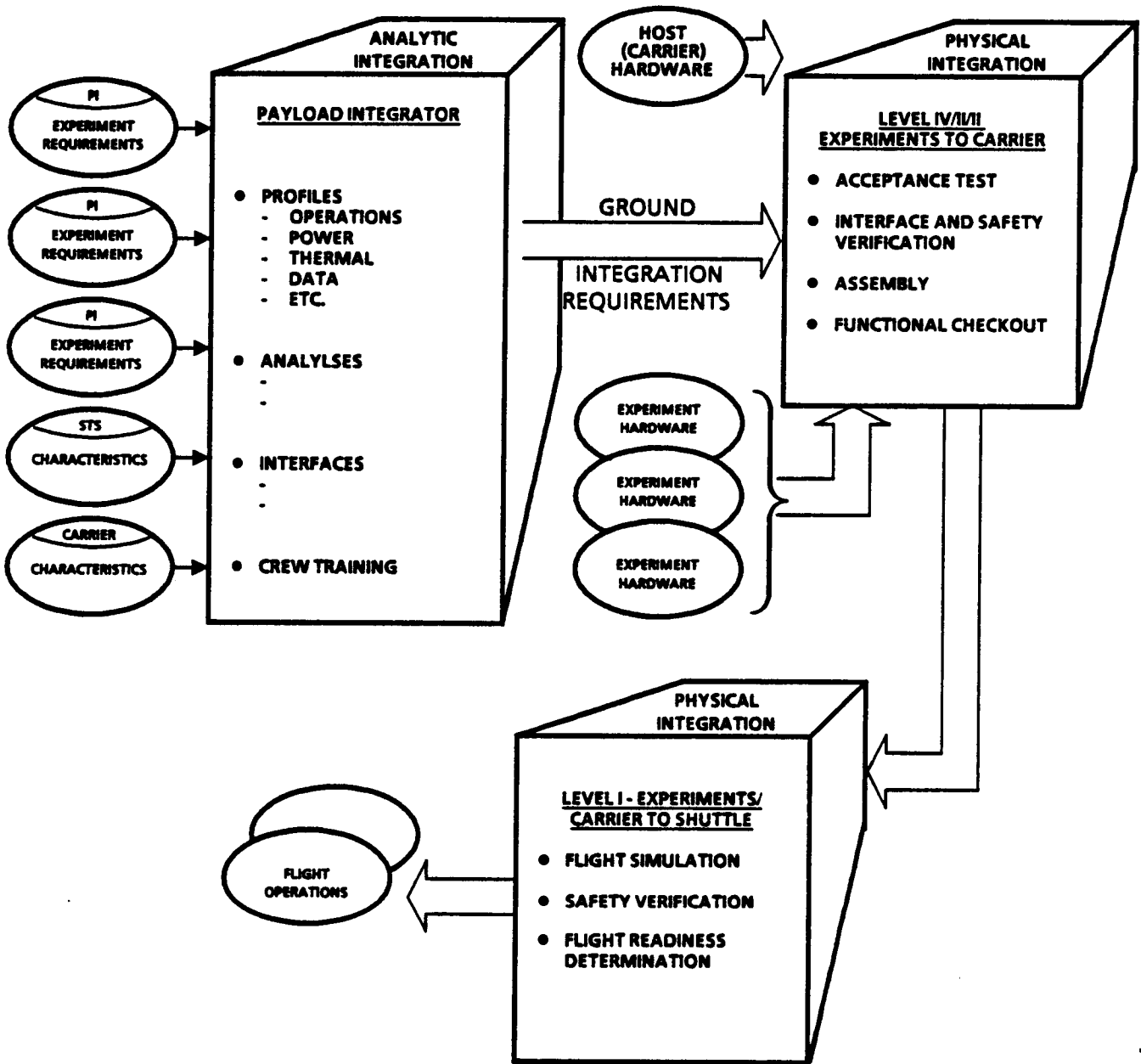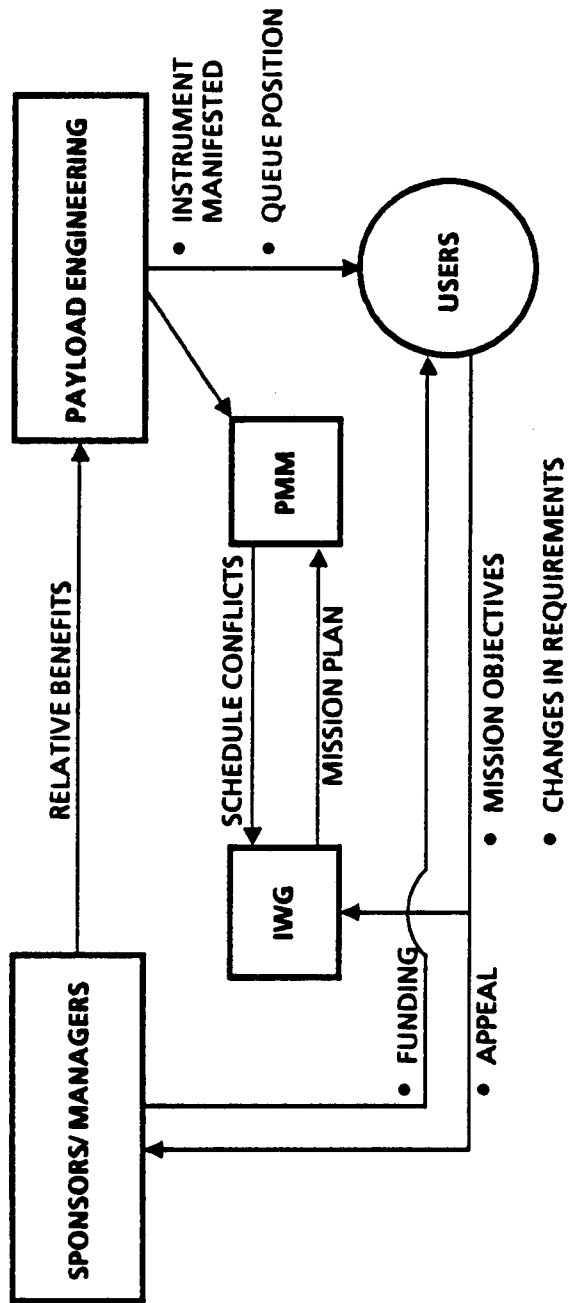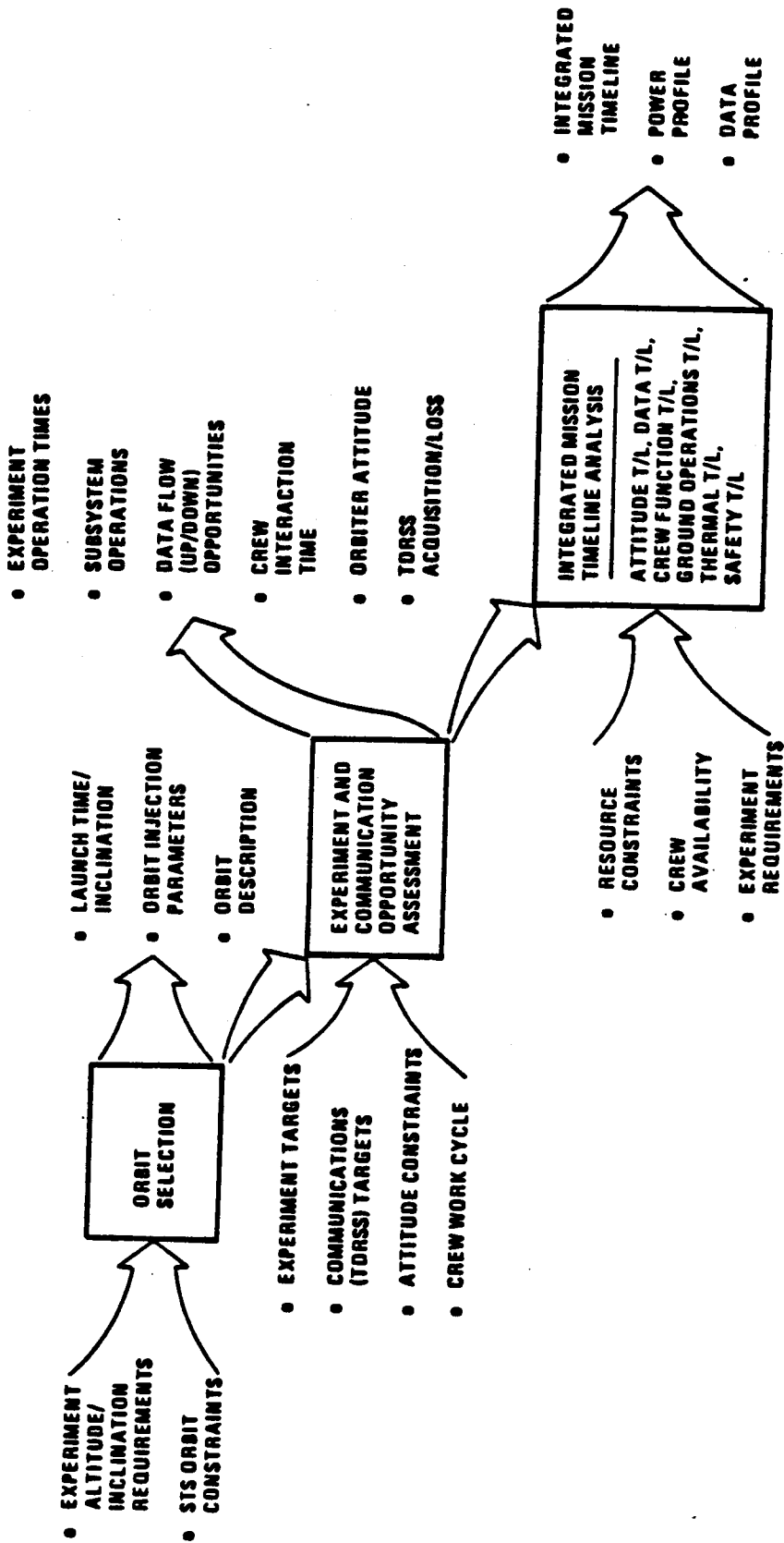
Figure H-4

Figure H-5

Figure H-6

IWG for the operations phase is the Science Operating Planning Group (SOPG). The structure and procedures of the SOPG are developed by the Mission Scientist in conjunction with the users.

For Spacelab 3, the decisions by the SOPG were made by majority rule of the users (or discipline representatives in the case of short term decisions) with the Mission Scientist casting the deciding vote in case of a tie.[3] However, decisions by the SOPG could be vetoed by the NASA Program Scientist if the decision did not meet NASA "programmatic requirements". The operating plan for Spacelab 3 also established initial priority guidelines for contingency operations which included a) the release of resources by a completely failed experiment, b) resuscitation of failed experiments using mission resources not previously allocated, if available, (resources would not be taken from previously planned resource use), and c) priority for use of extra time went as follows:

1. Experiments that lost opportunities due to STS problems,

2. Experiments that lost opportunities due to hardware/software problems from which it recovered,

3. Experiments that require troubleshooting.

C. Deep Space Network

The NASA DSN is a global network of tracking stations which monitor spacecraft, primarily NASA's interplanetary missions. Operations and management of the DSN and related facilities are performed by the Jet Propulsion Laboratory (JPL). The main

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[3] For very short term replanning of the timeline the Payload Operations Director (POD) establishes the reallocation of resources.

sources of information for this study were detailed conversations with personnel of the JPL Flight Project Support Office (FPSO) and a meeting with the Resource Allocation Planning Team (RAPT).

Before we present the details of the planning process for the DSN, let us look at the organizational structure for the planning, operations, and implementation of resource scheduling for the DSN. The Flight Projects Office manages the individual JPL deep space projects (e.g. Voyager) along with the utilization planning of the DSN through the FPSO. Within the FPSO, there are planning groups through which the initial and updated utilization plans are developed. Telecommunica- tions and Data Acquisition (TDA) is responsible for maintaining the DSN and implementing the plans generated by the FPSO.

1. Description of the DSN Utilization Planning Problem

The DSN consists of a set of antennas and support facilities, located in California, Australia, and Spain, that communicate with spacecraft (S/C) exploring the solar system. The scheduling problem for the DSN is that of assigning antennas to a set of S/C over a specified period of time, given the view periods of the S/C and their tracking requirements. In particular, Table H-1 presents the set of DSN system constraints and S/C requirements for DSN resources. Given the fixed resources of the DSN, S/C timelines are to be developed.

TABLE H-1

DSN System Constraints	S/C Requirements
o Tracking passes inside view period	o Min and max tracking period lengths
o Minimum elevation angle (or horizon mask)	o Number of tracking passes per station
o Turnaround time between successive tracking periods	o Specific assignment of tracking periods
o Single S/C tracking	o Antenna size
o Pre- and post- track time	o Simultaneous tracking multiple stations
o Station downtime or maintenance periods	o Arrayed antenna assignment
	o Fixed tracking period

2. S/C Manifesting

Long-Range Planning

In order to be considered for scheduling on the DSN, the flight project must be represented on the Joint Resource Allocation Planning Committee (JURAPC). This can be accomplished by obtaining sponsorship within NASA or by outside political means (e.g. political pressure from the State Department). The JURAPC is a high level committee consisting of representatives of the TDA, FPSO, and existing or planned flight projects requiring DSN resources. The FPSO sponsors monthly meetings of the JURAPC. This committee serves as a forum to discuss status reports of resource allocation plans and determine science needs, objectives, and trade-offs. The committee provides the general direction of the long-term (2-8 years) plan for the utilization of the DSN and related facilities.

The documentation required to begin the planning process is the receipt of S/C resource requirements by NASA and JPL management through a Support Instrumentation Requirements Document (SIRD). From the information on the SIRD, a long-term utilization plan is developed by the Resource Analysis Team (RAT) in the FPSO. It is the RAT that develops the utilization plan along with analyses, recommendations, and special studies. The long-term plan developed by the RAT becomes a proposed utilization plan. Figure H-9 provides the flow of the process to this point.

The long-range plan does not contain a detailed plan for implementation but only general information (e.g. total amount of view period needed).
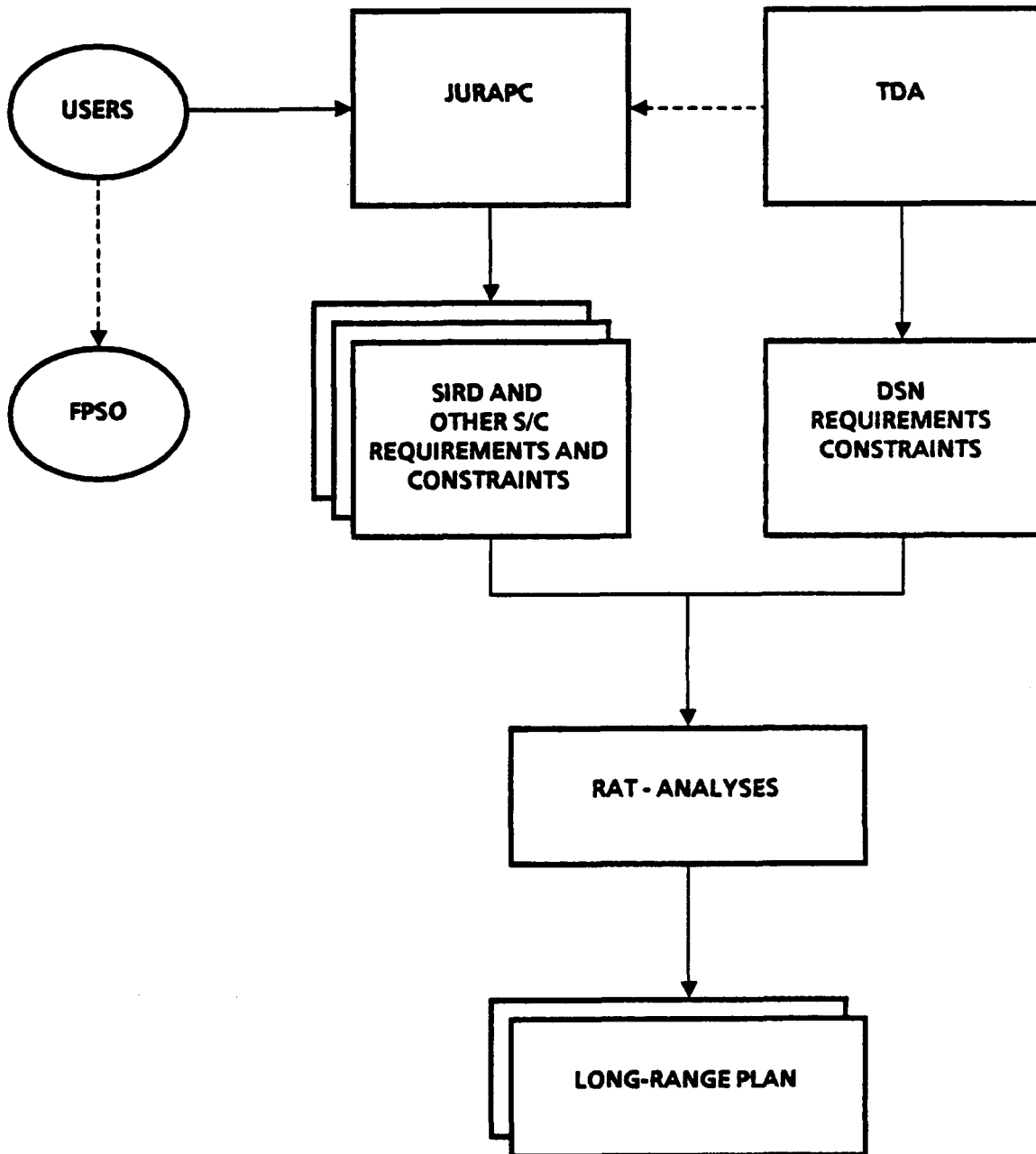
Figure H-9

H-20

Mid-Range Planning

As one might suspect, the request for resources are typically greater than what is available. In order to handle these excess demands and develop a conflict-free (feasible) schedule, the proposed plan must be refined. The focal point for this conflict/overload resolution is the Resource Allocation Planning Team (RAPT). The RAPT is a subcommittee of the JURAPC and is staffed by the leader of the RAT, one representative of each user, and DSN scheduling representatives.

The scheduling of resources to minimize conflicts among the users begins with users determining priority assignments for events that govern the scientific return from their project. The RAPT assigns priorities to events according to a numerical system (see Table H-2), with "one" being the highest priority.

This information is used as an input into a Computer Aided Resource Planning and Allocation (CARPA) system which develops and reschedules user requirements. If two users with the same priority contend for the same resources, the RAPT develops weighting factors which represent their relative scientific importance. Thus, the values of the event priorities and weighting factors are combined to help determine who gets what resource when; however, these values are only guides and conflicting users must reach a consensus before the schedule is submitted to be implemented. That is, the RAPT with the analysis from the RAT allows the users to negotiate and develop the schedule. If the RAPT is unable to resolve a conflict (normally all conflicts are resolved by RAPT) there is an

Table H-2
An example of a possible set of RAPT-negotiated event priorities

PRIORITY	ACTIVITY PERIOD AND PRIORITY CRITERIA *	EXAMPLES **
1	Spacecraft emergency which threatens achievement of primary objectives Time critical	Determined in Real Time
2	Single opportunity or one time event	Launch Midcourse Maneuvers Planetary Near Encounter Some Scientific Events
3	Mandatory for achievement of primary objectives Irregular events with subsequent opportunity available Time critical	Trim Maneuvers Some Orbital Cruise Some Interplanetary Planetary Radar
4	Regular or repeated events	Telemetry Dumps Some Interplanetary Cruise Some Orbital Cruise
5	Not mandatory for achievement of primary objectives Time Critical	Extended Mission Some Interplanetary Cruise Pulsar Rotation Constancy Some Orbital Cruise
6	Mandatory for achievement of primary objectives Not time critical	Some Orbital Cruise Some Interplanetary Cruise Pulsar Rotation Constancy
7	Not mandatory for achievement of primary objectives Not time critical	"Priority-6" for Extended Mission

*   These criteria are subject to revision by the RAPT, but they have not been advised for a number of years.

** Actual events as governed by the priority criteria would, of course, be more project-specific.

appeal route through the JURAPC then to a Senior Conflict
Resolution Committee and if the issue cannot be resolved at
either of these levels, it is referred to NASA Headquarters.

Figure H-10 Supplies a flow of the process to this point:

Short-Range Plan

The mid-range plan does not suddenly begin to reflect every
specific resource the user has requested. The detailed plan to
be implemented by the DSN and specific resource allocations is
the result of the RAPT meetings and user negotiation. It is
during the short-range planning that a conflict free schedule
is maintained and an operations schedule (timeline) is
developed by the RAT in detail. Thus, from Figure H-10 the
mid-range plan is continually updated through the RAPT
negotiation process until a conflict-free and detailed plan is
developed.

3. Schedule Implementation and Operations

Two weeks prior to a one-week execution (dispatching of
resources to users) the operating plan developed by the
RAPT/RAT is given to the DSN scheduling group within the TDA
who makes final adjustments, verifying pre- and
post-calibration times, etc. Any deviation of this schedule
due to real-time contingencies is the responsibility of the DSN
operators who have priority guidelines given to them by the
JURAPC. Whenever possible, affected parties from a contingent
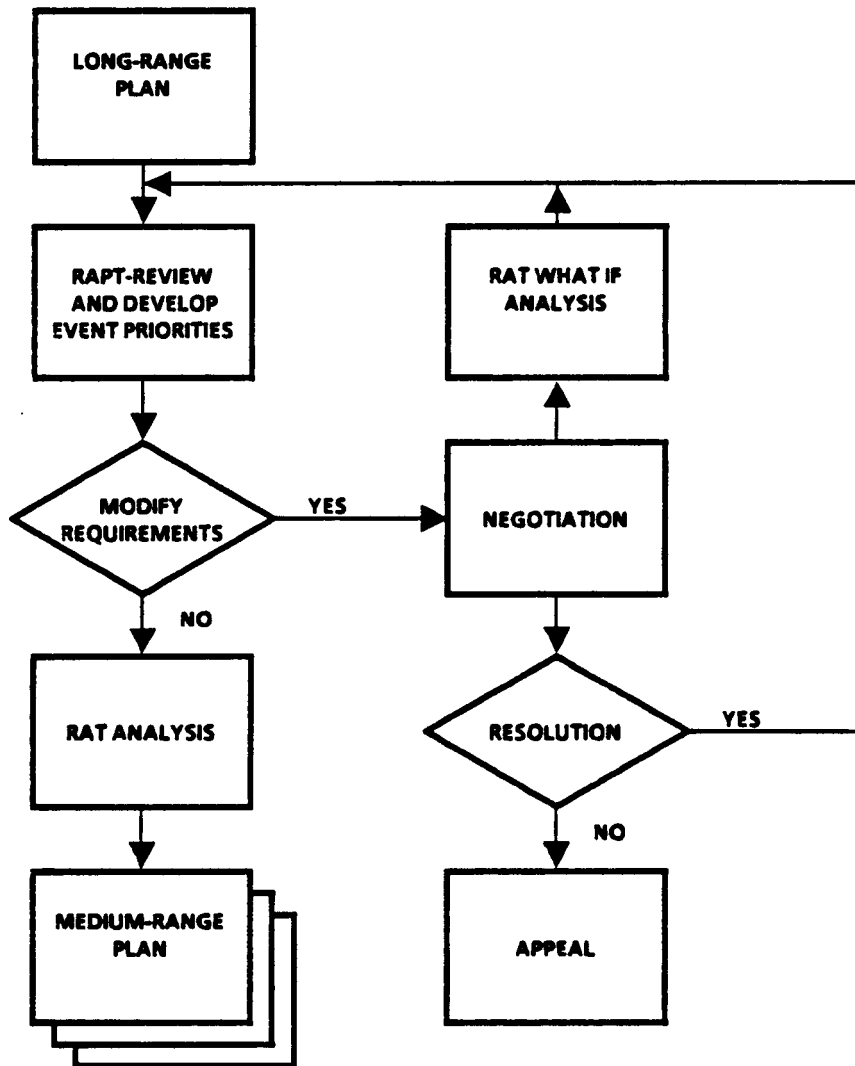reallocation are contacted and, if possible, negotiations
performed.

Figure H-10

4. Summary

The group responsible for the development of the utilization plan (RAT) is under the direction of the office responsible for DSN user (flight project) support. The allocation of resources is directed by the users through the JURAPC and the RAPT. Scheduling is performed via negotiated priorities by the users. That is, no specific allocations to users are made up front and user specific resource allocations are developed through a committee process of user negotiations.

The utilization planning function requires the use of automated and tailor-made computer scheduling system for the planning and replanning process of the RAPT. CARPA schedules user requirements based on event priorities and weighting factors. It is the responsibility of the RAPT to refine the schedule developed by the RAT into a conflict-free operating plan for a one-week execution period.

Finally, JPL and NASA management receive output from the planning process via the RAT concerning allocation plans, impact studies, forecasts, and statistical analyses so that they can make decisions concerning mission planning, staffing, capital improvements, etc.

D. Tracking And Data Relay Satellite System

The TDRSS is managed by the Office of Space Tracking and Data Systems (Code T) at NASA Headquarters, which determines which users will be supported. Newly Approved users are assigned a priority in relation to other currently approved users. The priority is based on such factors as national security (DOD), manned flight schedules (NSTS), time critical mission

requirements (e.g., newly launched spacecraft checkout), and other considerations. The Office of Tracking and Data Relay Systems (OTDRS) and the GSFC Director, who is responsible for NASA science spacecraft operations, determine TDRS user priorities. The priority list, with periodic updates, provides direction to the Network Control Center (NCC) at GSFC for scheduling users.

The NCC schedules the TDRS on a week-by-week basis, two weeks ahead of time. It is a continuous process. NCC contacts each user to obtain his requested time(s) of coverage (times of day for each day of the week) and the detailed information required to provide the coverage. The additional information includes coordinates of the spacecraft, frequencies, data rates, routing or disposition of received data, etc. User requirements may be for ground tests as well as spacecraft in orbit. Ground tests can be from remote locations, such as the spacecraft contractor's factory, launch sites, or simulators at White Sands Missile Range. In addition to user requirements, the NCC schedules TDRS checkout, repair, modification, and other maintenance. The schedule consists of tracking/communications time allocations for the various users. Users may have more than one time slot/week which are assigned by priority, i.e., the number one priority user is scheduled first, second priority next, and so on. If a user's requested time slot is not available, i.e., it is already scheduled for a higher priority user, he is not scheduled. This process is continued until all user requirements have been reviewed.

Users who have not been scheduled are contacted by the NCC and notified that their requested times are not available. If they wish other times they may request them. The individual users

are not informed as to what times are available, only whether their requested times are open or not. Working in this manner the NCC attempts to accommodate the unscheduled users.

Each user receives only his weekly schedule. They do not receive other users schedules or generally know who the other users are. Each user is in the blind as to TDRS utilization except for his own schedule. National security missions are the reason for this policy.

APPENDIX I

CENTRALIZED SPACE STATION UTILIZATION PLANNING CONCEPT

Robert T. Everline

Introduction

A centralized utilization planning function as depicted in Figure I-1 (Utilization Planning function), is proposed for the Space Station. This function would be located at NASA Headquarters as a line organization, staffed by technical personnel, aided by computer software tools, and have access to all levels of information necessary to carry out the responsibilities of the Space Station Utilization Planning function.

There are three primary reasons for proposing the above, which are discussed in the following paragraphs:

1. <u>A single planning focus</u> -- A centralized Utilization Planning function would provide a single focus within the SSP that is responsible for the planning for the Utilization Space Station. The very nature of the program with its international partners, the diversity of the User community, and the dependency on the National Space Transportation System for support requires that a single entity, at the program level, be responsible for pulling all these diverse inputs together into a single utilization plan for the entire Space Station Program.

2. <u>The political environment</u> -- The direct participation of the international partners in the development and operation of the Space Station; the U.S. emphasis to encourage commercial
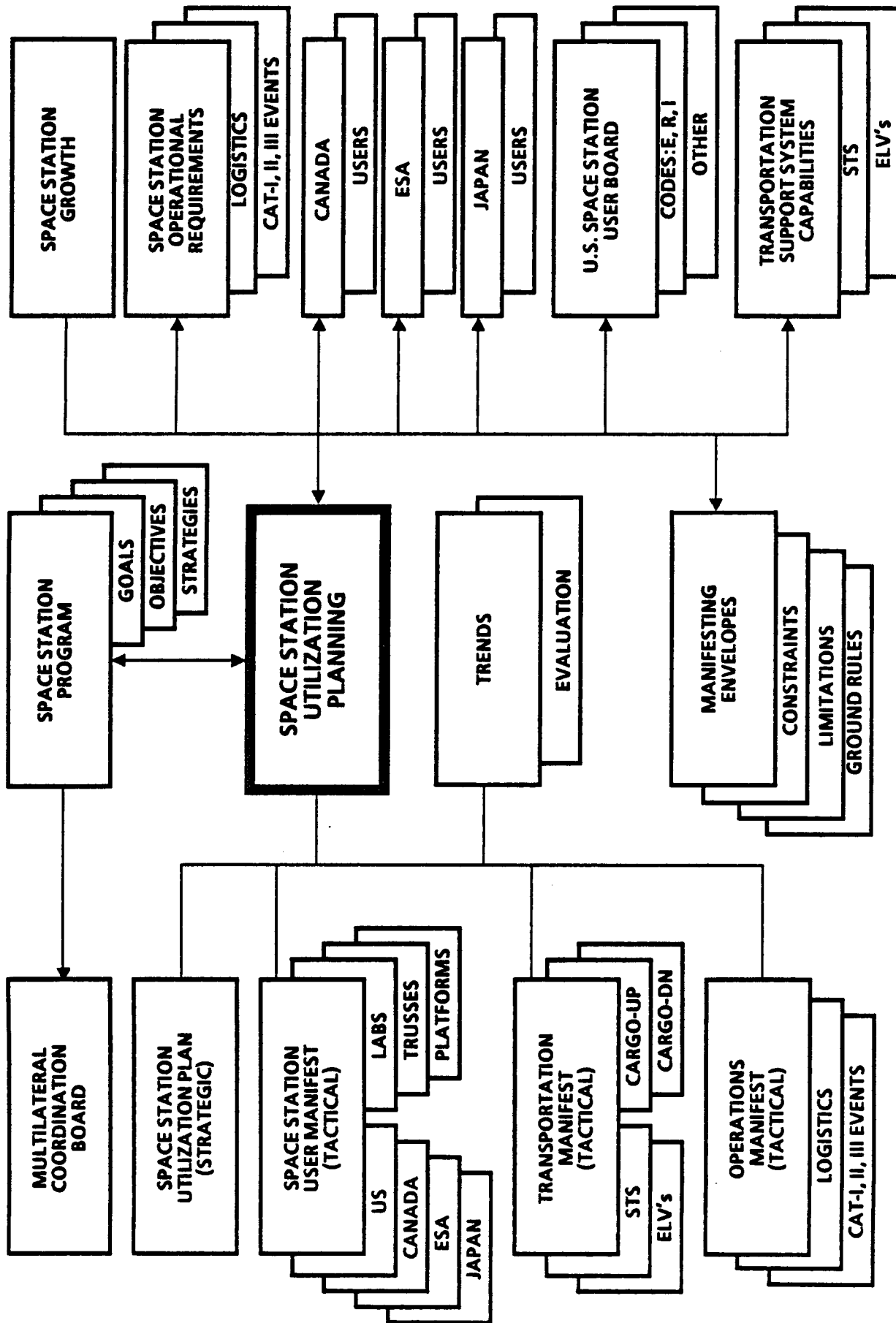
SPACE STATION GROWTH

SPACE STATION OPERATIONAL REQUIREMENTS
- LOGISTICS
- CAT-I, II, III EVENTS

CANADA / USERS

ESA / USERS

JAPAN / USERS

U.S. SPACE STATION USER BOARD
- CODES:E, R, I
- OTHER

TRANSPORTATION SUPPORT SYSTEM CAPABILITIES
- STS
- ELV's

SPACE STATION PROGRAM
- GOALS
- OBJECTIVES
- STRATEGIES

SPACE STATION UTILIZATION PLANNING

TRENDS / EVALUATION

MANIFESTING ENVELOPES
- CONSTRAINTS
- LIMITATIONS
- GROUND RULES

MULTILATERAL COORDINATION BOARD

SPACE STATION UTILIZATION PLAN (STRATEGIC)

SPACE STATION USER MANIFEST (TACTICAL)
- LABS
- TRUSSES
- PLATFORMS
- US
- CANADA
- ESA
- JAPAN

TRANSPORTATION MANIFEST (TACTICAL)
- CARGO-UP
- CARGO-DN
- STS
- ELV's

OPERATIONS MANIFEST (TACTICAL)
- LOGISTICS
- CAT-I, II, III EVENTS

Figure I-1. Utilization Planning Function

use of the Space Station; the potential for Department of
Defense (DOD) involvement; and the expected life of the program
combine to create a political environment which will generate a
multitude of "what-if" questions. For management to respond to
the many questions, issues, and problems that will arise, it
should have a single planning organization that can provide
credible answers in a timely manner. A centralized Utilization
Planning can provide that capability.

3. **Insures a management bias to the planning** -- By
establishing the Utilization Planning function as a line
organization at NASA Headquarters, reporting directly to the
SSP management, the planning would reflect the goals,
objectives, and strategies of the program management. With
this approach, management by direction can cause the planning
to be biased to the user, or operations, or the most cost
effective or any other bias through its own goals, objectives,
and/or strategies. Past experience has shown that the planning
done by the Users will have a users bias at the expense of
Operations and vice versa. Again, the very nature of the
program makes it important for the program to establish the
Utilization Planning function in a manner that will avoid the
biases that in the past have found their way into the planning.

The Utilization Planning function should be established early
in the SSP development phase. This will allow the process to
achieve a level of maturity with a high degree of credibility;
be responsive to all requirements, users, operations, and
transportation alike; and at the same time be an integral part
of the evolving operational readiness of the Space Station.

The Utilization Planning function must be responsive to the
goals, objectives, and strategies, many of which will be

dynamic in nature, as set forth by program management. This
planning effort must also be responsive to Space Station
operational needs and requirements which will change both in a
predictable manner as well as to unexpected emergencies, all of
which will have an impact on the Space Station Utilization
Planning.

Summary

The overall concept of the Centralized Utilization function
patterned after the NSTS manifesting process but has been
augmented to be more responsive to the Space Station partners
(in this context the U.S. is considered one of the partners) by
involving them directly in the process through representatives
who are co-located where the planning ,is being accomplished.
These representatives are expected to be participants in the
process, as well as provide a liaison with the partner's home
organization that they represent. For the U.S. users, this
representation will be achieved through direct representation
from the SSUB. Because of the advocacy nature of these
representatives, appointment to the position should be limited
to two to three years to avoid losing their perspective.

Responsibilities of the Utilization Planning function include
not only strategic planning but tactical planning as well. It
is recognized that the level of detail provided in the tactical
plan initially may not be sufficient to implement the plan
directly and, therefore, may require development of another
level of detail prior to execution. The concept emphasizes the
need to initiate development of "manifesting envelopes" early
in the program that can be utilized to develop the tactical
planning, including the manifests, with a high degree of
accuracy. For example, development of very detailed time lines

early in the program for such things as crew work schedules, power, and usage of other resources, should also be used to define an envelope or planning standard (rule-of-thumb), as well as defining ground rules, limitations, and constraints that can be used to support the manifesting process. To continue to pursue the kind of detailed time lines and power profiles that have been developed for past programs over the expected life of the Space Station may prove to be too labor intensive and therefore probably not affordable. (See Appendix J for further discussion of this subject).

Credibility of the planning will come with time; however, there needs to be a concerted effort to define and control the manifesting envelopes as well as the ground rules, limitations, constraints, and capabilities through a configuration management control process. In addition, there needs to be a clear understanding of what the management reserves are in such areas as power, crew time, fuel, performance, etc., as well as the policies and rationale used in establishing the reserves, how long the reserves are retained and the process for releasing these reserves in order to enhance the utilization of the Space Station.

The concept also relies very heavily on computer tools and software techniques to support the process. The NSTS has made effective use of computers and software to aid in its manifesting process. This concept would build on that knowledge and experience base and adopt the NSTS manifesting techniques where appropriate. In addition, the process relies very heavily on the Space Station Technical and Management Information System (TMIS) and its inherent configuration management principles for maintaining the manifesting envelopes in an up to date manner as well as controlling changes to the

system limitations, constraints, and capabilities. The TMIS
will also be used as a source for technical information on the
payloads being manifested.

The Manifesting Process

This process begins with notification of the selected users as
depicted in Figure I-2. (manifesting process begins with
notification of the selected users) It is proposed that such
notification be a "Form 200" with each of the Space Station
partners submitting a Form 200 for each of their selected
payloads. The selection and submittal of the Form 200's for
the U.S. payloads will be accomplished by the U.S. Space
Station User Board (SSUB). The Space Station Form 200 is
similar to the NSTS Form 100 in that it constitutes a formal
request for flight. For the U.S. Users, the Space Station
Form 200 would require the signature of both the sponsoring
organization and the Chairman of the SSUB. For the other
partners, the Form 200 will be signed by an authorized person.

It is also recognized that the international partners will be
performing a similar utilization planning and scheduling
function for their particular module.

The planning that results from this effort will also be an
important input to the Space Station utilization planning
process as well as the details contained in the Form 200.
Initially, those involved in the planning process will be
learning how to deal with problems that arise; verifying the
process; and developing new techniques designed to improve
both the effectiveness, as well as the efficiency of the
process. As Space Station operations and the planning process
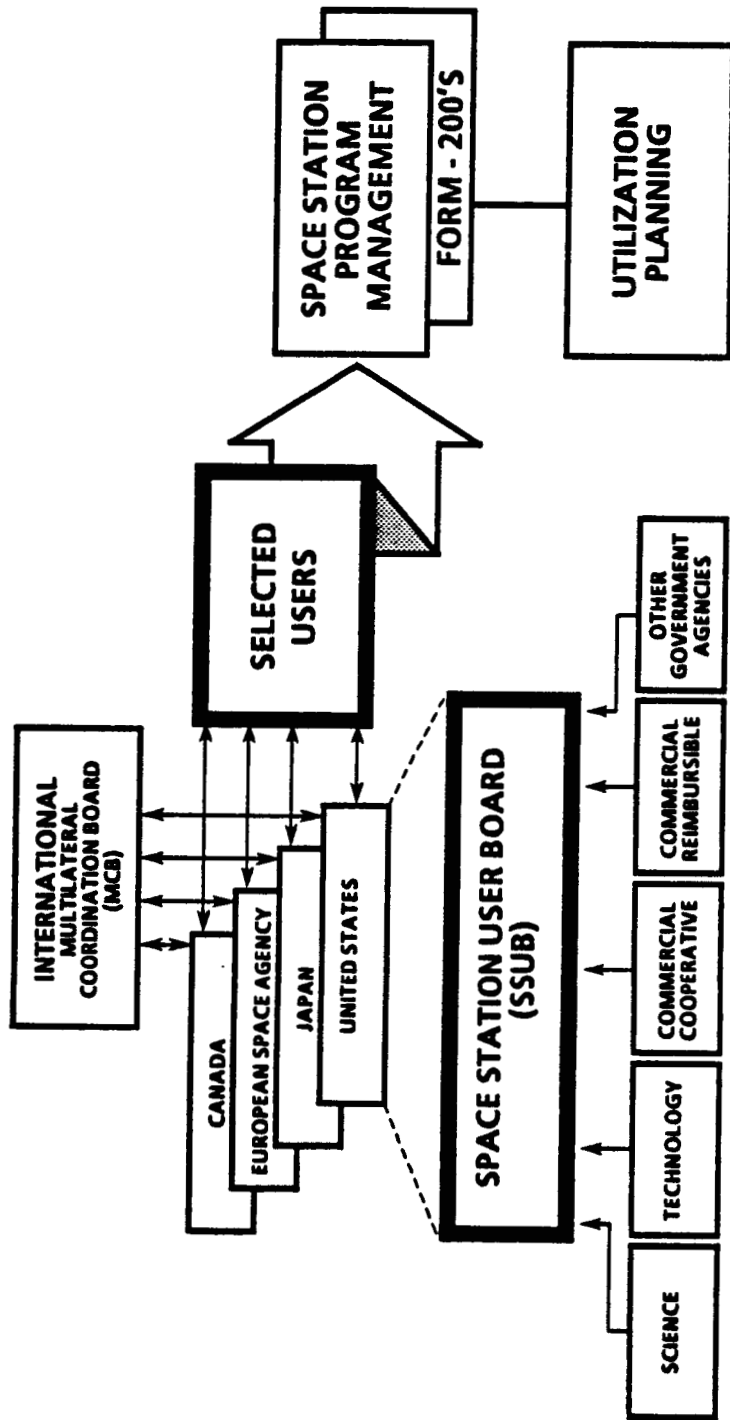matures, it is anticipated that the planning being accomplished

C-4

Figure I-2. Manifesting Process begins With Notification of the Selected Users

by the respective partners will converge with the Space Station Utilization Planning making the entire process more efficient and cost effective.

The Space Station Form 200 will require basic information such as size, weight, type, availability, resources, etc. It is anticipated that more detailed information on the payload/experiments will be available from a Space Station data base such as the MRDB. The User Accommodations organization or the Steering Committee for the Space Station User Working Group will also provide detailed information on the selected payloads. In addition, those responsible for development and maintenance of the various Space Station manifests will require some indication from the User, what their priorities are for the various payloads/experiments. To accomplish this purpose, the following categories are suggested. A designation of CAT-1, 2, or 3 for a specified payload would be included on the Space Station Form 200 of all selected payloads:

CATEGORY-1 (CAT-1)   User requirements which must be scheduled in the manifest at a specific time, thereby constituting an "anchor point" in the UM. Other user requirements are manifested around these anchor points.

CATEGORY-2 (CAT-2)   User requirements which must be scheduled in the manifest within a specified planning horizon. Where they are scheduled in the planning horizon is flexible.

CATEGORY-3 (CAT-3)   User requirements that can be scheduled in the manifest at the discretion of the Utilization Planning group.

There are operational needs and requirements necessary to keep the Space Station operational. Many of these can be scheduled in a predictable manner for many items such as food, clothing, fuel, etc., but many things will not be predictable such as the

failure of a line replaceable unit. Such a failure may result in several adverse impacts, for example, the need to accommodate a replacement unit in the next available logistics module, and causing some disruption in the station operation until the unit is replaced. The Utilization Planning function will be impacted by these actions and must be responsive to such needs as well as the necessary rescheduling that will result.

The manifesting process will also require an input from operations in the form of a list of events that need to be scheduled in a specified planning horizon. These events will address such things as station re-boosts, major maintenance, planned EVA's, etc. Such events will fall into the following three categories:

CAT-1   Events which are mandatory affecting crew safety
         or integrity of the Space Station. These events
         become anchor points in the manifest. Payload
         activities will be schedule around these events
         on a noninterference basis.

CAT-2   Events that must be accomplished within the
         planning horizon but not on a specific schedule.
         These events are manifested around the payload
         activities.

CAT-3   Events of convenience. Things that need to be
         scheduled but can be worked into the schedule when it
         is convenient. Many of these events will be elevated
         in priority if extended delays are experienced.

The Transportation Support System (TSS) must also provide the Utilization Planning function with appropriate information regarding the availability of the transportation system to support the Space Station needs. The Utilization Planning function must be notified of the flights that have been reserved in the NSTS manifest to support the Space Station

including the ascent and landing capabilities of each assigned flight. In addition, the Utilization Planning function must be kept informed of any changes in the assigned flights and/or the capabilities of these flights.

There are also a number of programmatic inputs required, such as schedules, hard freeze points, and performance reserves that are retained by the system for contingency purposes. Policies should be established between the Space Station and the TSS to insure that a clear understanding and agreement exist on the availability and capabilities of the system(s). Such policies should embrace a responsible management approach for system reserves, freeze points, and integrated schedules.

Using these inputs from the Users, Operations, and the TSS, several manifest will be generated, each of which will constitute a "plan of action" or "tactical plan" for a specific functional area of the Space Station over some finite planning horizon. Figure I-3 (The Utilization Planning Function will produce a number of manifests) depicts the different manifests envisioned in order to accomplish the Utilization Planning function. It needs to be made clear at this point that there is a level of detail that will be generated in order to put together a credible manifest. In most cases, two types of analyses will be accomplished to support the utilization planning function in developing the Space Station manifests. These consist of a feasibility assessment and a detailed compatibility analyses. The primary differences in these analysis are the level of detail and where they are accomplished. It is envisioned that the Space Station Utilization Planning organization would have the capability to perform all feasibility assessments within its own organization. Compatibility analysis would normally be accomplished by those

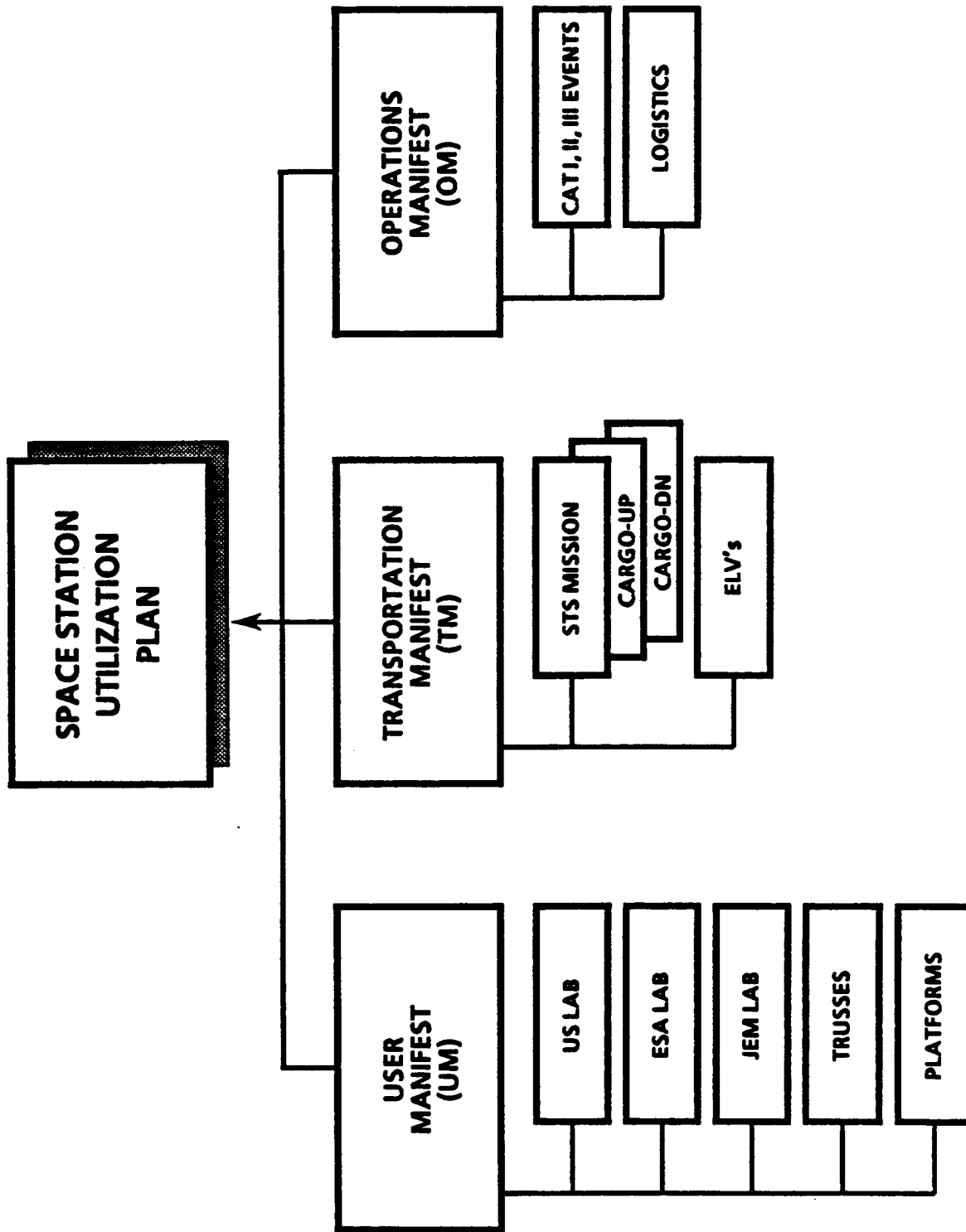# PRIMARY PRODUCTS OF THE UTILIZATION PLANNING FUNCTION

Figure I-3. The Utilization Planning Function Will Produce a Number of Manifests

organizations having the knowledge and expertise to accomplish the required analysis in a responsive manner. As the entire operation matures, including learning how to operate the Space Station efficiently, the need to perform the detailed compatibility analysis will decrease in much the same manner that has occurred in the NSTS Program. The level of detail generated, and it will not necessarily be the same across the board, forms a part of the tactical planning base that will be necessary to implement the execution phase. It is the intent to provide the data generated, as a result of the manifesting process, in both a timely manner and a useful form that will preclude the need to regenerate what has already been done. This data would be provided to those responsible for the detailed tactical planning of the program.

The following paragraphs discuss the three manifest that will be generated through this process.

- o <u>User Manifest (UM)</u> This manifest defines the science or users scheduled on the Space Station for a specific planning horizon. For the Strategic Planning the UM may cover a five year period, while a more detailed manifest with a shorter planning horizon may be appropriate to support tactical planning. This may be forty five days or the time between NSTS flights to the Space Station.

  In addition, a separate manifest may be necessary for each laboratory, for the truss, and co-orbiting platforms, etc., each of which may have a different planning horizon as well as a different level of detail. For example, co-orbiting platforms could have a planning horizon of a year or more and the planning be not much more than to schedule an NSTS flight for servicing with a general definition of the cargo elements that will be involved.

- o <u>Transportation Manifest (TM)</u> This manifest defines or schedules the transportation flights to the Space Station over a finite planning horizon. This planning

horizon to be the same as that used in the UM. The TM would reflect all arrivals and departures at the Space Station. Should Expendable Launch Vehicles (ELV) be utilized, they would also be reflected on the TM as well as the OMV flights scheduled to pick up the ELV cargo.

A number of supporting manifests are also envisioned and in the case of the TM these may be on a flight by flight basis. Where the NSTS is involved, it is anticipated that a specific cargo definition can be provided to the NSTS with very little being required to determine the feasibility and/or the compatibility of the cargo with the NSTS. It is assumed that some level of standardization can be achieved for NSTS logistic flights to the Space Station which would allow pre coordinated logistic flights to enter the integration process much later in the cycle, say seven to nine months before flight rather than the eighteen months currently required.

There is also another level of detail which will define the specific payload elements that go into the logistics module. This will have to be generated for both the ascent and return cargo on the NSTS missions. For these latter two manifests, it is envisioned that the manifesting function would generate only a portion of these manifests and would include only those items which are necessary to carry out the intended operation over the period of time between scheduled logistic flights. The remaining unused capability, both up and down, would be manifested by Operations in close coordination with those responsible for the overall Space Station manifesting function. The specific details of how to accomplish this activity will be determined later; however, it would be well to insure that a degree of flexibility is included in the process that will allow Operations, both on the ground as well as on orbit, to include essential items at the "last minute".

o Operations Manifest (OM) The OM will define those overall operations which are directly related to the UM and the TM and will include such station operations as station re-boost, NSTS, as well as OMV, arrivals and departures, satellite servicing operations, significant MSC operations and so on. These would constitute the CAT-1, 2, & 3 events described earlier in this paper. The intent would be to provide to Operations a plan of

action for those significant Space Station activities which must integrate directly with both the UM and TM, all having the same planning horizon. These three manifest must remain in "sync" at all times. A change to one will affect the others and in many cases adversely.

o   Review Process   The manifests described above will initially be developed as preliminary or "strawman" manifests. The manifests, including the results from the various analyses, will be reviewed in coordination meetings, similar to the FWAG used by the NSTS. In addition, reviews will be conducted with the SSUB or, in their absence, with the SSUWG Steering Committee. Likewise, a review will be conducted with each of the international partners. During these reviews, differences between the proposed SSUP or the UM and the planning submitted by the partners will be addressed.

The purpose of these reviews will be to identify problems or issues along with feasible solutions for resolving them; it is not to create or build a manifest. The unresolved problems or issues along with the recommended solutions will be utilized to support the decision process that may involve several levels of management in order to obtain a final resolution. Once these are resolved in a manner acceptable to management a final manifest will be produced, approved and issued as direction to the appropriate implementing organizations.

o   Organizational Elements   Figure I-4 (Functional Organization for Centralized Utilization Planning function) depicts the organizational structure proposed for the Centralized Space Station Utilization Planning function. It is envisioned that the Utilization Planning organization will be a line organization at the Division level located at NASA Headquarters.

The functional elements of this organization are Strategic Planning, which will produce a longer range view, approximately three to five years, of the utilization of the Space Station and is based on the detailed manifest or tactical planning. In addition, the Strategic Planning function would also perform the appropriate trend analyses necessary to support the overall utilization planning function. For example; manifested resources versus the allocation of resources among partners over time; downtime on the station
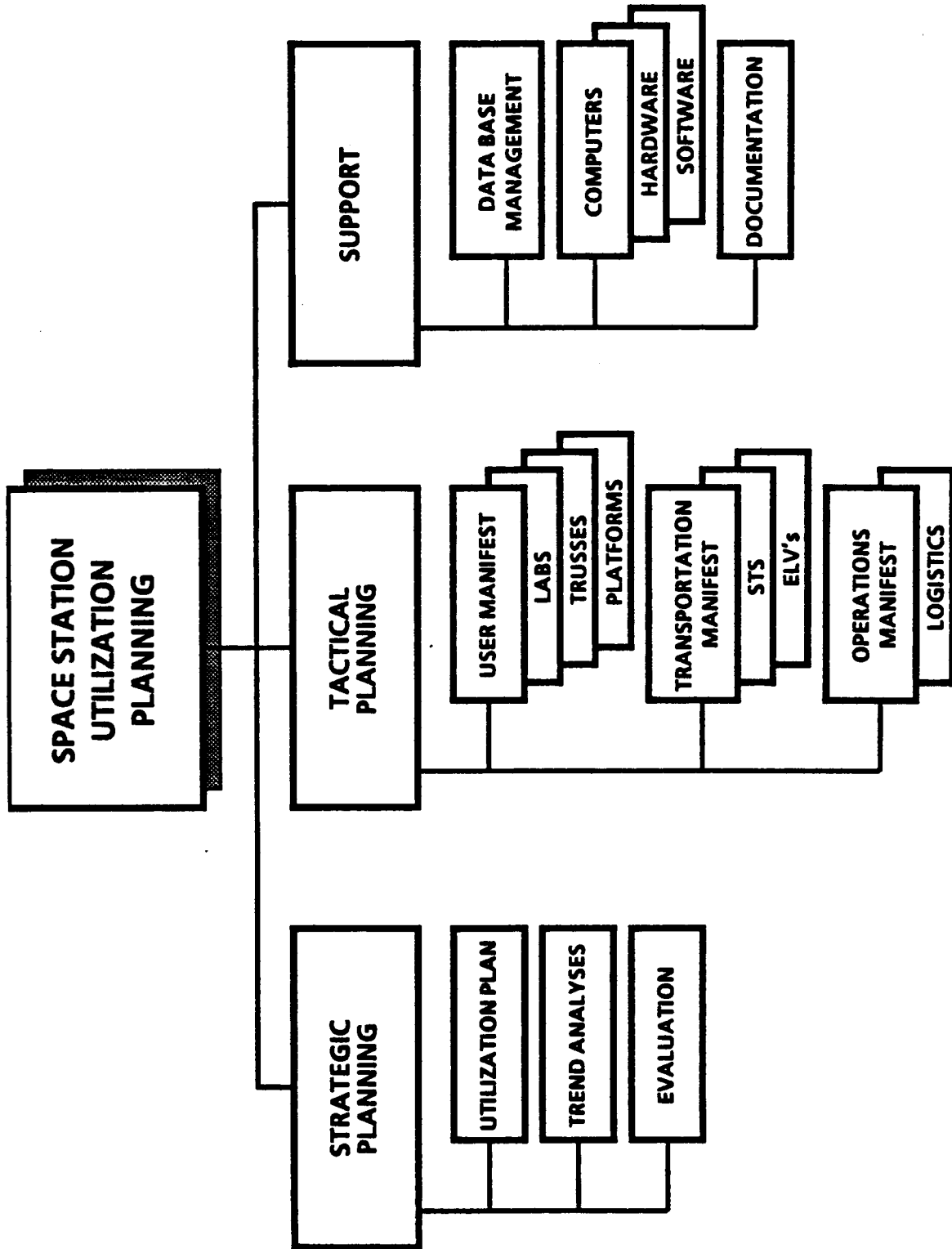
FUNCTIONAL ORGANIZATION FOR UTILIZATION PLANNING

Figure I-4. Functional Organization for Centralized Utilization Planning Function

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versus operating time in the Labs, on the trusses, etc.
The intent would be to focus on those trends which will
provide management with a high degree of visibility as
to how the planning is achieving the goals, objectives,
commitments and agreements that are an integral part of
the SSP. The function would also provide the
supporting analyses with recommendations to management
for correcting an unacceptable trend. An evaluation
function is also included that will perform an indepen-
dent overall assessment to determine the effectiveness
of the process, seeking out new ways to improve the
operation, to enhance Space Station Utilization, to
reduce overall operating costs, and to be more
responsive to the users.

The primary product of the manifesting function will be
the Tactical Planning. This is where the manifesting
of the Space Station will be accomplished. As depicted
in Figure I-4, there are three primary manifests, the
User Manifest, (UM) the Transportation Manifest, (TM)
and the Operations Manifest (OM).

The concept provides for co-location of a represen-
tative for each of the Space Station partners as part
of the staff that would be engaged in developing the
UM. The primary function of these representatives is
to participate in the development of the manifest as
well as providing a liaison function to their respec-
tive home organizations, to facilitate an exchange of
information in both directions, and to pre-staff
pending changes in the manifest that may affect the
partners directly. In the same manner, co-located
representatives from the NSTS, Space Station
Operations and Logistics, the OMV, and the ELV will
also be active participants in the respective
transportation or operations manifest and perform a
liaison role with their home organizations.

A support function is included to provide a central
control for such things as data management, computer
hardware and software, and general documentation that
is used across functional elements.

o Interfaces The following discussion defines in general
   terms, the interfaces that the manifesting function
   will develop and maintain with appropriate organizational
   elements to insure that the Space Station Utilization
   Planning function can carry out its responsibilities.

To the maximum extent possible these interfaces will be developed through those liaison personnel co-located within the organization.

1. <u>Transportation</u> It is recognized, that over the expected life of the Space Station, the transportation to and from the Space Station will no doubt include a variety of systems both manned and unmanned and in all probability, they will not all be vehicles owned and operated by the United States.

Initially the manifesting function for the Space Station will require only a working knowledge of the NSTS and a need to establish a working interface with their counterparts responsible for the manifest of the NSTS system. When other modes of transportation are assigned to the Space Station similar interfaces to those for the NSTS will be established. Through this NSTS interface, a set of manifesting ground rules, limitations, constraints, and an envelope for each flight that bounds the NSTS capability, both up and down, as well as schedule freeze points, will be established and maintained in an up-to-date and controlled manner. In addition, a clear understanding of the performance reserves, including the ground rules being used by the operator of the NSTS, will be established so that the delivery capability can be maximized for each flight.

The NSTS has established a working group called the FAWG which is a coordinating group for all matters pertaining to the NSTS manifest. The Space Station Utilization Planning organization will provide a permanent member to this group.

2. <u>Operations</u> To facilitate development of the Space Station OM, a working interface will be established with Space Station Operations through an operations representative co-located

within the Utilization Planning organization. The primary
purpose of this interface will be to provide real time
information regarding the on-board operations so that
appropriate adjustment can be made in the Space Station
manifest(s) with minimum impact. The data provided would
consist primarily of a list of events that have to be carried
out over the next planning horizon.

Such an interface will provide a coordination effort between
the manifesting function and operations to minimize the
surprises, thereby reducing the need for operations to
continually react to a manifest, but rather provide Operations
the opportunity to plan for the manifest.

3. **Users** The interface with the U.S. Users will be through
the SSUB or the SSUWG Steering Committee.

The expected output from the SSUB will be an approved Space
Station Form 200 requesting a flight, and is similar to the
NSTS Form 100. The Space Station Form 200 will be signed by
the chairperson of the SSUB and the sponsor of the experiments
or payload and would constitute authority to include on the
manifest. Those responsible for developing the manifest would
have an obligation to review with the SSUB the results of
manifesting the approved payloads including the rationale that
supports the results.

4. **Partners** The interface with the partners will be achieved
by the partners co-locating a representative within the
manifesting organization. The representative will participate
directly in the manifesting process and provide a liaison
function back to the home organization so that many of the
potential problems could be resolved at this level rather than

being elevated within the management structure for resolution.

5.   <u>Integrators</u> At this time is not clear that the manifesting function requires a formal interface with those responsible for integrating th payloads into the TSS or the Space Station.

<u>Pros and Cons</u>

Table I-1 provides a list of pros and cons, including the rationale that supports the Centralized Space Station Utilization Planning option.

TABLE I-1

PROS	RATIONALE
More Efficient	In the early phases of the program the centralized approach will provide a focus for developing the planning process; defining the manifesting envelopes and groundrules, as well as capturing the limitations, constraints and capabilities. In addition a Centralized Utilization Planning function will also provide a focus for a coordinated approach in developing the software tools that will be unique to the Utilization Planning process
Less Bias	Establishing a separate dedicated line organization to perform the Utilization Planning function should result in an organization that is not biased toward the users, operations, or engineering, but rather will reflect the direction, strategies, goals and objectives of the SSP management.
Located at NASA HQS	Consistent with current NASA management direction.
More Responsive	As a line organization, the Utilization Planning function will be more responsive to: -- Political Changes -- Space Station Management direction
Higher Cost	A Centralized Utilization Planning function will require dedicated people assigned to carry out the responsibilities of the organization and a budget to support the function. The number of people directly assigned to the function will probably be larger than other options and therefore, add to the SSP, cost. In a global sense of the SSP, the cost of accomplishing the Utilization Planning function is perceived to be insignificant, no matter which approach you pursue.
Less Responsive to changes in User requirements	An in-line organization responsible for the Utilization Planning function and reporting to the SSP management will be less responsive to changes in user requirements than it would be in an option where the users were responsible for the Utilization Planning or some portion thereof.

APPENDIX J

STATION MANIFESTING GROUND RULES

An important element that will be required to develop a credible Space Station manifest or utilization plan is the manifesting ground rules that define the capabilities, limitations, and/or constraints that form the boundaries for the manifesting function. For the Space Station these ground rules may consist of separate sets each covering a major element of the Space Station. Initially these ground rules may not be very definitive; however, as the program elements evolve through development, assembly on orbit, and early operations, the ground rules should evolve as well. It is, therefore, recommended that an activity be implemented early in the program which is directed at developing the necessary ground rules with adequate configuration management control procedures that will assure the ground rules are current and accurate. It is anticipated that many of these can evolve into manifesting envelopes that will make the entire process more efficient and cost effective.

The following paragraphs provide a first attempt at defining the scope and level of detail required in these ground rules to adequately support the Space Station manifesting function:

- o Space Station

    - Overall C.G., safety, and resources available

    - Constraints imposed by reboosting the Space Station

    - Constraints imposed by arrival and departure of the Shuttle

    - Constraints imposed by arrival and departure of the OMV

- Constraints imposed by added or enhanced capabilities

- Constraints imposed by EVA Operations

- Constraints imposed by MSC Operations

- Constraints imposed by Crew rotations

- Logistic requirements

- Unique constraints and limitations imposed by the developer and/or operator

o OMV

- Weight

- C.G.

- Payload dimensional envelope

- Availability

- Performance

- Unique constraints and limitations imposed by developer and/or operator

- Performance reserve approach

o LABORATORY MODULES

- Resource capability

- Unique constraints and/or limitations imposed by owner/developer and/or operator

- Availability

o MSC

- Availability

- General capability

- Unique constraints and/or limitations imposed by the developer and/or operator

o TRANSPORTATION SYSTEM

   - Availability

   - Ascent performance

   - Down weight capability

   - Delivery altitude

   - C.G. constraints up and down

   - Attached duration of the Shuttle

   - Station crew size

   - Allowable cargo size

   - Schedule freeze points

   - Reserve capability and approach

   - Station resources required

o LOGISTIC MODULE

   - Availability

   - Weight

   - C.G.

   - Maximum cargo element size

   - Minimum cargo element size

   - Unique constraints and/or limitations

o LAUNCH SITE

   - Constraints and limitations imposed by the cargo
      handling capabilities at the launch site

o USERS

   - Separation time between related science

   - Minimum time between repeated users of the same
      flight hardware

- Refurbishment time for flown hardware

- Identify scarce hardware resources that are
  intended to support multiple disciplines or users

This is not intended to be a comprehensive list but rather to
provide some idea of the scope of the task. In the process of
developing these ground rules there needs to be constant
surveillance to insure that the ground rules being used and
maintained current are in fact necessary to accomplish the
manifesting function.

It should also be kept in mind that developing a comprehensive
set of manifesting ground rules will provide the basis for set
of knowledge base rules that can form a part of an expert
system used to support the manifesting process.

Manifesting Envelopes

One way to make the manifesting process more effective and
efficient is to define manifesting envelopes. Such envelopes
should be developed that define the capabilities, limitations,
and constraints of each major Space Station element for which a
manifest will be developed. For example; for each NSTS flight
that is assigned to the Space Station a manifesting envelope
can be defined. Given that such parameters as altitude,
inclination, crew size, and duration are standardized for the
Space Station flights, the NSTS can define the ascent delivery
capability, the landing weight limitations and the CG
constraints for each mission. As long as the cargo that is to
be assigned to the flight remains within this envelope a
compatible manifest will exist.

This approach can be used to define many of the Space Station elements, from experiment racks in the modules, to the Logistics Module or the OMV. Initially such a process would be confined to determining the feasibility of manifesting selected payload elements. As the process matures and the envelopes becomes more precise, the integration and operations will become more confident that what is manifested is compatible and can be accommodated with a minimum of effort.