STATION AND SHUTTLE UTILIZATION REINVENTION (SSUR) FINAL REPORT

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SSUR TEAM MEMBERS

Michele Brekke
JSC, Manager, Space Shuttle
Customer and Flight Integration

Dr. Charles Fuller
University of California, Davis
Director of the Chronic Acceleration
Research Unit

John Conway
Consultant – Retired NASA

Dr. Gary Jahns
ARC, Deputy Fundamental Science
Biology Program

Todd Corey
KSC, Chief Electrical Systems Branch
ISS/Payload Processing

Barbara Kreykenbohm
NASA HQ, OBPR Mission Planning
and Integration Manager

Joe Cremin
Consultant – Retired NASA

Dr. Feng Liu
JPL, Deputy Project Manager,
Low Temperature Microgravity Physics
Facility (LTMPF)

Dr. Dan Mulville
External Sub-Team Leader
Consultant – Retired NASA

Stan Nichols
NASA HQ, OSF Enterprise Coordinator
Launch Services

Ron Porter
MSFC, Microgravity Science and
Program Management Group Lead

Lesa Roe
JSC, ISS Payloads Office

Russell Romanella
KSC, Deputy Director ISS/Payload
Processing

Dr. Albert Sacco, Jr.
Northeastern University, Director of
The Center for Advanced Microgravity
Materials

Tom St. Onge
GRC, Chief, ISS Facility Projects

Dawn Schaible
KSC, Technical Assistant to the
Director of ISS/Payload Processing

Richard Swalin
Consultant – Retired NASA

Teresa Vanhooser
MSFC, Manager, Payload Operations
and Integration

Rita Willcoxon
Team Leader
KSC, Associate Director
Spaceport Technology Projects

Letter from the Team Sponsors

In January 2003, we challenged a team of NASA employees to reinvent Station and Shuttle utilization processes to: strengthen NASA's emphasis on the research community to enable a world-class research environment in space; remove impediments to the utilization process; optimize Agency high priority research throughput; and enable ISS Research Institute success. We augmented the internal team with an external team composed of former NASA employees and current external researchers who viewed the system from different perspectives that could contribute to understanding the problems and improving the utilization process. The challenges required all team members to rise above their current or past organizational comfort levels to recommend change strategies that are best for users of the Station and Shuttle and, thus, for all of NASA.

The team succeeded beyond our expectations. They enlisted help and advice from a multitude of NASA and non-NASA people who were knowledgeable of one or more aspects of the Station and Shuttle utilization system. Our expressions of appreciation go not only to the team but also to those who advised and supported their work along the way, as well as to their home organizations for their support during the team's activities.

The team generated a set of fifteen valuable change strategies. The top eight strategies were selected by a series of processes starting with a review by an experienced group of internal and external principal investigators and payload developers, continuing with an analysis by the team members and a review by Station, Shuttle, and research program managers, and culminating with a presentation to the NASA Executive Council chaired by the Deputy Administrator. The Executive Council endorsed the eight change strategies with minor modifications and agreed to oversee the implementation process.

We are pleased to present this report of the Station and Shuttle Utilization Reinvention Team. We pledge to assure that the report recommendations, as adopted by the Executive Council, are fully implemented.

Mary E. Kicza
Associate Administrator
Office of Biological and Physical Research

William F. Readdy
Associate Administrator
Office of Space Flight

VISION FOR INTERNATIONAL SPACE STATION AND SPACE SHUTTLE UTILIZATION

The International Space Station (ISS) is the boldest space research laboratory ever conceived. Accomplishing world-class research in this facility demands the engagement and involvement of the best and brightest in the research community. To engage this community, NASA must transform the culture that emphasizes the engineering feats accomplished thus far to one that places an equal focus on world-class space research. To facilitate partnerships for this endeavor, NASA must increase focus on the research community and improve its advocacy.

To operate ISS as a modern research laboratory, it is important that the environment, both on ISS and within NASA, become that of a research organization. Research teams in partnership with NASA will direct their respective investigations, recognizing that cutting edge science and research is the objective. This will be accomplished without compromise to safety of the crew, vehicle, or companion payloads. There will be a mix of “confirming science” that verifies scientific hypotheses, leap-frog “discovery science”, and technology that changes the way humanity lives, works, and explores. To realize the full ISS research potential, NASA must optimize access to ISS commensurate with its utilization capacity.

The ISS and Space Shuttle Program (SSP) business structures must be simplified and integrated to allow research customers to be accommodated smoothly and effectively. Utilization priorities will be clearly established and endorsed by the research community. Strong focus on the customer, clear entry points into the utilization process, and a “One NASA” utilization process will be implemented across the Agency.

The ISS and SSP research operations should approach those of ground-based laboratories. The end-to-end research process must be tailored to the investigation and the nominal process from proposal submission to NASA's delivery of flight data to the investigator must be to facilitate graduate research and commercial product development cycles. NASA should continue to strive to improve and streamline processes, while partnering with the research community and an International Space Station Research Institute to promote mature proposals and expedited development schedules.

When the ISS and SSP Programs team with the Research Community as equal partners, the SSUR team envisions a truly world-class research facility that will:

Enhance life on Earth.

Enable exploration beyond Earth.

Inspire the next generation of researchers.

EXECUTIVE SUMMARY

Introduction

As the United States portion of the International Space Station (ISS) nears completion, NASA must optimize the use of that unique facility for world-class research. NASA realizes that the Agency must ensure that the very best processes are in place to enable the cutting edge research that will be accomplished on the ISS.

NASA's Associate Administrators for the Office of Biological and Physical Research (OBPR) and the Office of Space Flight (OSF) have taken specific steps to facilitate the conduct of world class research on the ISS and Shuttle. In 2002, NASA initiated an International Space Station Utilization Management Concept Development Team Study to develop recommendations on how to best manage the science and research utilization of ISS. That team proposed establishing a nongovernmental organization, specifically a non-profit institute (the ISS Research Institute [ISSRI]), to perform leadership for ISS Utilization.

In 2003, NASA's senior management commissioned the Station and Shuttle Utilization Reinvention (SSUR) team. This team was challenged to develop and recommend change strategies that would streamline the utilization process and embrace the research community as partners in accomplishing world-class science and research using both the ISS and the Space Shuttle as research platforms. The SSUR team was chartered to evaluate the Station and Shuttle utilization process to determine where NASA could increase focus on the research/user customer, simplify and improve the processes, and maximize utilization research productivity. The goal was to cut across NASA Programs, Enterprises, and Centers to identify and prioritize the areas most needing change and develop change strategies and recommendations where appropriate. Final recommendations were approved by NASA's Executive Council, chaired by the Deputy Administrator.

The SSUR team's senior advocates approved the charter with the following study goals:

(1) Optimize Agency high priority research throughput.

(2) Remove impediments to the utilization process.

(3) Enable ISS Research Institute success.

(4) Strengthen NASA's emphasis on the research/user community to enable a world-class research environment in space.

Investigative Process

The SSUR team followed a methodical set of steps, culminating in a final set of recommendations. The SSUR team gathered a comprehensive set of information from current and past customer feedback data, previous studies, ongoing improvement initiatives, focus groups including Principal Investigators (PIs), Payload Developers (PDs), and other stakeholders throughout the Agency and the external research community. The current utilization process was documented through flowcharts, interface diagrams, and cycle time data.

In addition, an extensive analysis was conducted using these data. Individual cause and effect diagrams and detailed Program Evaluation and Review Technique (PERT) diagrams were used to capture the major problems and impediments in the end-to-end process. Using an iterative cause and effect analysis, the team produced an integrated cause and effect diagram, shown in figure ES-1, which created a "roadmap" for the team to follow in identifying and analyzing impediments to overcome to solve the major problems.

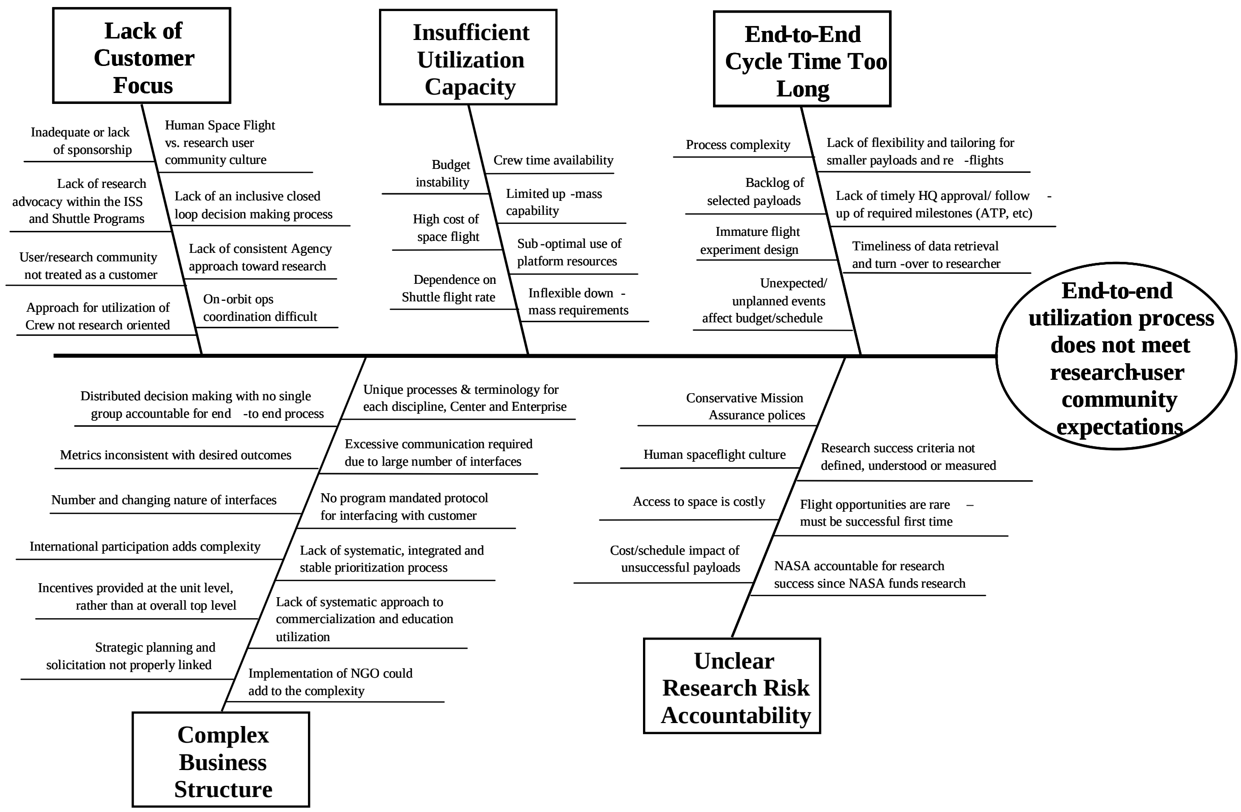

Figure ES-1. Integrated Cause and Effect Diagram Identifying Major Problem Areas

After the data gathering and analysis phases of the study process, Red Team I, a team of senior NASA managers from across the Agency, evaluated the soundness of the study process developed by the SSUR team. Red Team I recommendations were incorporated into the process and used throughout the remainder of the study.

The next steps in the process were to develop solutions to the problem areas and develop recommendations. Subteams of SSUR members were formed to address the five major problem areas identified by the team. Brainstorming within the SSUR team, iterative discussion with focus groups and stakeholders, and soliciting feedback from senior NASA management were instrumental in generating ideas for solving the identified problems. Other organizations and processes were benchmarked to identify methodologies for improving the processes. Subteams conducted peer reviews to assist in evaluating and refining each of the change strategies. Eighteen strategies were initially developed.

A critical step in the process was Red Team II's evaluation of proposed change strategies. Red Team II was composed of widely respected Principal Investigators and Payload Developers, both internal and external to NASA. They were asked to evaluate the change strategies developed by the SSUR team, to propose any changes, and to prioritize the strategies in terms of value to the research community. The Red Team II response, in conjunction with the SSUR team's subsequent deliberations resulted in combining portions of several strategies and led to a final total of 15 strategies. The SSUR team's selection criteria, which included the Red Team II's response as one criterion, were used to develop the team's final list of prioritized change strategy recommendations. It is noteworthy that both the Red Team II and the SSUR Team independently arrived at a consensus recommendation of the top strategies.

Several iterations with senior management, including the ISS and Shuttle Program Managers, the Astronaut Office Manager, NASA Center Directors, Research Program Managers, and the team's Senior Advocates further refined the strategies and their implementation approaches. This resulted in concurrence to proceed to the Executive Council with eight high priority change strategies for immediate implementation, and a second grouping of seven additional strategies that could be implemented when appropriate. The Executive Council approved the eight strategies with minor modifications. This study was conducted and the change strategies were approved prior to the release of the Columbia Accident Investigation Board (CAIB) report. While the SSUR team does not believe that any of the actions outlined in the change strategies are influenced by the findings of the CAIB report, the OBPR and OSF should, as a follow on, assess the entire SSUR report fully informed by the CAIB results.

The following is a high level summary of the change strategies. Section 3 of the report describes these strategies in detail; along with rationale for the changes, a listing of similar recommendations from past studies, and an implementation approach including change strategy owners and senior advocates.

Highest Priority Strategies

Strategy 1: Unified Station and Shuttle Utilization Process

Establish a senior management position that oversees the entire end-to-end utilization process for the Agency, and establish a Headquarters (HQ) Human Space Flight Utilization Board (HSFUB) co-chaired by OBPR and OSF Associate Administrators (AAs) to integrate and prioritize Shuttle and ISS utilization.

Strategy 2: Reduced Process Complexity

Continue the current ISS Payloads Office process improvement activity, which reduces data deliverables, requirements, panels, boards, etc., and extend the current activity to include Shuttle payloads.

Conduct a process improvement effort for the proposal, selection, definition, and development phases (front-end) of the end-to-end process, and develop a forward action plan to improve those phases of the process.

Develop policies, procedures and agreements between NASA Centers to accept each other's analysis, technical specifications, review results and certifications to strengthen Center-to-Center reciprocity. Extend to Research Partnership Centers as appropriate.

Develop a process and service standard to ensure the Principal Investigator has a consistent interface throughout the end-to-end research process for both ISS and Shuttle payloads.

Strategy 3: Emphasize Agency's Focus on Research

A major paradigm shift is needed in the Agency to increase the attraction and retention of world-class researchers and to grow U.S. advocacy for space-based research. To be successful in implementing this paradigm shift, increased focus and priority on the research/user community is needed from the top down. This strategy includes increased emphasis on the research/user community as a customer throughout the Agency, increased awards and incentives for research and increased flight crew emphasis on research.

Strategy 4: Alternate/Supplemental Space Access

Work with the Integrated Space Transportation Plan (ISTP) team to assure that utilization requirements are thoroughly considered in the ISTP trade space analysis. This includes conducting an assessment of the potential demand for future Station and Shuttle utilization, including science, commercial, education, DoD, and others; assessing value of providing additional Expendable Launch Vehicle (ELV) cargo capability to and from the ISS; and proposing near term solutions to upmass and downmass capability.

Strategy 5: Principal Investigator Decision Maker for Research

Develop a methodology to build flexibility into the system for the Principal Investigator to change and mature the research ideas, objectives, and direction throughout the end-to-end process.

Strategy 6: Integrate Utilization at JSC

Combine Shuttle payload integration and ISS Payloads Office functions within the ISS Program, providing a single interface to the research/user community and providing a common payload integration service for Shuttle and Station platforms.

One year after the functions are combined within the ISS Program, assess implementation of a separate Utilization program at JSC.

Strategy 7: Increase Utilization Funding Stability

Develop and implement a strategy and plan to increase utilization funding stability and establish a better overall process for grant management.

Strategy 8: Maturity of Proposals

Revise OBPR's NASA Research Announcement (NRA) solicitation, evaluation and selection processes to ensure selected investigation proposals are of sufficient maturity to allow for predictable progress to flight. Support this process by developing and maintaining a comprehensive list of existing equipment, capabilities and options for the use of that equipment.

Additional Recommended Strategies

Strategy 9: Agency Research Success Philosophy

Recognize research access and mission success are two separate measures. Measure research success using research community's criteria.

Strategy 10: Expand Scope of ISS Research Institute

Expand the ISS Research Institute's scope to include core functions (strategic planning, advocacy, customer support, education, and public outreach) across Enterprises for ISS and Shuttle Utilization payloads. Establish the ISS Research Institute as NASA's entry point for all potential research on Shuttle and the ISS.

Strategy 11: Timelines Tailored to Experiment With Payload Classification

Customize through negotiations with each research investigation the specific process plans and schedules for each spaceflight experiment. Establish a payload classification system and ease the development path for smaller and/or less complex payloads.

Strategy 12: Improve Research Advocacy

Implement an integrated approach for research advocacy that increases emphasis on ISS and Shuttle utilization and meets the needs of the Research Enterprises and the ISS and Shuttle Programs.

Strategy 13: Concurrent Payload Development and Integration

Conduct a pilot program to demonstrate the feasibility of applying concurrent engineering processes to the design, development, and integration of Shuttle and ISS utilization payloads.

Strategy 14: Agency Approach to Commercial Use

Provide a single headquarters focus to assess and approve commercial utilization efforts that directly contribute to the Agency mission.

Strategy 15: Manifest Optimization

Assess feasibility of using a market-based tool for payload manifest optimization. Initiate a pilot program, if the tool seems useful and cost effective.

Implementation Recommendation

The SSUR team proposes a definitive implementation plan, discussed in the main body of this report, for each of the strategies. Further, the team recommends immediate implementation of the top eight priority strategies, subsequently approved by Agency management, with the remaining strategies representing lesser but still important priority.

The following steps are proposed to ensure implementation:

(1) Treat each change strategy as a project with a plan and schedule for implementation.

(2) Report to the Executive Council and/or the Leadership Council every six months on progress.

(3) Assign a SSUR team member to each change strategy owner as a consultant to ensure implementation meets the intent of the team.

(4) Conduct an independent assessment by the SSUR team in one year.

It is the opinion of the SSUR team that NASA implementation of the above change strategies will result in achievement of our vision of the desired state for the ISS and Shuttle research utilization.

VOLUME 1

CONTENTS

VOLUME 2

COMBINED APPENDICES

1. INTRODUCTION

Numerous studies conducted over the past decade consistently identified a number of issues that have been problematic in the utilization of International Space Station (ISS) and Space Shuttle as research platforms. For a variety of reasons, many of the recommendations have not been implemented. Similarly, customer feedback studies continue to identify the same issues voiced by the Principal Investigator and Payload Developer community without any significant resolution of the problem areas.

To improve the research/user community's capability to utilize the ISS and Shuttle, the Agency formed a team to assess the current state of ISS/Shuttle utilization and to recommend ways to improve the end-to-end process. This team, the Station and Shuttle Utilization Reinvention (SSUR) Team, was a direct spin-off from the International Space Station Utilization Management Concept Development Team Study, which proposed the establishment of a non-governmental organization, specifically a Non-Profit Institute, to perform leadership functions for the ISS. An option of "Reinventing NASA" was considered as a possible candidate for utilization management by the Concept Development study team. Although this option was not the final choice selected by the study team, senior Agency management considered aspects of "Reinventing NASA" as imperative for the user community's successful utilization of the International Space Station and Space Shuttle.

The Associate Administrators for the Office of Biological and Physical Research and the Office of Space Flight became the senior advocates for the formation of the SSUR team to further investigate the possibilities for "Reinventing NASA." The intent was to cut across Programs, Enterprises, and Centers to identify and prioritize the areas most needing change, and where appropriate, to propose change strategies that would streamline the utilization process and embrace the research community as partners in accomplishing world-class science and research using both the ISS and the Space Shuttle as research platforms. The SSUR team was chartered to evaluate the Station and Shuttle utilization process to determine where NASA could increase focus on the research/user customer, simplify and improve the processes, and maximize utilization research productivity.

The SSUR team consisted of both internal NASA and external membership. Abbreviated education and experience biographies of team members are listed in Appendix A. The internal group included knowledgeable senior representatives from Headquarters and each Center involved with the Station and Shuttle Utilization process. The external group consisted of former NASA managers with extensive utilization experience together with active Principal Investigators from academia. The external component of the SSUR team provided added depth of knowledge in some of the process problem areas as well as served to challenge and stimulate the internal members to tackle the more difficult issues. Both groups worked as an integrated team to accomplish the SSUR charter.

The study was an eight-month effort that began on January 13, 2003, and presented recommendations on August 19, 2003. The team reported recommendations to the NASA Executive Council, chaired by the Deputy Administrator, for approval.

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2. METHODOLOGY

At the beginning of the study, one of the first actions of the SSUR team was to define a methodical set of steps to follow in order to reinvent the Station and Shuttle Utilization Process. Figure 2-1 represents the approach chosen by the team. Each of the steps shown on figure 2-1 are discussed in detail in the following paragraphs.

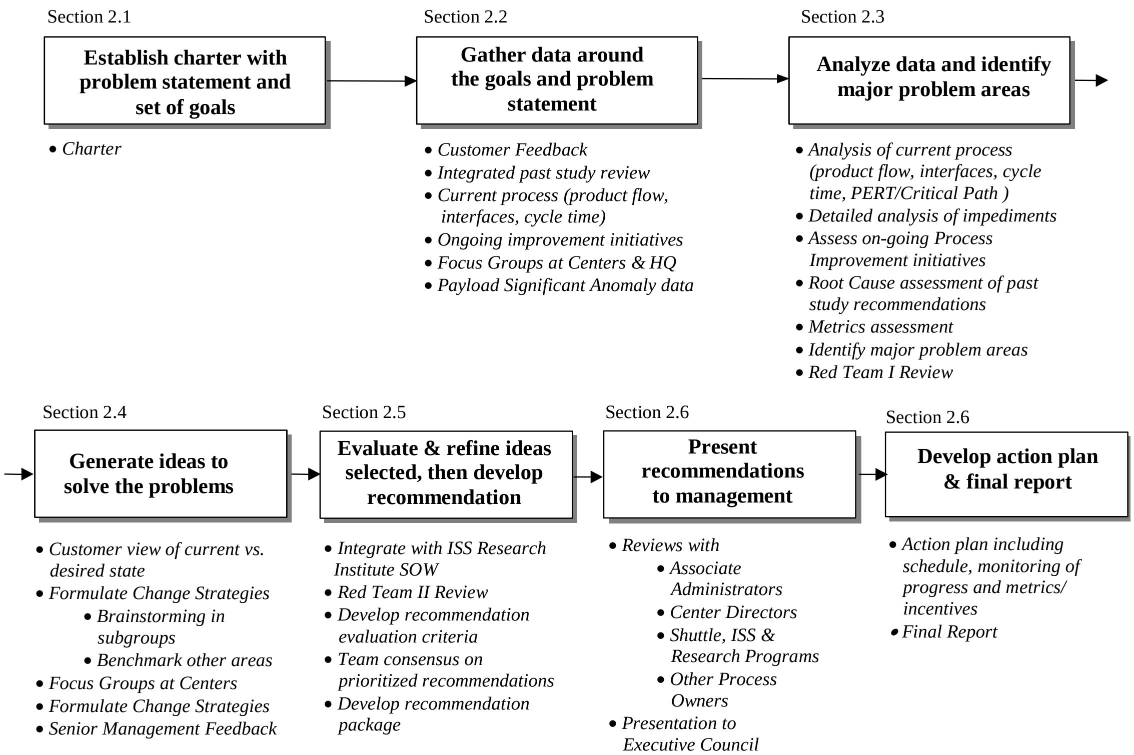

Figure 2-1. SSUR Team Process

2.1 ESTABLISH TEAM CHARTER

A team charter (Appendix B) was developed to define the goals the SSUR team sought to accomplish. The following goals from the charter provided the primary focus for the study.

(1) Optimize Agency high priority research throughput.

(2) Remove impediments to the utilization process.

(3) Enable ISS Research Institute success.

(4) Strengthen NASA's emphasis on the research/user community to enable a world-class research environment in space.

In addition to the charter goals, the SSUR Team worked with the understanding that:

(1) With the ISS assembly completion on the horizon, this is the optimum time to implement needed changes.

(2) Increased partnership is desired with the science community.

(3) NASA's internal utilization process must be improved to facilitate the ISS Research Institute's success.

(4) The SSUR team will closely coordinate with the ISS Research Institute Statement of Work (SOW) team to ensure consistency with Request for Proposal requirements.

(5) Recommendations include a proposed implementation approach because many previous studies and improvement efforts lacked the necessary follow through to ensure successful implementation.

2.2 GATHER DATA

The SSUR team gathered a comprehensive set of information from all available sources including customer feedback data, previous studies, and ongoing improvement initiatives. Additional comments were solicited from Principal Investigators (PIs) and Payload Developers (PDs) (both internal and external to NASA), as well as other stakeholders at all involved Centers and Headquarters. Products were also generated by the SSUR team to aid in the analysis portion of the study. These included detailed flow charts for the current processes.

2.2.1 Customer Feedback

An integrated comments summary (Appendix C) was developed that contains 535 feedback suggestions and comments on the end-to-end utilization process. These were categorized to help organize the data and aid in the analysis process. The suggestions and comments were collected from numerous feedback forums:

(1) Space Station Freedom Continuous Improvement Customer Support Team, 1991.

(2) Payload Engineering Processing Study Phase A, 1997.

(3) Payload Operations Concept Architecture Assessment Study (POCAAS), 2001-2002.

(4) Salzman Findings (KSC customer feedback data, Howard Ross PI interview data, Cocoa Beach User Conference), 2001-2002.

(5) KSC Customer Survey, 2001-2002.

(6) Cocoa Beach User Workshop, 2002.

(7) Freedom to Manage, 2002.

(8) Shuttle Payload Office Customer Feedback/ Freedom to Manage, 2002.

(9) JSC ISS Survey Data (ISS Program needs assessment, post increment customer survey), 2002-2003.

(10) Internal suggestions and comments generated during SSUR internal focus groups, 2003.

2.2.2 Integrated Past Study Review

The findings from previous studies (Appendix D) were used for problem analysis. As with the customer feedback, the data were categorized to aid in the analysis of the problem areas. "Recommendations implemented" reflect both the time frame and the action taken. "Recommendations not implemented" show a rationale, if available. The following studies were evaluated:

(1) Space Station Freedom Continuous Improvement Customer Support Team, 1991.

(2) Utilization, Operations, and Training Assessment Team (UOTAT), 1995.

(3) NRC – Factors Affecting the Utilization of the International Space Station for Research in the Biological and Physical Sciences Space Station Utilization Advisory Subcommittee, 1996-2002.

(4) Payload Engineering Processing Study Phase A & B, 1997.

(5) Microgravity Research Program Study, 1999.

(6) ISS Operations Architecture Study, 1999-2000.

(7) National Research Council, 1999-2000.

(8) Biological & Physical Research Advisory Committee (BPRAC) Recommendations, 2000-2002.

(9) Payload Operations Concept Architecture Assessment Study, 2001-2002.

(10) Freedom to Manage, 2002.

2.2.3 Current Process

Numerous products were developed that documented the end-to-end process and were used to aid in the analysis and identification of impediments and the development of change strategies.

2.2.3.1 Product Flow

An ISS/Shuttle product flow was generated to show how deliverables (documentation, hardware, software) are linked to major milestones. The end-to-end process was then separated into the various phases of the process; i.e., Strategic, Definition, Development, and Operations.

2.2.3.2 Interfaces and Transactions Between PIs/PDs and NASA

Transaction Diagrams (Appendix E) were developed illustrating the interactions and lines of communication between the various organizations involved in the end-to-end process for both NASA and non-NASA developed payloads. Each numbered line on the diagram represents an interface path for coordination of activities such as the development of products and decision making. For completeness, separate interaction diagrams were generated for Program Management, Science Management, Development/Operations, ISS Payloads, and SSP Points of Interaction.

A Points of Interactions Table (Appendix F) was developed that relates the interface path to activities that those organizations perform, such as the ISS/Shuttle Program Forums, Boards and Teams. In the table the type of interaction, such as boards, forums, etc., is shown with the corresponding interface path, the decision maker of the activity, and the products produced by those organizations. For example, path 2 on the Transaction Diagram (Appendix E) connects the JSC ISS Payloads Office and the Research Integration Offices. In the Points of Interaction Table (Appendix F), all actions with a number 2 in the fifth column (Interaction Path) represent activities conducted between these two organizations.

2.2.3.3 Cycle Time (Payloads Flows to Date)

Cycle time data were collected on past and current ISS payloads to establish a basis for assessing improvements of proposed recommendations in achieving the goal for reduced cycle time. These cycle time data were divided into solicitation, definition, development, and operations phases and are discussed in more detail in paragraph 3.5, End-to-End Cycle Time Too Long.

The difficulty in obtaining cycle time data resulted in recommendations for additional payload metrics in the future.

2.2.4 On-going Process Improvement Initiatives

Information was collected regarding on-going process improvement initiatives to determine if an initiative addressed a problem area identified by the SSUR team (e.g., need to reduce cycle time) and the degree to which that initiative would either mitigate or fix the major problem area. A summary of these initiatives is included in Appendix G.

2.2.5 Inputs From Focus Groups

There are numerous individuals and groups closely involved with the different aspects of ISS and Shuttle utilization processes. To gain a thorough understanding of the end-to-end process, the SSUR team interviewed a significant number of these "focus groups" to collect their opinions regarding various problems within the system. As part of these interviews, the SSUR team solicited their ideas for solving their respective problems. The focus groups consisted of Principal Investigators and Payload Developers internal and external to NASA, as well as NASA personnel knowledgeable of the utilization process. The SSUR team traveled to the various NASA Centers and Headquarters to meet personally with these focus groups or, when necessary, conducted interviews via teleconferences.

Each focus group was provided with a set of generic questions and area-specific questions. These questions were based on customer feedback comments related to their organization/affiliation. Insight into known problem areas was also solicited from the respective Center Directors and their staffs during trips to each NASA Center.

Following each focus group session, the SSUR team discussed the dialog that had taken place, developed notes related to that discussion, and discussed possible additions to the integrated comments summary shown in Appendix C.

The following is a list of the focus groups interviewed:

(1) NASA Headquarters (Offices of the Administrator, External Relations, Legislative Affairs, Space Flight, Education, Public Affairs, Safety and Mission Assurance, Space Science, Biological and Physical Science, and Earth Science).

(2) Customer Focus Telecons (PIs and ELV Program Managers).

(3) Risk Management Telecons (Mission Assurance organizations across the Agency, Commercial PIs and PDs, NASA PIs and PDs).

(4) GSFC (Center Director, GAS, Hitchhiker).

(5) MSFC (Center Director, Microgravity Science Department, Space Product Development, Payload Operations).

(6) KSC (Center Director, Operations, Life Sciences, PI, PD).

(7) JSC (Center Director staff, Commercial Process, ISS Crew, Resources at Assy. Complete, DSO Process, Post Increment Payload Survey, ISS Program Manager., STS-107 Mission Manager and Lead Increment Scientist).

(8) ARC (Center Director staff, Life Sciences Division, Space Station Biological Research Project).

(9) JPL (Center Director, Associate Center Director for Flight Projects and Mission Success, PI, PD, Manifest Optimization Tool, Concurrent Engineering Design Center).

(10) GRC (Center Director staff, Microgravity PD, and Project Scientist [Rack, EXPRESS, and, Glovebox Payloads]).

2.2.6 Payload Significant Anomaly Data

Data were collected to categorize anomalies for Commercial Payloads and NASA-developed Payloads. The study team also obtained the ISS Payload Anomalies Report (PAR) data from real-time operations, and assessed the degree to which NASA quality standards affect the overall success rate of the flight hardware. PAR data will be discussed further in paragraph 3.2, Unclear Research Risk Accountability.

2.3 ANALYZE DATA TO IDENTIFY MAJOR PROBLEM AREAS

2.3.1 Analysis of Current Process (Product Flow, Interfaces, Cycle Time, PERT/Critical Path)

A detailed Process Evaluation and Review Technique (PERT) chart was developed to further define the critical path of the end-to-end process. This tool aided the team in identifying which phases of the process were causing the lengthy cycle times. Analyses were conducted to determine contributing factors to lengthy payload stay in particular phases of the process. PERT summary and analysis is further discussed in paragraph 3.5, End-to-End Cycle Time Too Long.

Using the products described, the team characterized various problems identified in the end-to-end process and evaluated possible root causes.

2.3.2 Detailed Analysis of Impediments

More detailed analyses were performed in those areas where significant improvements were needed. Where appropriate, additional information was solicited from Principal Investigators (PIs), Payload Developers (PDs), other stakeholders throughout the Agency, and the external research community. Additional data products resulting from this effort were:

(1) Detailed PERT critical path analysis of the end-to-end process.

(2) Cross analysis of cycle time data history with product flow to determine process impediments.

(3) In-flight anomaly assessment.

(4) Cycle time historical data.

(5) Payload mission assurance and risk management philosophy discussions.

2.3.3 Assess On-going Process Improvement Initiatives

Some of the on going initiatives, such as the JSC Payloads Office Process Improvement activities, were found to be key to addressing problem areas identified by the SSUR team. When appropriate, positive existing initiatives such as this were endorsed by the team and incorporated into the recommended change strategies.

2.3.4 Root Cause Assessment of Past Study Recommendations

An assessment of past study recommendations was performed to determine if current impediments were previously addressed and to assess reasons why previous recommendations were not implemented. Appendix H summarizes the root causes leading to the failure to implement past study recommendations. This assessment was used to help determine the best possible approaches to assure that recommendations from this study will be implemented.

2.3.5 Metrics Assessment

Current Shuttle and Station utilization metrics were assessed to determine consistency with the desired outcome of increased research/user community satisfaction, reduced cycle time and increased research through-put. No top level Agency metrics exist for the end-to-end process. Metrics that do measure the process or its various parts are neither consistent nor readily available across disciplines.

2.3.6 Identify Major Problem Areas

Using the products described above, the team characterized problems identified in the end-to-end process and evaluated possible root causes. To facilitate this activity, a cause and effect diagram was generated based on goals in the charter and categories of concern discussed within the team. Major impediments to overcome for each problem area were identified and analyzed. The impediments were grouped into five major problem areas:

(1) Complex Business Structure.

(2) Unclear Research Risk Accountability.

(3) Lack of Customer Focus.

(4) Insufficient Utilization Capacity.

(5) End-to-End Cycle Time Too Long.

2.3.7 Red Team I Review

During this phase of the study process, senior NASA managers across the Agency were asked to evaluate the soundness of the SSUR processes. This team, called Red Team I (Appendix I), was asked to review SSUR team processes and planned products to assure they:

(1) Addressed the goals stated in the charter.

(2) Adequately characterize the current end-to-end Station and Shuttle utilization process.

(3) Systematically identify the major problems with the process.

(4) Enable the SSUR team to prioritize those areas most needing change.

(5) Ensure developed change strategies to address the goals stated in the charter.

In addition, Red Team I was asked to assess the SSUR team schedule and determine its ability to meet the charter requirements and to also identify steps ensuring forward action plans, once approved, would be implemented.

Red Team I determined the SSUR team was using a logical, well-structured process that should enable the team to fulfill its charter, if the process is allowed to methodically drive out the answers (i.e., avoid premature conclusions) and some modifications/additions were implemented in the sub processes including:

(1) SSUR charter modification.

(2) Modifications to the current process to allow for more systematic analyses in subsequent steps including PERT analysis of the end-to-end utilization process.

(3) Development of “prioritization criteria” before prioritization of the problems.

(4) Discussions with affected “process owners” prior to evaluation and refinement of solutions.

Red Team I encouraged the SSUR team to keep a broad view of the problem and to not narrow the scope unnecessarily or prematurely. Recommendations on the study process were accepted and resulted in improvements to the overall SSUR process. Observations noted by Red Team I, Appendix I, were reviewed and taken into consideration throughout the SSUR team’s activities.

2.4 GENERATE IDEAS TO SOLVE THE PROBLEMS

2.4.1 Customer View of Current Versus Desired State

The external component of the SSUR team was tasked to define a vision of the desired state for the research/user community (as shown in the beginning of this document). This vision was used as a guide and validation tool to assure the solutions proposed would result in the desired state.

2.4.2 Formulate Change Strategies

The SSUR Team divided into subteams to facilitate the development of solutions for the identified problems that fell into five major areas as shown in figure ES-1 (also figure 3.0-1). These subteams used various techniques such as benchmarking other Government agencies, expert consultations through focus group meetings, evaluating previous study findings and recommendations, and brainstorming sessions in generating ideas for solving the problems. These subteams identified major change strategies that would provide solutions to the identified problem areas. The problem areas and change strategies are listed as follows:

(1) Complex Business Structure.

- Unified Station and Shuttle Utilization Process.
- Integrate Utilization at JSC.
- Agency Approach to Commercial Use.
- Expand Scope of ISS Research Institute.

(2) End-To-End Cycle Time Too Long.

- Maturity of Proposals.
- Timelines Tailored to Experiment With Payload Classification.
- Concurrent Payload Development and Integration.
- Reduced Process Complexity.

(3) Insufficient Utilization Capacity.

- Increase Utilization Funding Stability.
- Alternate/Supplemental Space Access.
- Manifest Optimization.

(4) Lack of Customer Focus.

- Emphasize Agency's Focus on Research.
- Improve Research Advocacy.

(5) Unclear Research Risk Accountability.

- Agency Research Success Philosophy.
- Principal Investigator Decision Maker for Research.

2.4.3 Senior Management Feedback

At each step in the process, feedback from senior management and process owners was used to help validate whether the proposed change strategies were addressing the identified problem areas and impediments in the end-to-end process.

2.5 EVALUATE AND REFINE IDEAS TO DEVELOP A SET OF RECOMMENDATIONS

Inter-subteam peer reviews were conducted to facilitate evaluation and refinement of each of the proposed change strategies. Briefings on the proposed change strategies were given to the ISS Research Institute Statement of Work Team in order to coordinate and integrate the two initiatives.

A highly respected team of Principal Investigators and Payload Developers, both internal and external to NASA, further reviewed and assessed the proposed change strategies. Members of this team, Red Team II, are identified in Appendix J. Red Team II's charter was to evaluate the change strategies developed by the SSUR team and to determine if implementing them would significantly improve the end-to-end process and the external research community's perception of the value of NASA's Station and Shuttle research platforms. In addition, Red Team II identified those change strategies that would be most compelling in terms of their value and significance to the user community by ranking them in high, medium, and low categories. The Red Team II out-briefing report is in Appendix J.

Feedback from Red Team II was used in conjunction with a set of selection criteria developed by the SSUR team to prioritize the complete set of change strategies. The team agreed that the best criteria for judging the significance of the change strategies were the four goals stated in the charter plus the importance of each change strategy to Red Team II. The criteria and associated definitions are shown in table 2.5-1. Each change strategy was scored either high (three points), medium (two points), or low (one point) against each of the five criteria, then prioritized based upon the total score each strategy received. The prioritization results are shown in table 2.5-2.

All change strategies are considered important and valuable. To focus on the most important change strategies, the SSUR team developed its recommendation package of the top eight change strategies for immediate implementation. The remaining seven strategies should be considered for implementation by the Enterprises based on cost, schedule, and personnel available. It is noteworthy that both the Red Team II and the SSUR Team independently arrived at a consensus recommendation on the top strategies.

Table 2.5-1. Criteria Used to Prioritize Change Strategies

Criteria used from SSUR Team Charter	**Definition**
1. Importance to Red Team II	• Priority placed upon change strategy by Red Team II
2. Optimize Agency high priority research throughput	• Assure throughput is aligned with capability • Ensure selections reflect Agency priority • Increase capability • Resource stability
3. Remove impediments to the utilization process	• Streamline the process • Increase process flexibility
4. Enable ISS Research Institute success	• Simplify NASA's and PI's interface to ISSRI • Improve the way the ISSRI will function
5. Strengthen NASA's emphasis on the research/user community to enable world-class research environment in space.	• Cultural and organizational changes that will increase Agency research focus • Attract and maintain strong research community

Table 2.5-2. Final Ranking of All 15 Change Strategies

Priority	Change Strategy
1	Unified Station and Shuttle Utilization Process
2	Reduced Process Complexity
3	Emphasize Agency's Focus on Research
4	Alternate/Supplemental Space Access
5	Principal Investigator Decision Maker for Research
6	Integrate Utilization at JSC
7	Increase Utilization Funding Stability
8	Maturity of Proposals
9	Agency Research Success Philosophy
10	Expand Scope of ISS Research Institute
11	Timelines Tailored to Experiment with Payload Classification
12	Improve Research Advocacy
13	Concurrent Payload Development and Integration
14	Agency Approach To Commercial Use
15	Manifest Optimization

2.6 PRESENT RECOMMENDATIONS TO NASA MANAGEMENT

Several iterations with NASA senior management, including the ISS and Shuttle Program and Astronaut Office Managers, Center Directors, Research Managers, and the team's senior advocates further refined the strategies and their implementation approach. Upon concurrence by the senior advocates, these changes were taken to the Executive Council. The Executive Council approved the recommended eight change strategies with associated change strategy implementation responsibilities (table 2.6-1). Owners were asked to return to the Executive Council in six to eight weeks with implementation approaches including schedules as well as identifying any of the remaining seven change strategies that would also be implemented at this time.

In addition, The SSUR team recommended the following steps to ensure implementation:

- Treat each change strategy as a project with a plan and schedule for implementation.

- Report to the Executive Council and/or the Leadership Council every six months on progress.

- Assign a SSUR team member to each change strategy owner as a consultant to ensure implementation meets the intent of the team.

- Conduct an independent assessment by the SSUR team in one year.

Table 2.6-1. Action Plan for Change Strategy Implementation

Priority	Change Strategy Title	Proposed Change Strategy Owner	Proposed Senior Advocate	SSUR Team Consultants
1	Unified Station and Shuttle Utilization Process	OBPR AA, Mary Kicza OSF AA, William Readdy	OBPR AA, Mary Kicza OSF AA, William Readdy	Russell Romanella Lesa Roe
2	Reduce Process Complexity	OBPR Deputy AAs for Science and Programs, Peter Ahlf, Bernard Seery JSC ISS Payloads Office Manager, Dan Hartman	OBPR AA, Mary Kicza NASA Chief Engineer, Theron Bradley	Tom St. Onge Lesa Roe
3	Emphasizing Agency's Focus on Research			
	Part 1: Emphasis on research/user community	NASA Chief Scientist, John Grunsfield	OSF AA, William Ready OBPR AA, Mary Kicza	Teresa Vanhooser
	Part 2: Awards and Incentives for Research	OBPR Deputy AA for Science, Howard Ross	OBPR AA, Mary Kicza	Teresa Vanhooser
	Part 3: Crew Emphasis on Research	ISS Program Scientist, Don Thomas (and the Crew Office)	OSF AA, William Readdy	Rita Willcoxon
4	Alternate/Supplemental Space Access	OBPR Division Director, Mission Integration, Peter Ahlf	NASA Space Architect, Gary Martin	Feng Liu Gary Jahns
5	Principal Investigator Decision Maker for Research	OBPR Deputy AA for Science, Howard Ross	NASA Chief Scientist	Gary Jahns
6	Integrate Utilization at JSC	JSC ISS Payloads Office Manager, Dan Hartman	ISS Program Manager, Bill Gerstenmaier Shuttle Program Manager, Bill Parsons	Michele Brekke Rita Willcoxon
7	Increase Funding Stability	Deputy CFO, Gwen Brown	NASA Deputy Administrator, Fred Gregory	Barbara Kreykenbohm
8	Maturity of Proposals	OBPR Deputy AA for Science, Howard Ross	OBPR AA, Mary Kicza	Ron Porter

3. CHANGE STRATEGIES

As outlined in figure 3.0-1, there are five major problem areas where significant change is needed. Paragraph 3.1 addresses four changes that will simplify the complex business structure. Paragraph 3.2 addresses two changes that will better clarify research risk accountability. Paragraph 3.3 addresses two changes that will improve customer focus within the Agency. Paragraph 3.4 addresses three changes that will increase utilization capacity. Paragraph 3.5 addresses four changes that will reduce the end-to-end cycle time. In each of these paragraphs the subteams address the background of the problem area and their methodology for determining recommended change strategies to remove impediments and solve the problem. In addition, each recommended change strategy is divided into a description of the change, rationale for the change, similar past study recommendations, a discussion of how the change will enable the ISSRI, and a proposed implementation approach. This detail is included to improve the Change Owner's ability to implement the change.

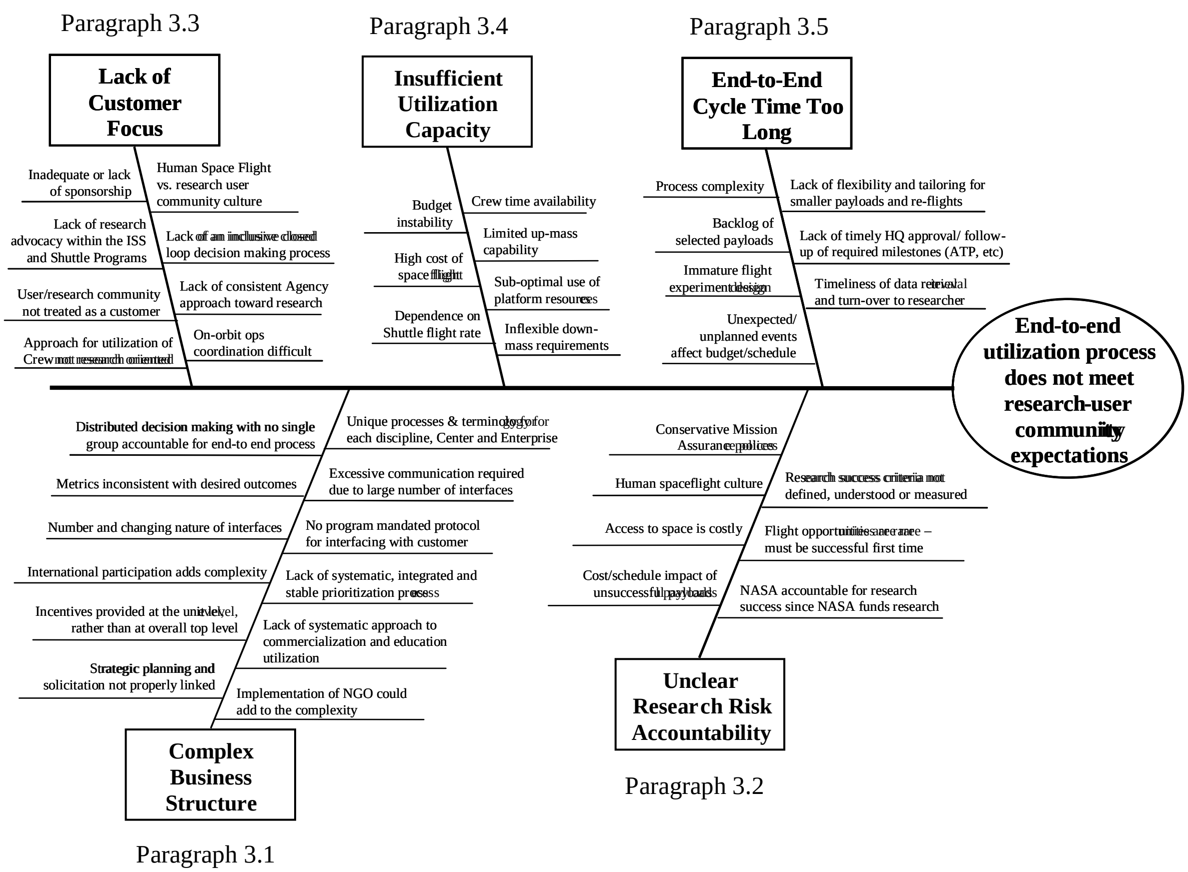

Figure 3.0-1. Integrated Cause and Effect Diagram Identifying Major Problem Areas

3.1 COMPLEX BUSINESS STRUCTURE

Background

Historically, the Space Shuttle was used extensively as a space platform for science and research. Today, the Space Shuttle's primary mission is to support the construction, maintenance, operation, and utilization of the International Space Station (ISS). Even though its mission has shifted, the organization supporting Space Shuttle utilization remains intact. The organization responsible for ISS utilization is also well established. These two organizations have different processes for prioritizing, manifesting, and implementing ISS and non-ISS utilization payloads. Although the ISS and the Space Shuttle Programs have streamlined utilization processes and tried to make them consistent, there are still separate processes for each program. No individual group is responsible for overseeing the total end-to-end utilization processes for either ISS or Space Shuttle. Metrics for these processes are limited and are not consistent throughout the Agency or Enterprises. Entry points for customers are not always well defined and understood. Alignment of overall resource requirements with resource availability is limited and not always coordinated with Agency infrastructure requirements.

The time is right to consolidate the utilization processes (including payload prioritization, manifesting, customer integration and implementation) of both Programs. Our vision is that a single authority be responsible for overseeing the end-to-end utilization process. Looking forward, there will be an ISS and Shuttle utilization business structure, both at the Agency level and among the field centers that enables customers to pass through the system smoothly and effectively. This business structure will have clear accountability and coordination at all levels and will be flexible and responsive to the changing needs and priorities of both the Agency and its customers. ISS and Shuttle utilization priorities will be clearly established and endorsed by the research community. Strong support for the ISS and Shuttle as research platforms will exist throughout the science/research community and across NASA, within every discipline and Enterprise. Utilization resources and requirements will be evaluated against overall Space Shuttle and ISS capabilities to assure the maximum utilization allocation is achieved against competing needs such as assembly and logistics. There will be clear entry points into the system and creative /realistic solutions for customer problems will be actively pursued across the Agency. Common “One NASA” utilization processes based on best practices will be defined and followed throughout the Agency. The ISS Research Institute will be established and effectively integrated with the overall NASA business structure. Utilization customers will find supportive processes and people that understand the system and will facilitate and guide them through the process. The end-to-end utilization process will be measured and tracked to assure high customer satisfaction and outstanding science, commercialization, technology, education, and outreach results.

The following section addresses the methodology necessary for achieving these objectives and the individual change strategies that will result in a common ISS and Space Shuttle utilization business structure that will enable the research/user community customer to pass through the system smoothly and effectively.

Subteam Methodology

Subteam members identified and analyzed major business structure impediment areas to develop potential change strategies. Members then performed a detailed analysis of each area, validating the impediments and collecting data on existing processes and concerns. Existing Board charters were gathered for those Boards responsible for Space Shuttle or ISS utilization selection, prioritization, or manifest activities. Charters currently in the revision process were reviewed for potential revisions to the baseline and relevance to potential change strategies. Organizational roles and responsibilities were defined, clarified, and mapped to potential change strategies together with pros and cons for each potential solution. The SSUR team’s knowledge base, together with discussions with experts, and the information just described, was used to generate a set of proposed change strategies to simplify the Agency’s complex ISS and Space Shuttle Utilization business structure.

Following review and critique across the entire SSUR team, subteam members reviewed these proposed change strategies with key stakeholders external to the SSUR team. Comments and suggestions were integrated with the overall SSUR process to develop a final set of recommended change strategies.

This concluded with four Complex Business Structure change strategies:

(1) Unify The ISS and Shuttle Utilization Process.

(2) Integrate Utilization at JSC.

(3) Expand the Scope of the ISS Research Institute.

(4) Change the Agency's Approach to Commercial Use.

3.1.1 Change Strategy: Unified Station and Shuttle Utilization Process

a. Description of Change Strategy

The ISS and Space Shuttle responsibilities currently assigned to multiple Headquarters boards will be consolidated into a single HQ Human Space Flight Utilization Board (HSFUB) co-chaired by the Office of Biological and Physical Research (OBPR) Associate Administrator and the Office of Space Flight (OSF) Associate Administrator. The OBPR Associate Administrator will establish a new senior management position and supporting staff that oversees the entire end-to-end utilization process.

Establishing a senior management position is an enabling strategy that elevates and focuses ownership of the end-to-end process at a senior Headquarters level, provides utilization advocacy within the Agency, and oversees research/user community customers' interest in the end-to-end utilization process for both ISS and Space Shuttle. This position is needed because multiple organizations are involved in the ISS and Space Shuttle end-to-end process. Figure 3.1-1, illustrates the primary ownership of the different phases of the process.

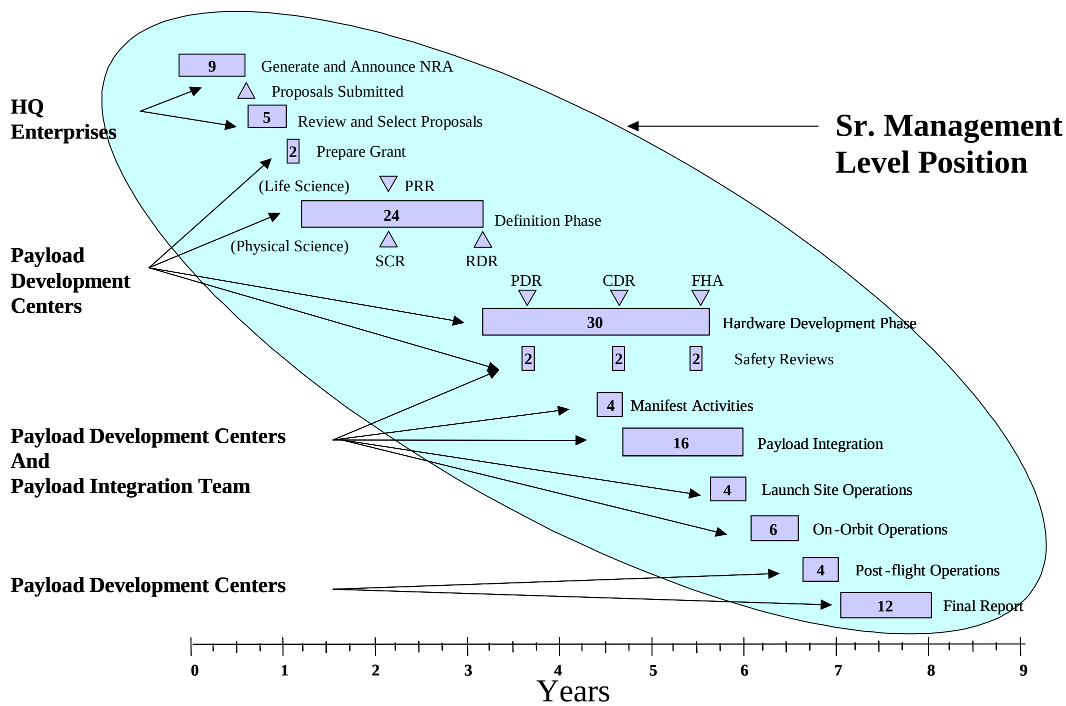

Figure 3.1-1. Primary Ownership of the Phases of the End-to-End Process

This position, under the guidance of the HSFUB, will:

(1) Be responsible for integrating ISS and Space Shuttle utilization activities at Headquarters.

(2) Be responsible for oversight of the end-to-end utilization processes.

(3) Define and implement a single unified (One NASA) allocation/prioritization process for all ISS and Shuttle utilization.

(4) Serve as an advocate for Utilization and ensure that utilization processes meet research/user community customer needs and expectations.

(5) Develop appropriate top-level metrics to measure research/user customer satisfaction, process performance, and research throughput for both ground and flight research. Present these metrics to the HSFUB and flow them down to the applicable Centers and Programs.

(6) Assure that best practices for payload development and integration are recognized and implemented across disciplines and Enterprises.

(7) Provide oversight of ISSRI as the customer entry point or "Front Door" for the Agency.

(8) Recommend to the HSFUB the appropriate staff (NASA, contractor, ISSRI) required to support the operation of the HSFUB.

(9) Develop recommendations that streamline existing boards, panels, and working groups currently supporting utilization processes and make recommendations to the HSFUB.

(10) Oversee the implementation of the SSUR change strategies and continuously review the end-to-end process for improvements.

The HSFUB will be responsible for implementing an integrated ISS and Shuttle utilization allocation process where allocations, priorities, and set-asides are determined and results are analyzed, assuring alignment with resources and Agency strategy and vision. HSFUB responsibilities will include:

(1) Establish integrated Station and Shuttle utilization priorities.

(2) Provide a single decision making authority for the limited ISS and Space Shuttle utilization resources and assure those resources are allocated properly across Agency Enterprises.

(3) Regularly revaluate NASA's portfolio of utilization and supporting infrastructure in light of changing conditions.

(4) Seek alignment of current and future infrastructure and services with requirements, allocations, and priorities.

(5) Provide decision authority on sponsorship of flight experiments where there is no clear authority or there is conflicting authority.

(6) Develop and annually review a multi-year outlook plan for Shuttle and ISS utilization.

(7) Advocate additional utilization capability where required.

(8) Provide final resolution of priority conflicts where resolution cannot be reached at the Enterprise level. This includes issue resolution across logistics, assembly, utilization, etc.

(9) Routinely review flight and ground utilization metrics that measure process performance, research throughput, and research/user community customer satisfaction and recommend appropriate improvements, corrective actions, and rewards.

(10) Determine and/or approve utilization set-asides where flights of certain types of utilization payloads may be "set-aside" within the overall priority.

(11) Determine the best method to distribute available resources between the Enterprises (today it is a fixed allocation process).

(12) Determine utilization allocation for Enterprises.

(13) Periodically review Enterprise solicitations for consistency with resources.

(14) Approve barter agreements when those agreements affect only utilization capacity or use.

Figures 3.1-2 and 3.1-3 show the existing board structure and the proposed new board structure.

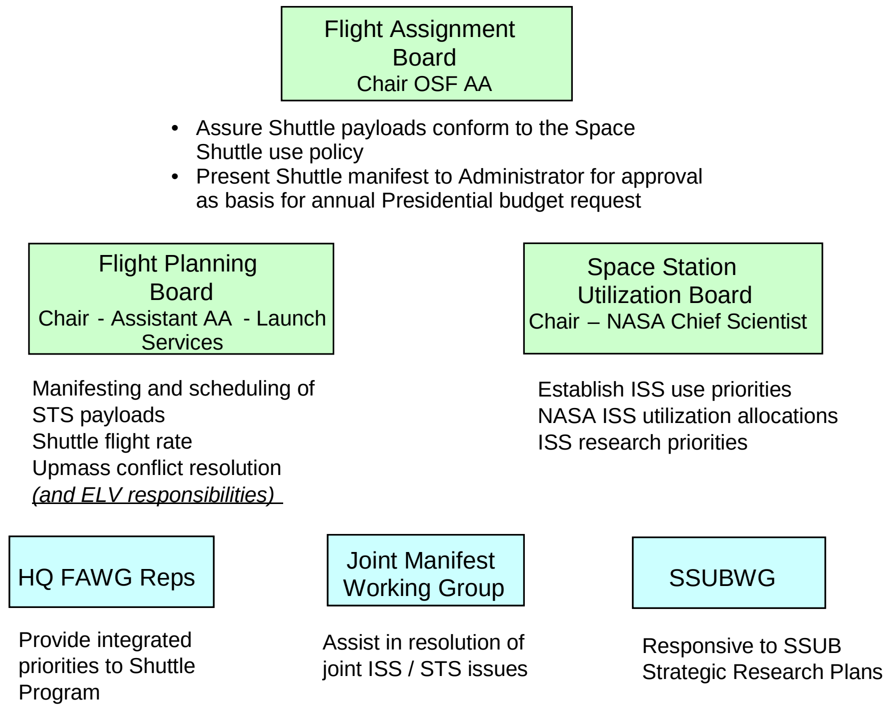

Figure 3.1-2. Existing Board Structure

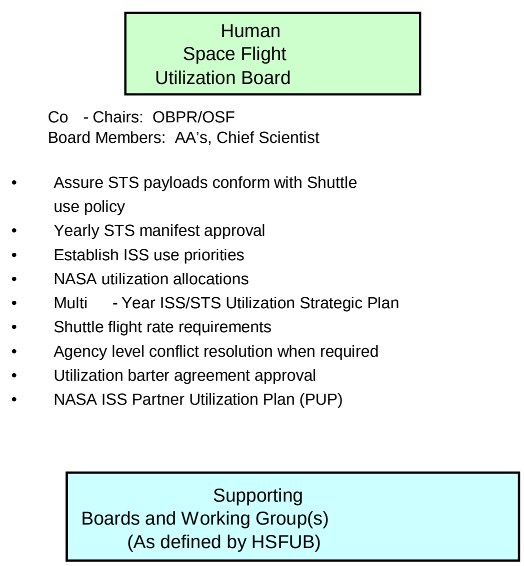

Figure 3.1-3. Proposed Board Structure

b. Rationale for Change Strategy

Today the utilization process has multiple owners throughout the Agency and no one person or organization oversees the end-to-end process. The change proposed will provide oversight of the end-to-end, unified utilization process. It will ensure research/user community customers' interests and expectations in the utilization process are met and will help assure best practices are recognized and implemented across disciplines and Enterprises. This will implement a "One NASA" approach to utilization.

The primary user of the Space Shuttle today is the ISS Program (Assembly, Utilization, Logistics, Crew Rotation, and Resupply). Utilization requirements are established within the Enterprises (OBPR, M, S, Y, N, etc.). These codes drive ISS utilization requirements and can also generate Space Shuttle secondary requirements (non-ISS). These requirements compete for up mass with ISS Utilization, which competes with ISS Assembly, Logistics, etc., requirements. Currently, there is no integrated U.S. utilization approach for all ISS and Space Shuttle utilization. This proposed change would enable all ISS and Space Shuttle utilization requirements to be considered as a single set of utilization requirements and to follow one process for Flight and Increment Assignments based on Agency priorities. It would provide a single decision making authority for the limited utilization resources and would assure those resources are allocated properly across Agency Enterprises. It would also allow the Agency to continually evaluate utilization requirements and adjust them accordingly to respond to changing conditions. This change strategy also defines a forum to resolve conflicts, should they arise.

The Agency's current metrics do not uniformly address the desired outcome of increased research/user community satisfaction, reduced cycle time, and increased research through-put. "You get what you measure," and in some cases what is being measured may support only Center-level activities and not the Agency's overall desired outcome of the end-to-end process. This change strategy assures the process is viewed as an end-to-end system and is measured, assessed, and focused at the Agency level.

c. Similar Previous Study Recommendations

Time Frame	**Title of Study**	**Recommendation**
1991	Space Station Freedom Continuous Improvement Customer Support Team	• No consensus in goals – external and internal — The SSF Program should periodically coordinate with user codes (at least twice a year) to assure that plans, budgets, and program status is consistent with implementation of the approved goals for SSF. • Establish Agencywide plan for continuing space research capabilities that are consistent with SSF goals and are supported by the Shuttle Manifest. — Absence of Agencywide plan for continuing space research capabilities – i.e., Science & Technology Proposals, Spacelab/SSF Transition Pressurized module utilization, Shuttle manifest. • Communicate these goals and plans across the Agency and user community at all levels. — No Coordination between codes and SSF Program.

Time Frame	Title of Study	Recommendation
1995	Utilization, Operations, and Training Assessment Team (UOTAT)	• Consolidate Station and Shuttle long-range manifesting and scheduling elements into an integrated traffic planning function. • Consolidate Station program planning functions into an integrated program planning function. Includes Station Strategic and Tactical Planning, and Station Common Operations Cost function. • Consolidate all program (Station and Shuttle) and implementation functions (organizations, processes, and facilities/tools) associated with Cargo/Payload Integration and preflight testing.
1997	Payload Engineering Processing Study Phase A & B	• NASA establishes a centralized payload steering committee for balancing U.S. research allocations on platforms across all disciplines, partners, and commercial entities. The steering committee would be comprised of representatives for all NASA research organizations and chaired by the NASA chief scientist. — NASA does not have an integrated manifesting approach to optimize NASA resource utilization.
1999-2000	ISS Operations Architecture Study - Cox	• A top-to-bottom Utilization Management and Implementation architecture should be developed within NASA and the ISS Program to focus, organize, and streamline Utilization on the ISS. • Structure utilization management as part of the total Program. Bring the utilization community's goal setting, budgeting/funding allocation, and decision-making processes together, under the same organizational umbrella from NASA HQ to the ISSPO and the NASA field-Center level. ISS Utilization management from concept to flight results reporting needs to be ISS focused. No single Utilization organization is managing the overall research development, prioritization, hardware development and testing, mission integration, operations, and communication of results to the public.

d. How the Change Strategy Will Enable ISSRI Success

This change strategy would provide the ISSRI with a unified interface at HQ for the ISS and Shuttle as research platforms and provide clear decision-making accountability.

e. Proposed Implementation of the Change Strategy

Implementation Approach

(1) OBPR would establish a senior management position and select an individual.

(2) OBPR would establish a small, dedicated support staff that can be accommodated through detail and permanent assignments.

(3) The senior management position would, in concert with the Enterprises, develop a HQ Human Space Flight Utilization Board (HSFUB) charter. OBPR and OSF Associate Administrator levels would chair the HSFUB. Membership in the HSFUB should include Enterprise Codes Associate Administrators and the NASA Chief Scientist.

(4) Concurrent with the HSFUB charter development, the new senior manager would develop HSFUB supporting infrastructure requirements such as supporting boards or working groups. This recommendation would be presented to the HSFUB chairs for approval.

(5) Support to the new HSFUB would be from those members of the existing Space Station Utilization Board, Flight Assignment Board, Flight Planning Board and associated Working Groups currently supporting ISS and Space Shuttle activities within those Boards and Working Groups.

(6) This new senior manager, working in concert with the appropriate representatives from the Enterprises and the Agency Chief Scientist, would define appropriate Agency top-level metrics to measure research/user customer satisfaction, process performance, and research throughput and recommend these to the HSFUB. After approval, these would be flowed down to the Centers and Programs. Metrics would measure both ground and flight research utilization activities. Metrics should be submitted no less than annually to the HSFUB for evaluation and inclusion in the Agency performance report.

(7) This senior management position ensures that the ISS Research Institute, once established, supports the end-to-end products necessary for the function of the HSFUB. As part of this effort, the senior management position assures proper definition of tasks and commensurate funding.

The following table represents the proposed change strategy owner and senior advocate as well as some additional implementation details.

Proposed Change Strategy	**Proposed Senior Advocate**	**Resources Required**	**Potential Metrics**	**Implementation Time Frame**
OBPR Associate Administrator	OBPR and OSF Associate Administrators	Establish a permanent staff of Civil Servant FTEs to support the new senior management position. In addition, periodic contractor FTEs from the ISS Research Institute at contract start to support functions of new position and HSFUB (this support is expected to reduce civil service staffing requirements).	Process performance, research throughput, research/user community customer satisfaction, and others as determined appropriate by the HSFUB.	September 2003 - February 2004

f. Challenges of Implementing Change Strategy

This new senior management position must represent the interest of all Enterprises relative to ISS and Space Shuttle utilization. An unbiased approach towards utilization must be maintained to assure fairness and promote cross Enterprise interest, participation, and trust.

Provision of appropriate staff and budget required to support this position and the HSFUB is critical to accomplishing the responsibilities described.

3.1.2 Change Strategy: Integrate Utilization at JSC

a. Description of Change Strategy

This change strategy integrates the ISS and Space Shuttle utilization activities at JSC within the ISS organization. The combination of selected Space Shuttle payload integration functions and the ISS payloads office would establish one interface to the research/user community, consolidate and streamline processes, requirements and documentation, and provide a unified payload integration service for current ISS and Space Shuttle platforms and to potential future launch service vehicles/providers. The new combined office would manage the resources budget for both civil service and contractor research payload integration functions with budgets being realigned to support the change. The new combined office would acquire services from Space Shuttle and ISS Programs or future launch service vehicles/providers for all utilization customers. Figure 3.1-4 shows the proposed areas for consolidation.

Consolidating functions should take six months or less. One year after the functions are combined, the HSFUB and the ISS Program Office should assess the success of this combination and the feasibility of elevating this combined function to a separate Utilization program at JSC distinct from the existing ISS and Space Shuttle Programs.

b. Rationale for Change Strategy

The payload integration processes in the Space Shuttle and ISS Programs are very similar. The Programs have streamlined these processes but additional efficiency can be realized by combining them into a single organization. By establishing the ISS Payloads Office as the customer integration office there would be one customer service office to work to gain efficiency across processes and requirements for both platforms, reduce complexity, and simplify interfaces to the user.

By combining these organizations the best part of both processes can be used to achieve maximum user satisfaction and efficiency. It also establishes a single interface to the ISS Research Institute and one interface to the HQ Human Space Flight Utilization Board (HSFUB) for all Payload Integration activities.

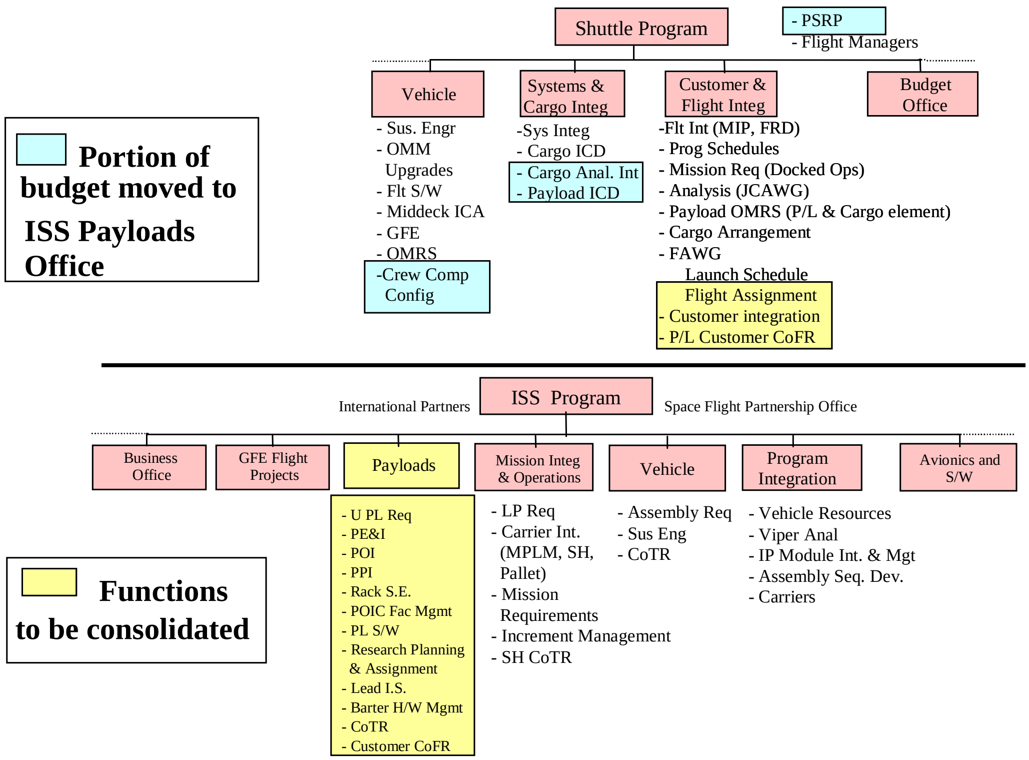

Figure 3.1-4. Proposed Areas for Consolidation

One year after the functions are combined within the ISS Program, the costs and benefits of establishing a separate Utilization program would be assessed. Establishing a new Utilization program would elevate research priority and importance within the Agency. Research/utilization would be elevated to be as important as the vehicle programs. This change would include a single Program Manager whose sole focus is Utilization. The Program would be an advocate for the research/user community and would support utilization of ISS and Space Shuttle platforms and future launch service vehicles/providers. There are significant issues and concerns associated with creating a new Utilization program. Assessing this proposed course of action should weigh any issues or concerns against the potential benefits to find the best possible solution for both the users and the ISS Program.

c. Similar Previous Study Recommendations

Time Frame	Title of Study	Recommendation
1995	Utilization, Operations, and Training Assessment Team (UOTAT)	• Consolidate all program (Station and Shuttle) and implementation functions (organizations, processes, and facilities/tools) associated with Cargo/Payload Integration and preflight testing.
1999-2000	ISS Operations Architecture Study – Cox	• A top-to-bottom Utilization Management and Implementation architecture be developed within NASA and the ISS Program to focus, organize, and streamline Utilization on the ISS. — ISS Utilization management from concept to flight results reporting needs to be ISS focused. No single Utilization organization is managing the overall research development, prioritization, hardware development and testing, mission integration, operations, and communication of results to the public.
		• Structure utilization management as part of the total program. Bring the utilization community's goal setting, budgeting/funding allocation, and decision-making processes together, under the same organizational umbrella from NASA HQ to the ISSPO and the NASA field-Center level. — ISS Utilization management from concept to flight results reporting needs to be ISS focused. No single Utilization organization is managing the overall research development, prioritization, hardware development and testing, mission integration, operations, and communication of results to the public.

d. How the Change Will Enable ISS Research Institute Success

This change strategy would provide the ISSRI with a single interface at JSC for ISS and Shuttle integration activities.

Proposed Implementation of the Change Strategy

Implementation Approach

A small team of experts from both the Shuttle and ISS Programs should develop a transition plan that includes the following:

(1) Transitioning specific work content from Shuttle to ISS. This would include products, documentation, etc.

(2) Establishing roles and responsibilities associated with boards and panels.

(3) Defining contract work content that would transition, with associated schedule and costs.

(4) Determining Changes in civil service personnel assignments.

(5) Assess one year after the functions are combined within the ISS Program, the costs, concerns, and benefits of a separate Utilization program.

The following table shows the proposed change strategy owner and senior advocate as well as some additional implementation details.

Proposed Change Strategy Owner	**Proposed Senior Advocate**	**Resources Required**	**Potential Metrics**	**Implementation Time Frame**
ISS Payloads Office Manager	ISS and Shuttle Program Managers	Civil Service and contractor personnel are required to evaluate existing contracts and documentation to support combining the Shuttle Payload Integration and Customer Interface functions within the ISS Payload Office	Customer Satisfaction, Process Efficiencies gained from combining processes	Immediately consolidate Station and Shuttle utilization activities at JSC within the Station Program. One year after the functions are combined within the ISS Program, assess implementation of a separate Utilization program.

f. Challenges of Implementing Change Strategy

Initial challenges would be identifying and acquiring the resources, both in costs and workforce, to move the work from the Space Shuttle Program into the ISS Program. Implementing programmatic changes impacting ISS and Space Shuttle during the Space Shuttle return to flight activities may prove to be problematic.

3.1.3 Change Strategy: Expand the Scope of the ISS Research Institute

a. Description of Change Strategy

The scope of the ISS Research Institute (ISSRI) would be expanded to include core functions across Enterprises for all Space Shuttle and ISS utilization payloads. Core ISSRI functions including strategic planning, advocacy, customer support, educational and public outreach, and commercial programs should be provided for all Headquarters Enterprises involved or potentially involved over time. ISSRI responsibilities should include evaluating all commercial proposals for OBPR. It's recommended that the ISSRI's role in this area be extended to include evaluating all commercial proposals for ISS or Space Shuttle use and to make recommendations for approval or disapproval with potential priority recommendation for flight to the appropriate Enterprise and disciplines. The ISSRI should support the functions of the new senior management position within OBPR as well as the new HQ Human Space Flight Utilization Board (HSFUB).

The ISSRI should provide a structured Agency entry point for all potential ISS/Shuttle research utilization customers, regardless of platform. This would result in the identification of a relevant Enterprise for potential sponsorship and the initial customer relationship with the researcher. Entry point effort includes:

(1) Identifying the appropriate relevant HQ office for the researcher from within the NASA Codes.

(2) Being responsible for establishing interface/relationship with appropriate NASA HQs sponsor (Research Codes).

(3) Providing an Agency wide utilization research/user community customer help desk to facilitate research/user community customer linkage to the appropriate NASA sponsor (Research Codes).

(4) Maintaining a utilization customer website (capabilities, current research investigations, process for initiating research with NASA, etc.).

b. Rationale for Change Strategy

The Agency is making a significant investment in defining, creating, and operating the ISS Research Institute; yet there is no Agency wide commitment to use the ISSRI for all Enterprises using the Space Shuttle and the ISS for research. With rare exceptions such as the HST (Hubble Space Telescope) servicing missions, the ISS Research Institute should represent all utilization associated with either Space Shuttle or ISS. The ISSRI would then have the total broad view of all such research and should be in a better position to represent both the total research/user community and NASA. This change would allow broader research input into utilization priorities across all Enterprises and across the ISS and Space Shuttle and assure alignment with Agency strategies and visions.

Today it is difficult for new utilization customers to find a single clear entry point into the Agency for ISS/Shuttle utilization. Allowing the ISSRI to provide a structured Agency entry point for all potential utilization customers, regardless of platform, would simplify user interfaces by providing a clear entry point and identifying potential Enterprise sponsors for their endeavor. This effort would also help utilization customers understand program requirements and capabilities.

c. Similar Previous Study Recommendations

Time Frame	**Title of Study**	**Recommendation**
1999	NRC Study	Provide the research community with a user friendly-single point of contact through which it can access the capabilities of ISS.
2002	Freedom to Manage	Create a central website location for customers to access information concerning the details of flying on the ISS, Shuttle or ELV.

d. How the Change Will Enable the ISSRI Success

This change strategy would allow the ISSRI to represent the full scope of all ISS and Space Shuttle utilization and better represent the Agency and research community. It would also provide better customer support and a clearer entry path into the process.

e. Proposed Implementation of the Change Strategy

Implementation Approach

(1) The ISSRI Procurement Development Team reviews the specific recommended changes and determines which to pursue.

(2) The ISSRI Procurement Development Team must then gain agreement among the appropriate Associate Administrators.

(3) OBPR Associate Administrator provides direction to the ISSRI Procurement Development Team.

The following table shows the proposed change strategy owner and proposed senior advocate and well as some additional implementation details.

Proposed Change Strategy Owner	**Proposed Senior Advocate**	**Resources Required**	**Potential Metrics**	**Implementation Time Frame**
ISSRI Procurement Development Team	OBPR Associate Administrator	Resources estimated by the ISSRI Procurement Development Team	Overall process metrics recommended for Change Strategy 1 are applicable.	Schedule should follow the ISSRI Procurement Development Team Schedule

f. Challenges of Implementing Change Strategy

Getting cross-Enterprise commitment to the expanded scope of the ISSRI will be a challenge.

3.1.4 Change Strategy: Agency's Approach to Commercial Use

a. Description of Change Strategy

NASA should provide a single HQ focus to assess and approve commercial utilization efforts that directly contribute to the Agency mission. This change allows the Agency's approach toward partnerships with commercial organizations that use the Space Shuttle and ISS to be integrated. It provides a NASA HQ entry point for potential commercial partners and an advocate for this class of users in Agency-level Shuttle and ISS priorities discussions.

The change does not propose changing the relationship between OBPR and Research Partnership Centers (RPC). The OBPR Enterprise would continue to be responsible for assuring the RPC activities are aligned with the overall Agency mission and goals.

The ISSRI responsibilities would also include evaluating all commercial proposals for OBPR. It is recommended that the HQ organization responsible for the commercial use consider tasking the ISS Research Institute to evaluate all commercial proposals for ISS or Space Shuttle use and have the ISSRI make recommendations for approval with potential priority for flight.

b. Rationale for Change Strategy

Today there are multiple uncoordinated efforts for creating arrangements with commercial organizations seeking flight opportunities. Given the diversity of potential users and the number of different organizations currently working and promoting commercial arrangements, it is necessary to gather all such activities in one place.

Any Space Act Agreement (SAA) that can potentially result in flight hardware would have a single place for approval and coordination. Implementing this change strategy would reduce complexity and simplify the interfaces between NASA and the commercial community. This would provide a HQ entry point for potential commercial partners and an advocate for this class of users in Agency level discussions concerning priorities for Space Shuttle and ISS payloads.

c. Similar Previous Study Recommendations

Time Frame	Title of Study	Recommendation
1999	Biological & Physical Research Advisory Committee (BPRAC)	• The NASA Administrator should address the status of commercial programs and develop standard policies and coordinate them. The assistant to the administrator for Commercial Development should have designated staff co-located in file Centers and HQ offices to facilitate communication and cooperation in all endeavors. • Commercial space development activities are increasing. These activities occur in many parts of … NASA … and lack central policy guidance and coordination;. Moreover, individual PI's increasingly seeking to establish business relationships with private sector investors with uniform guidance from NASA on appropriate legal matters such as patents, licensing, trademarks, and procurement.

d. How the Change Strategy Will Enable ISS Research Institute Success

This change strategy would provide a single interface to the ISSRI for all commercial activities. If asked to provide support for this class of payload, the ISSRI would understand what payloads have a realistic chance of flight and would appropriately apply existing resources or seek additional capability accordingly.

e. Proposed Implementation of the Change Strategy

Implementation Approach

The Office of Space Flight (OSF) would be established as the one HQ organization to integrate and coordinate all Agency activities for commercial use of the Station or Shuttle. The organization would be the HQ entry point and the advocate for this class of users in Agency-level discussions regarding payload priorities. The office would be responsible for agreements that have cross discipline aspects.

The Space Flight Partnership Office at JSC, which supports both the ISS and Shuttle Program Offices regarding commercial activities, would coordinate their efforts through this single HQ focus. OSF would be responsible for managing and governing any commercial use approach and would provide an entry point for commercial customers, when needed.

RPC activities would not change. They would remain under OBPR who would be responsible for assuring their activities are aligned with overall Agency mission, goals, and objectives.

The following table shows the proposed change strategy owner and senior advocate for the changes as well as some additional implementation details.

Proposed Change Strategy Owner	**Proposed Senior Advocate**	**Resources Required**	**Potential Metrics**	**Implementation Time Frame**
TBD by OSF Associate Administrator	OSF Associate Administrator	Civil Service resource required to be focal point	Assessment of commercial customer satisfaction.	Immediately

f. Challenges of Implementing Change Strategy

Definition of OSF, OBPR, and other Agency organizations, roles, and responsibilities related to this strategy would be a challenge in view of the current Agency approach to commercialization.

3.2 UNCLEAR RESEARCH RISK ACCOUNTABILITY CHANGE STRATEGIES

Background

The dominant risk philosophies developed within Shuttle and ISS Programs focus on crew safety as a core value of Human Exploration of Space. With this focus, the risk philosophy is appropriately adverse to failure. While this risk philosophy is appropriate for developing and operating systems to transport humans to space and sustain life in space, the philosophy should be tailored for the development of research and its associated hardware. When dealing with research risk, there should be adequate allowance for procedural flexibility and for failures in real time experimentation. Failures can be just as important as successes in testing scientific hypotheses. On the engineering side, the hardware and software must be developed in ways that do not create crew safety problems, and that maximize the time available to the crew to perform science, as opposed to equipment maintenance.

The Agency has no uniform definition for success criteria for research. As primarily an engineering organization, NASA often correlates mission success with equipment performance. With no clear Agency definition of success criteria for research, it has been left to the individual payload teams to determine what is acceptable with respect to science risk and the commensurate success criteria. It is therefore left to the discretion of each hardware development organization to determine what level of reliability and mission assurance to apply. These decisions are frequently made without considering the principal investigator's input into what level of risk is appropriate. As a result, research experiments are often driven more by engineering limitations than by science objectives. In addition, there is a substantial resistance to making changes to research on-orbit. This resistance to change is in part a result of the philosophy that any change may increase the risk of failure. By restricting the ability to make changes to research on-orbit the potential research returned by the experiment is significantly reduced. This places a higher risk of failure on the principle investigator, whose professional reputation is at stake.

Looking forward to the future, research performed on the ISS and Space Shuttle would resemble work in a modern research laboratory or major national research facility. The idea environment would be one where there is an optimization between developing the best science in a flexible environment where options are available to the PI, balanced wit the assurance that the best quality and reliability of the hardware is developed to achieve that science. The primary responsibility, authority, and risk for the research would rest with the principal investigator and the associated research team. There would be an optimization of the best science and reliable hardware and software to achieve that science. Facility personnel, hardware developers, and experiment operators would support the vision and direction of the Principal Investigator. Research teams would drive the research with the hardware development teams supporting them with reliable hardware and software that will support their science objectives with a minimum of downtime. As long as safety of the crew and the success of other companion payloads are not jeopardized, integration teams would recognize that cutting edge research is the objective and all measures within budgetary constraints should be taken to maximize the research in terms of both science yield and crew time efficiency.

There would be an Agency wide understanding of mission and research success criteria. The NASA research message portrayed to the public would be communicated in terms of these criteria, which would be consistent with other research organizations. Peer-reviewed papers and useful patents would be used to judge the success of the research. The question of “how much science was gained or lost during a mission” would be based on science outcome, not the amount of data or time allocated to the research. There would be a mix of “confirming science” that confirms a scientific hypothesis and “leap frog” discovery science/technology that changes the way humanity lives, works and explores.

The ideal on-orbit environment would be one in which the PI is responsible for the experiment operation and execution with the crewmember acting as the surrogate PI. Being a surrogate PI in orbit would require the crew to be an integral part of the research team at all stages of the research development (training, communication, development, and testing). The crew would then be better equipped to operate the experiment, handle off nominal situations, expand or repeat experiments, and take advantage of research enhancement opportunities.

The utilization process would have the flexibility on-orbit to either expand or repeat experiments. Investigators would have flexibility to change experiment direction and/or scope while in orbit. Researchers would have knowledge of and ready access to all resources available on the ISS and Shuttle platforms. Investigators would regularly communicate with other Cadre researchers to discuss common questions or trading/sharing of resources during flight operations.

The following sections will address the methodology for achieving these objectives and the individual change strategies that would result in the PI’s assuming accountability for research success.

Subteam Methodology

The following steps were taken by the Research Risk Accountability Subteam to arrive at their recommended change strategies:

(1) Reviewed data supporting the cause and effect analysis for the Research Risk Accountability problem area.

(2) Established definitions related to risk.

(3) Defined the Vision/Operational Concept (“Ideal State”) for research on NASA’s International Space Station and Space Shuttle Research Platforms.

(4) Compared the design/development processes as it relates to reliability, maintainability, risk management philosophy, documentation, reviews, and quality assurance.

(5) Established a set of risk management questions.

(6) Conducted teleconferences with Payload Developers and Principal Investigators (Commercial and NASA) on risk management and research success philosophy and practices.

(7) Conducted teleconferences with Quality Assurance Representatives at HQ, ARC, GRC, JSC, and MSFC on risk management for research experiments (Appendix K).

(8) Compared risk management philosophy to that of the oceanographic research community that has missions with similar complexity and safety concerns to NASA philosophy.

(9) Collected and reviewed Payload On-orbit anomaly data to assess differences between commercially developed payload failure rates and in-house NASA developed payload failure rates.

(10) Generated recommended change strategies.

(11) Prioritized recommended change strategies.

(12) Assessed related change strategies from past studies.

(13) Developed change strategy package.

After completing the previous steps, the subteam developed the following observations summarized from the data in Appendix K:

(1) No universal research success criteria have been established at the Agency.

(2) No consensus of accountability for the success of the research has been developed.

(3) Commercial Space Centers feel the Principal Investigator is accountable.

(4) Most NASA payload developers believe the Project Manager is accountable, with the Principal Investigator as a key member.

(5) Commercial Payload Developers and Principal Investigators believe NASA is too conservative in its risk philosophy. NASA Payload Developers and Quality Assurance feel the risk philosophy is conservative but appropriate for what we do.

(6) Both NASA and commercial developers believe the risk philosophy we have is driven by:

- High cost of space flight, so everything must work right or you may never get to fly again.
- Need for a paper trail to cover oneself if a failure occurs because the Agency reaction to failure is a painful process.
- Bad NASA publicity when failures occur.
- Because of the risk to crewmember's lives to go in space to run experiments, the experiments should work.

(7) No consistent set of standards used to design payload flight hardware. There used to be a NASA Policy Guideline (NPG), but it was deleted. Design Centers are using their own informal classification system based on that obsolete document. Practices are not consistent across design Centers.

(8) Both commercial and NASA Payload Developers endorse a "test as you fly, fly as you test" philosophy and believe what is working today works well. This exhaustive test philosophy can be used as a risk mitigation technique to balance potential reduction in payload reliability.

(9) Both commercial and NASA Payload Developers believe there is a clear distinction between safety and mission assurance and that NASA's safety processes and philosophy are fully endorsed.

(10) General perception exists that there are differences between number of reviews and documentation of Commercial projects compared to in-house projects. There appears to be at least a difference in terms of formality from Center to Center and from in-house to commercial. (Needs further investigation).

(11) Some experienced PIs do not respond to NASA solicitation because of:

- Long life cycle times (many times outliving the nominal time span of research assistants).

- Hassle of dealing with NASA (complex interface).

- Perceived lack of authority over research (including hardware development, flight operations, "operation" of grant).

(12) Enabling multiple flights for experiments/payloads would give the PI time to improve experiment protocol between missions and would enable "top-notch" science.

(13) Some external investigator feel NASA-sponsored research does not represent "cutting edge" science.

(14) There is no consensus from PIs or PDs that shorter life cycle (2 years) will increase "cutting edge" science.

(15) Lessons can be learned from other research communities, such as the oceanographic research community, that have analogous challenges with unique research platforms, human safety, federal grant funding, limited technical resources, etc. (e.g., initial safety certification then no Government oversight, PI's put hardware acquisition and modification in proposal then they are responsible for all risk management).

After developing these observations, the subteam used the data to develop a set of recommended change strategies. The two change strategies for the unclear research risk accountability area are:

(1) Principal Investigator Decision Maker for Research.

(2) Agency Research Success.

3.2.1 Change Strategy: Principal Investigator Decision Maker for Research

a. Description of Change Strategy

(1) Build flexibility into the system for the Principal Investigator to change and mature the research ideas, objectives, and direction throughout the end-to-end process.

(2) Facilitate updates and adjustments to research requirements and focus from payload selection through delivery to the launch site to the maximum extent available resources will allow.

(3) Enable flexibility for Principal Investigator to make changes in research direction based upon results to date and resources available during on-orbit operations.

b. Rationale for Change Strategy

If the ISS is to operate as a modern research laboratory or national facility it is important that the associated culture at NASA become that of a research organization. Research teams should be driving the research with the hardware development teams and the integration teams recognizing that cutting edge research is the objective. All measures (within budgetary constraints) should be taken to maximize the research, as long as safety of the crew research platform and the success of other companion payloads are not jeopardized.

The two primary motivators for success for a Principal Investigator are the investigator's reputation and the ability to fund the research environment around them. Researchers are very motivated to create successful experiments that allow them to preserve or advance their reputation and to create new winning proposals. To fully motivate the PI, constraints limiting the PI from being fully responsible for the final research performance need to be removed. Within this context, investigators would use their best judgment on changes to be made and "risk" to be taken to maximize discovery within the time (3 years for Ph.D.) and costs (grant funding) available. This requires investigators to constantly reassess the way an experiment is performing and to change direction if necessary to improve possible data collection based on initial performance.

Other federal organizations with missions of similar complexity and human safety concerns successfully allow their Principal Investigators complete control over changing and maturing their investigation with little to no input or oversight. Oceanographic research is an example that fits into this category. PI's are given the entire responsibility for research with no oversight from the National Science Foundation (NSF). PI's bid hardware as part of the proposal, NSF does a science certification, and then the entire responsibility for the research is assigned to the PI. As in spaceflight research, people in this environment also risk their lives to perform this research.

There would be several benefits to the research/user community. These include:

(1) Since the PI will be the primary decision maker on his or her experiment they will be more involved in controlling all research-related questions and trade-offs.

(2) The PI/PDs will decide what effort their experiment requires and will balance results against cost/resource options.

(3) The PI/PD can make decisions that can impact flight opportunities; such as whether or not to use crew members, degree of training required, etc.

(4) Since there will be fewer encumbrances on the PIs, there will be a greater chance of bringing more prestigious PIs into NASA, thus elevating NASA's public image.

c. Similar Past Study Recommendation

Time Frame	**Title of Study**	**Recommendation**
2000	Biological & Physical Research Advisory Committee (BPRAC) Recommendations	NASA (should) expedite the mechanism that would allow update or incorporation of changes to experimental plans within the scope of the original investigation, but without impacting the length of the flight authorization process.

d. How the Change Strategy Will Enable the ISSRI's Success

This change strategy would help the ISSRI to be a better education and outreach advocate for the Agency. If the ISSRI can tell potential researchers NASA has a flexible system that allows the research team to drive the way the research is conducted on the ISS and Shuttle platforms, then it would be easier for them to help get the research and scientific community behind NASA.

e. Proposed Implementation of the Change Strategy

A team would be established to review the decision making process during experiment development (from peer review through flight operations). The team should include representatives from the Chief Engineer's Office, OBPR UM Division, Research Integration Office (RIOs), Principal Investigators of different disciplines, MSFC Ops, ISS Payload Office, and the JSC Crew Office.

The team will develop methodology to build flexibility into the system for the PI to play a key role in the decision making including:

(1) Removing impediments that prevent investigators from being able to adjust research requirements to more fully respond to the dynamic nature of research.

(2) Taking advantage of information gained in ground testing.

(3) Gaining new insight from the literature.

(4) Changing NASA philosophy on "baselining" of requirements to allow and encourage flexibility based on science improvement without requiring a new peer review.

(5) Allowing the Principal Investigator to change and mature the research ideas and objectives within the resources available throughout the development process.

(6) Adding the flexibility to allow the PI to change research direction on-orbit in a timely manner dependent on resources available and results to date.

(7) Emphasizing throughout the payload development community that flexibility in research development is a critical element of research success and assuring project management training is modified to include this philosophy change. Investigate possibility of PIs doing the training.

(8) Include PI input in Project Manager and Project Scientist performance appraisals.

The SSUR team's proposed ownership and advocacy for the change as well as estimated resources, metrics and implementation timeframe is shown in the following table.

Proposed Change Strategy	**Proposed Senior Advocate**	**Resources Required**	**Potential Metrics**	**Implementation Time Frame**
OBPR Deputy AA for Science	NASA Chief Scientist	No resources required for pilot implementation	No absolute metric can be singled out. The publications and patents resulting after the mission and public recognition of "cutting edge" research is the desired outcome.	October 2003 through December 2004

f. Challenges of Implementing Change Strategy

The prevailing culture in the Agency is geared toward processes and policies with the researcher treated as someone that uses the system. Due to culture and processes, it is difficult for the employees in the system to add flexibility and customization into the process. Employees are accustomed to and rewarded for following processes within the system. Employees are not rewarded for generating and proposing creative ways to get more research out of an experiment.

It will be difficult to control costs if changes are allowed throughout the hardware development process and even during on-orbit operation of the experiment.

Agency culture is such that NASA employees feel accountable for the success of the research hardware and feel that they already involve the PI as much as necessary.

3.2.2 Change Strategy: Agency Research Success Philosophy

a. Description of Change Strategy

Develop new philosophy, definitions, and Agency measures for research/science success that clearly differentiate between mission success and research success.

(1) Define success in research solicitations using the external science and engineering communities' definition of research success when making presentations outside the Agency.

(2) Infuse a greater understanding of scientific practices, culture, and standards of scientific achievement in all management positions that make decisions concerning science.

(3) Educate the NASA workforce to understand research success, not just real-time engineering success, which historically has dominated the way the Agency approaches scientific investigations. It is important for the workforce to recognize that an experiment's success has multiple components and no single measurement is adequate.

(4) Select new and effective ways to communicate (both internally and externally) the progress, outcomes and successes of each mission and on the overall success of research supported by the Agency. Educate employees on this communication approach.

(5) Use new metrics at the Enterprise level to measure science success, including, but not limited to, papers, patents, citations, commercial applications, and presentations at scientific and engineering conferences.

b. Rationale for Change Strategy

Current internal confusion within NASA on the appropriate success criteria to be applied to research activities results in unclear communication both internally and externally. Internally, defined research success criteria would allow the engineering culture within NASA to better understand and appreciate the scientific approach, give NASA more pride in the science it does, and would set the stage for NASA to become involved with the "risk" for cutting edge research.

By implementing this strategy, NASA would align itself with the majority of other research organizations and would gain respect and thereby reduce external criticism. This would also be seen by the outside scientific community as a positive step and would encourage outstanding researchers to become involved with NASA.

Today, there is confusion between Payload Developers, Principal Investigators, and subsequently the Increment or Mission Scientist(s) on "Science Success Criterion." People realize that the equipment must work to obtain data for results (operational success), but usually refer to the number of samples processed or data acquired as being a measure of scientific success. This is done in part because the recognized standards of scientific achievement require time to complete and do not lend themselves to the "instant feedback" NASA feels is needed for public questions of mission success. NASA needs to discuss "operational success" and explain that science success takes time and careful evaluation. This is done in other expensive, "high risk enterprises" such as deep-sea oceanographic research, medicine, etc.

There are some specific benefits that this change would provide to the research/user community. These include:

(1) A new success philosophy will allow the Agency to benefit from accepted scientific and engineering norms of success, and in so doing promote cutting edge research. This will bring recognition to NASA and thus promote research importance to the Agency's image and thus its importance overall.

(2) PIs will be encouraged to publish "failures" as well as successes. This will allow PI's more confidence in designing their experiment and protocols, and thus encourage high-risk cutting edge research.

(3) Publications and patent awards will become the measures of success. Eliminating excessive documentation on science success, and burdensome "what is the percentage loss of science" questions.

(4) The PI can adjust science to take advantage of opportunities as long as it is patentable or publishable.

(5) Less time will be spent on developing success criterion and more on maximizing experiment success. More efficient use of the PI/PD time.

Similar Past Study Recommendation

Time	Title of Study	Recommendation
1991	Space Station Freedom Continuous Improvement Customer Support Team	Responsibility for mission success and payload success is not clearly and separately defined for customers and integrators. This is a major driver for verification, safety, and integration requirements and implementation. Not all customers are treated equally or fairly across the Agency. There is no uniformity between field Centers on standards/requirements, which are levied on customers. The Agency must define the NASA program and customer responsibilities for mission success and payload success in the form of a NASA Management Instruction (NMI) or appropriate policy directive.

d. How the Change Strategy Will Enable the ISSRI

This new recognition of research success and research risk accountability would stimulate innovation and "riskier" high payoff science payloads coming out of the ISSRI. This would increase the possibility of a breakthrough being made, both on the ground and in orbit. This distinction is made every day in research institutes. This clarification would help the ISSRI to be a more effective advocate for the outstanding research that is done at NASA. In addition, it would keep the ISSRI aligned with accepted scientific and engineering norms.

e. Proposed Implementation of Change Strategy

Implementation Approach

The following steps are required for the Agency to change its overall philosophy on research success criteria.

First, establish a small group of HQ, Center, and Principal Investigator representatives to develop the new philosophy, definitions, and Agency measures for research/science success. Establish and document a clear and consistent definition of success criteria at each level and stage of research. It is important to recognize that different organizations have a need to determine the success of the payload/mission/research in order to make decisions and take actions. However, the same criteria do not apply at each level. The success criteria definitions need to take into account: a) what phase the research is in; b) the type of decisions that need to be made based upon the established criteria; c) the audience to which the criteria would be provided; d) the need for both fundamental and applied research; and e) the type of research it wants to pursue and support. The success criteria should be defined for at least the following levels:

(1) Hardware Success: The criteria for Hardware success should be based to the ability of the hardware to perform the necessary operations in support of whatever investigations are being pursued. Safety must never be compromised and the appropriate safety requirements criteria must always ensure the safe operation of the hardware, irrespective of research and mission success.

(2) Mission Success: The criteria for Mission Success should be based on whether or not the mission was successful in providing each of the payloads with the necessary resources to operate successfully and to collect the quality data needed for each PI to complete their research. In the definition phase, the PIs and Project Managers should agree upon the success criteria for each mission.

(3) Research Success: The criteria for Research Success should be commensurate with that used in the research community. The true measure of research success should not be asked, and cannot be answered, immediately following the mission. Both Shuttle sortie and ISS increment research should be aligned with existing measures of success as follows:

- Publications, patents, and commercial applications/spin-offs.

- Quality of journals containing published research, the citations for research performed in space, the impact of patents, and determining if these discoveries make a public impact.

Second, the Agency should address the current trend for media and management to seek out clear-cut engineering answers to the question of research success. Educate the Agency to understand research success, not just real-time engineering success, which has dominated the Agency's approach to scientific investigations. In all cases, the criteria for success, according to function, must be clearly spelled out and understood by all involved.

Third, consult with experts on the best way to communicate (both internally and externally) the progress, outcomes, and successes of each mission and on the best way to communicate the overall success of research supported by the Agency. Educate employees on this communication approach. It is also important to distinguish between research for the betterment of mankind and research necessary for NASA-specific objectives, such as successful exploration.

Fourth, infuse a greater understanding of scientific practices, culture, and standards of scientific achievement in all management positions responsible for making decisions concerning science. One way to accomplish this is to select managers with stronger science backgrounds. Alternately, seminars should be conducted on scientific practices that educate management on the correct questions to ask to allow proper decisions to be made.

Fifth, define success in research solicitations utilizing external science and engineering communities' definition of research success in materials presented outside the Agency.

Sixth, develop new metrics at the Enterprise level to measure science success, including, but not be limited to, papers, patents, citations, commercial applications, and presentations at scientific and engineering conferences.

Additional implementation details are shown in the table below.

Proposed Change Strategy Owner	**Proposed Senior Advocate**	**Resources Required**	**Potential Metrics**	**Implementation Time Frame**
OBPR Deputy AA for Science	NASA Chief Scientist	No "new" cost (FTEs). Will need to prioritize among existing work force.	Patents, Publications per increment or mission.	October 2003 through April 2004

f. Challenges of Implementing Change Strategy

The results from missions will not be instantly available to put on a viewgraph and sometimes a mission's "real" success would not be known for years. This is typical of most research performed today; such as research performed in the arctic, in oceans, in forests, in physics, chemistry and in medicine. Public scrutiny would require NASA to carefully explain, and often educate the media and the public on science and the scientific process. This would require the NASA spokespersons to understand and stay current in the disciplines they are responsible for communicating achievements in.

Using the publications, patent and citation metric as an aggregate will not be straight forward and should be used in conjunction with other measures. Currently, there is no benchmark to judge the metric against, and at an aggregate level not all disciplines would be weighted equally. The scope of the research and the size of the particular research community will affect this metric.

Defining success criteria, in general and for specific missions, may be difficult and will require a great deal of negotiation to reach consensus. However, this process should become easier as everyone becomes more comfortable with the new approach over time.

3.3 RESEARCH/USER COMMUNITY CUSTOMER FOCUS SUBTEAM

Background

Developing the ISS and the Shuttle are two incredible feats of human engineering. To date, NASA's primary focus has been on the engineering and operation of these vehicles, versus the research opportunities they provide. NASA must now place equal attention on world-class space research – its relevance and its capacity to improve life on earth and enable the exploration of the universe. To achieve partnership between "research enabler" programs and the potential researchers, NASA must focus on and give priority to the ISS and Shuttle research community – its primary customer. NASA must also improve advocacy to the internal and external community, and provide a customer-focused interface throughout the research investigation end-to-end cycle.

NASA's ISS and Space Shuttle Programs should team with the research/user community as equal partners in accomplishing the Agency's vision for world-class space research using those platforms. The following change strategies based on customer focus are intended to increase NASA's focus and emphasis on research within the Agency.

Subteam Methodology

The customer focus subteam evaluated the customer feedback data and integrated past studies data for common themes. Data was also collected from face-to-face meetings with multiple focus teams, and by interviewing individual stakeholders.

The team reviewed the Agency, Enterprise, ISS, and Shuttle high-level plans and mission statements to determine the degree of emphasis placed on the research/user community as well as the focus on their users as the primary customer. The team also identified Programs recognized for successful customer relations (ELV, Spacelab) to evaluate strengths that could be applied to the ISS Program and implemented as part of the ISS Utilization. The Customer Focus Team evaluation resulted in two primary change strategies:

(1) Emphasize the Agency's Focus on Research.

(2) Improve Research Advocacy.

3.3.1 Change Strategy: Emphasize Agency's Focus on Research

a. Description of Change Strategy

A major paradigm shift is needed in the Agency's focus on research to better attract and retain world-class researchers and to grow U.S. advocacy for space-based research. To be successful in "implementing" this paradigm shift, all Agency levels and Programs need to focus on the utilization research customer as their primary priority. A key objective should be to make the ISS/Space Shuttle research flexible and more responsive to the needs of the research community, thus creating an environment that is most conducive to "cutting edge" research, that most benefits the researchers' and that strengthens NASA's role as a provider of world-class researcher. Recommended steps include:

Part 1

(1) Strengthen and communicate the Agency high-level plans to place greater emphasis on the research/user community as the customer. Flow down implementation throughout the Agency.

(2) Emphasize research/user community customer satisfaction in performance plans of AAs, Center Directors, and the ISS and Shuttle Program Managers versus the current emphasis on internal customers.

(3) Give strong consideration to the research/user community's requirements and concerns in all research platform deliberations; and communicate decisions and rationale for those decisions impacting the research/user community to the research/user community.

Part 2

(1) Reinforce emphasis on research/user customer satisfaction by providing significant awards and incentives to employees (NASA or Contractor) who exemplify outstanding research customer support on Shuttle and Station.

(2) Increase awareness and encourage nominations of Station and Shuttle Principal Investigators and Co-Investigators whose research efforts contribute significantly to Agency goals and objectives. Examples are Agency-level awards such as Public Service Medals, Exceptional Scientific Achievement Medals, etc.

Part 3

(1) Increase time for crewmember research training and allow more time for direct interface with research team during pre-flight preparation. One method may be to assign crewmembers earlier.

(2) Promote crewmember rotational assignments for skill-based training in Agency research areas and encourage crewmember participation with the PIs as potential joint authors on publications when appropriate.

(3) Increase and expand on-orbit opportunities for communications between PI/PD and crew (science conferences, troubleshooting, etc.).

(4) Identify research skills needed and fill the skills gap through skills training, new crew selection, and inclusion of non-career astronaut researchers in flight crews.

b. Rationale for Change Strategy

The above steps to emphasize the Agency's focus on research are critical to strengthening NASA's partnership with the research community and achieving the vision of world-class research on NASA's space platforms. These steps would elevate the research utilization customer importance to the level of ISS and Space Shuttle vehicle operations and engineering.

They are also expected to result in a broader constituency in the U.S. research community (scientific, technical, commercial, educational), much stronger university partnerships, and increased U.S. advocacy for space-based research.

Additionally, increasing the direct involvement of the crew with the experiment hardware development and training would significantly improve research on-orbit output. More direct involvement of the crew throughout the payload development process, embracing more opportunities for more crew to PI/PD communications, and increasing skills-based research training would pay dividends in terms of outstanding research. These measures would improve research advocacy to the external community and attract world-class researchers to use the ISS.

c. Similar Past Study Recommendations

Time Frame	**Title of Study**	**Recommendation**
1991	SSF Continuous Improvement Customer Support Team	Implement a customer survey process in each integration organization to measure customer satisfaction.
1999	ISS Ops Architecture Study – Cox	Increase the number of available crew hours devoted to research. This effort should target 70% as that desired for research with a 7-person crew. To increase the effectiveness of in-flight research, NASA should use science astronauts.NRC Study – 1999 – NASA should consider adopting the Spacelab payload specialist model for ISS.
1999	NRC Study	NASA should consider adopting the Spacelab payload specialist model for ISS.
2002	Freedom to Manage (F2M)	NASA HQ to host customer forum to present status, changes and improvements to customer access for flying payloads on ISS, Shuttle and ELV.
2002	Salzman Findings	Lack of commitment to ISS as a world-class International research facility.
2002	JSC Customer Needs Assessment	ISS is building hardware – not doing science. Need more astronaut time for science. Science needs much more serious consideration. ISS Payloads Office needs to be more responsive and more customer-oriented.
2002	Cocoa Beach User Workshop	2002 Consider incentives/disincentives for improvements (not just change).
2003	Focus Group	Science Officer more than just a crew. Time to devote to science before flight.

d. How the Change Strategy Will Enable the ISS Research Institute

The initiatives in this change strategy would create the positive environment necessary for successful research partnership, thereby enabling the ISSRI's success.

e. Proposed Implementation of the Change Strategy

(1) Part 1: Emphasis on research/user community.

Implementation Approach

- Add an element to the performance plans of AAs, Center Directors, and the ISS and Shuttle Program Managers to emphasize research/user community customer satisfaction.

- Establish a plan with the ISS Program Manager to emphasize the research/ user community as a customer within the ISS Program (e.g., Principal Investigator presentations to engineering organization, rotate engineers through PI sites, add engineers to increment research teams).

- Develop an effective mechanism within the ISS and Shuttle Programs to identify, formally assess, and communicate the impact of changes of vehicle capabilities and/or accommodations that affect the research/user community.

The following table shows the proposed change strategy owner and senior advocate as well as other implementation details.

Proposed Change Strategy Owner	**Proposed Senior Advocate**	**Resources Required**	**Potential Metrics**	**Implementation Time Frame**
NASA Chief Scientist	OSF and OBPR Associate Administrators	None	Improved ratings in Customer Satisfaction Survey	One year beginning in FY04

(2) Part 2: Awards and Incentives for Research.

Implementation Approach

- Establish an "Outstanding Research/User Community Customer Service" Award at the Agency level for ISS and Shuttle research utilization.

- Increase awards to Principal Investigators and Co-Investigators.

The following table shows the proposed change strategy owner and senior advocate as well as other implementation details.

Proposed Change Strategy Owner	Proposed Senior Advocate	Resources Required	Potential Metrics	Implementation Time Frame
OBPR Deputy AA for Science	OBPR Associate Administrator	Resources required for awards.	Number of candidates submitted for the outstanding research/user community customer service award and the Principal Investigator/Co-investigator award.	One year beginning in FY04

(3) Part 3: Crew Emphasis on Research.

Implementation Approach

- Ensure U.S. ISS Commander communicates that research is an important component of the Increment's success.
- Develop strategies to allow increased time for crew member research training and have a more direct interface with research team pre-flight, both near-term and long-term.
- Establish a mechanism for research/user community representatives (i.e., ISS Program Scientist, OBPR Deputy AA for Science) to have input into Science Officer selection.
- Include crewmember rotational assignments for skill-based training in Agency research areas as part of formal training plans. Encourage crewmembers to work with the Principal Investigators as potential joint authors on publications, as appropriate.
- Modify processes to increase on-orbit opportunities for communications between Principal Investigators/Payload Developers and crew.
- Identify time-phased research skill needs and training needs for flight crews. Perform gap analysis of current skill and training base against needs; fill gaps via skills-based training, new astronaut selections, and inclusion of non-career astronaut researchers in flight crews.

The following table shows the proposed change strategy owner and senior advocate as well as other implementation details.

Proposed Change Strategy Owner	Proposed Senior Advocate	Resources Required	Potential Metrics	Implementation Time Frame
ISS Program Scientist and the Crew Office	OSF Associate Administrator	Resources required for crew member travel	Non-career astronauts selected for flight Crew members involved in research training and rotational research assignments	October 2003 - March 2004

f. Challenges of Implementing Change Strategy

With other high priority issues facing the Agency, including Space Shuttle return to flight, completion of ISS assembly, and development of the Integrated Space Transportation Plan, it will be difficult to focus Agency attention on the importance of strengthening ISS utilization. Partnership with the research/user community (the customer) is recognized as essential to achieving longer term ISS Program success and cutting edge discovery science. However, without near term Agency emphasis and commitment to research effort beyond the narrow confines of the current NASA utilization supporting elements, the necessary research infrastructure and customer base required to take full advantage of the research environment created by the research platforms will not exist.

3.3.2 Change Strategy: Improve Research Advocacy

a. Description of Change Strategy

Establish and implement a plan for research advocacy that dramatically increases emphasis on ISS utilization to meet the Agency research objectives implemented by both the Research Codes and the ISS and Space Shuttle Programs. This would require increasing available resources at NASA Headquarters and the Field Centers, incorporating messaging and other professional skills, and better utilizing and training NASA's "advocacy corps" to promote space based research. The plan should also integrate the outreach capabilities of the NASA Public Affairs Office (PAO), the Research Codes, the ISS and Space Shuttle Programs, and the ISSRI to communicate the relevance of research on ISS and to highlight significant research achievements and spin-offs throughout NASA, the research community, and the general public.

b. Rationale for Recommended Change Strategy

Implementing this change strategy would dramatically improve the communication of NASA's research relevance, accomplishments and spin-offs within NASA, the research community and the general public. It would provide NASA with the capability to reach out and advocate for the research/user community, recognizing that they are NASA's customers. In addition, it should clearly communicate and distinguish the unique roles of space-based research facilitated by the launch vehicle and enabled by the research platforms (ISS and Space Shuttle), and emphasize collaboration between research and vehicle programs. The plan should also integrate and appropriately distribute the research advocacy functions, each with their required emphasis (HQs Research Codes, OSF/ISS/SSP/Crew, PAO, PIs, Field Centers/RIOs,) to provide the resources and capabilities necessary to achieve advocacy – dollars, structure, skills, materials and training.

c. Similar Past Study Recommendations

Time Frame	Title of Study	Recommendation
1991	SSF Continuous Improvement Customer Support Team	No coordination across codes and Programs. No consensus on goals – internal and external. Communicate this consensus to the customer – administration, Congress, research community, public.
1999	ISS Ops Architecture Study- Cox	Research and experiment success not emphasized or properly prioritized within the ISS Program. Give science an advocate.
2002	Cocoa Beach User Workshop	No outreach; US public doesn't know about ISS research. Public outreach is horribly lacking. …but its relevance (ISS research) is not communicated effectively to the public. Need for the NGO (ISSRI) to be an advocate for the user. PIs are in best position for outreach…should spend more time and money on this, possibly hire a firm to publicize the results of research.

d. How the Change Strategy Will Enable the ISSRI

The ISSRI should play a complementary role in implementing NASA's advocacy approach with the broader research community, the public, and with respect to Congress.

e. Proposed Implementation of the Change Strategy

Implementation Approach

(1) Establish a team to develop an integrated advocacy approach for research conducted on the ISS and the Shuttle. Integrate this process team with the newly formed ISS Communication, Education, and Outreach Working Group. The team should address:

- Development of pre-mission and post-mission presentations and other advocacy materials to use both external and internal to NASA.

- Establishment of a web site link to
  http://iss- www.jsc.nasa.gov/ss/issapt/issprogram/.

- Education of NASA employees on research utilization importance.

- Integration of science and vehicle outreach (i.e., joint briefings).

- Assignment of Field Center who can deliver the research message.

- Implementation budget to hire outside firm with messaging skills.

(2) Obtain necessary expertise to implement an on-going hard-hitting campaign, both within NASA and through the mass media.

(3) Identify key positions within the Research Codes, the research community, and the ISS/Shuttle Programs responsible for advocacy; involve key personnel as advocates (Crew, Principal Investigator, Chief Scientist, Program/Project Manager, etc.) and have them disseminate the research message at appropriate venues.

(4) Take advantage of the ISSRI's status to complement research advocacy.

(5) Implement the approach across the Agency.

The following table shows the proposed change strategy owner and senior advocate as well as other implementation details.

Proposed Change Strategy Owner	**Proposed Senior Advocate**	**Resources Required**	**Potential Metrics**	**Implementation Time Frame**
OBPR Special Assistant for Change Management with support from the ISSRI and NASA PA	OBPR Associate Administrator	Resources required to contract message skills.	Annual utilization customer satisfaction	Two years beginning in FY04

f. Challenges of Implementing Change Strategy

The challenges in implementing this strategy include obtaining the appropriate budget to implement an integrated research advocacy approach and proactively engaging all Agency elements and Programs, including the Research program Offices, the ISS, and Space Shuttle Programs in research advocacy.

3.4 INSUFFICIENT UTILIZATION CAPACITY

Background

The resources that the ISS and Shuttle currently provide do not meet the needs of the research/user community. This imbalance is, in part, due to the planned schedule for ISS assembly not being met. Selected flight research attuned to the original ISS assembly buildup schedule already exceeds present capability. This over subscription would be further aggravated by Shuttle return-to-flight modifications resulting from the Columbia investigation.

It is envisioned that future ISS and Shuttle research system capabilities and research timelines will approach those of cutting-edge ground-based research. NASA will have a robust transportation system with options assuring projects are launched and returned on schedule. NASA and the research community would plan and execute projects based on budget projections that remain stable from year to year. The following sections address the methodology for achieving these objectives and the individual change strategies that, when implemented, would enable NASA to provide a utilization capacity more nearly aligned with the current and projected future needs of the research/user community.

Subteam Methodology

The subteam reviewed focus group inputs and customer feedback to identify potential change strategies. In addition, the NASA Comptroller's Office was interviewed and NRC reports were reviewed to understand budget drivers and impacts. To determine both the timing and magnitude of various past major budget perturbations which have affected Shuttle and ISS payloads and/or Principal Investigators (PI), informal discussions were held with project managers and NASA budget experts. To place the entire process in context, schedule changes in availability of core ISS science capabilities, delays in ISS Program buildup, and Shuttle stand-down data were collected.

NASA's strategies for future access to space were reviewed through meetings with the Integrated Space Transportation Plan (ISTP) manager and through briefings from the OBPR Mission Integration Office. As part of this effort, user requirements for access to space as determined by the ISS Utilization Operations Panel and through Shuttle secondary payload requirements lists, were reviewed. To assess new ways to optimize the current resources for users, the subteam also attended several briefings on optimizing manifests through a market based manifesting approach. From these considerations, three change strategies were developed to address insufficient utilization capacity problems:

(1) Increase Utilization Funding Stability.

(2) Alternate/Supplemental Space Access.

(3) Manifest Optimization.

3.4.1 Change Strategy: Increase Utilization Funding Stability

a. Description of Change Strategy

This recommended change strategy consists of developing and implementing a strategy and plan to increase funding stability at all levels, including options such as:

(1) Working with Congress to allocate multi-year funding for NASA.

(2) Working with Congress to request that earmarks are accompanied by additional funding.

(3) Mitigating the impact of new Agency policies and procedures on ongoing projects by providing funding for the changes or exempting existing projects.

(4) Evaluating alternatives that would result in more funding stability.

(5) Establishing a better overall process for grant management. Examples include:

- Fully fund selected research proposals consistent with peer review recommendations.
- Cost grants at the time of obligation on a yearly basis.
- Establishing a policy that research grant funding would not be reduced once the grant is awarded unless there is lack of performance or significant changes in enterprise priorities.

b. Rationale for Change Strategy

Funding instability problems range from the uncertainty in year-to-year funding to unexpected "small" percentage cuts across broad program areas. Top-level budgets can vary over time depending on decisions by Congress and OMB. Unfunded earmarks take a toll that seems to increase with time. NASA has, on occasion, exacerbated utilization funding problems with internal decisions regarding programmatic and Enterprise-related issues.

Total research output is reduced by the amount of resources spent on replanning, redesign or downsizing of facilities, and extension of contract duration due to the changes. Budget problems and launch delays can increase the end-to-end timelines for research execution by extending the time required to design and develop the payload.

NASA needs to support the research community with consistent funding for researchers and for projects selected through standard processes such as NASA Research Announcements. Within NASA, management decisions with the best of intentions, e.g., implementation of NPG 7120.5 project management procedures and ISO 9000 quality records can materialize as "unfunded mandates" to a project manager struggling to stay within budget and on schedule. NASA should consider if it is appropriate to either provide funding for these additional requirements or exempt some or all aspects of existing projects.

Budget instability can never be completely avoided, but NASA history shows delays and schedule hits are the norm. A top-management initiative to address the problems would have positive benefits even if some aspects are not fully successful. Funding stability would improve the end-to-end cycle time because many of the delays in the current system are caused by holds resulting from funding problems.

c. Similar Past Study Recommendations

Time Frame	**Title of Study**	**Recommendation**
2000	Biological and Physical Research Advisory Committee (BPRAC)	• The Committee noted a number of issues that are negatively affecting PI morale including low selection rates for funding, a shortage of flight opportunities, de-selection of flight experiments, and a recent 5% cut to all ongoing OBPR investigations. Such practices discourage new investigators from applying to the program and alienate established investigators. • Stabilize ISS Research – now that lab is on-orbit NASA should stop the deferral of scientific/experiment hardware funding and stabilize the funding to ensure ISS research facility development and deployment. • OBPR should provide sustained support of ground-based and flight research in order to foster the growth of a cadre of investigators who will bring forward the mission of the new Enterprise. OBPR funding rates must be made competitive with those of other federal Agencies. • Research Vision Support – NASA should improve its grants management service in: (a) stability and magnitude of funding, (b) streamlining its review procedures, (c) firm commitment to timelines for releasing NRA's, funding and activation of grants, and (d) improving its relationship with academic and commercial grants management offices.
2001	Biological and Physical Research Advisory Committee (BPRAC)	• The committee expressed concern focused on protecting and restoring the ISS research budget, the reductions impact on various disciplines, effect of cancelled or delayed research facilities and impact of 3-person crew. Further, NASA should perform a cost-analysis study to determine the feasibility of using such middeck locker reconfigurations vs. that of continuing to develop facilities at a slower completion timetable.

d. How the Change Strategy Will Enable the ISS Research Institute

The ISSRI can develop a more stable plan if there is less worry about impacts to their planned budget. New researchers are more likely to participate in space research if the system has a reputation for stability and productivity.

e. Proposed Implementation of Change Strategy

Implementation Approach

The recommended approach is to establish a team as described below. The team should review actions recommended here, survey for other funding stability ideas, and establish task teams for each action area. Team membership should include:

(1) Deputy Financial Officer, Chairperson.

(2) Comptroller.

(3) Office of Legislative Affairs.

(4) Chief Engineer.

(5) Office of Biological and Physical Research.

(6) Research Integration Office (RIO) from a NASA Center on a rotating basis.

The following table shows the proposed change strategy owner and proposed senior advocate as well as some additional implementation details. The Team should review the metrics recommended in the table below, establish the best metric(s), and include that assessment in an early brief to the Enterprise Council.

Proposed Change Strategy Owner	Proposed Senior Advocate	Resources Required	Potential Metrics	Implementation Time Frame
Deputy Chief Financial Officer	Deputy Administrator	Civil Servant resources required the team to participate in plus travel for the Research Integration Office representative	Percentage change in planned versus actual budget for research programs. (Negative is bad, zero is acceptable, positive is better.) Number of grants that are fully funded.	Start immediately. Continue until Enterprise Council determines that the implementation is satisfactory – approximately two years.

f. Challenges of Implementing Change Strategy

Developing new long-term budget agreements with Congress and the Office of Management and Budget (OMB) is very difficult.

Providing supplemental funding to mitigate the impact of new internal NASA initiatives would make the initiatives more expensive. Decisions on which projects deserve supplemental funding would also be difficult.

Full funding of research proposals may result in a lower total number of research grants and this could be unpopular with the research community and their supporters.

Costing of grants at time of award will require a revision in the way NASA has typically done business and may require significant changes to sections of the financial software.

3.4.2 Change Strategy: Alternate/Supplemental Space Access

a. Description of Change Strategy

This recommended change strategy focuses on adding research accommodation emphasis to the ongoing Integrated Space Transportation Plan (ISTP). The team recommends that OBPR work with the ISTP team to assure that utilization requirements are thoroughly considered in the ISTP trade space analysis. The ISTP should assure that space access and earth return capability provided is robust enough to accommodate the requirements of the research/user community during nominal times and through stand downs.

The ISTP should include a detailed assessment of the capability to meet and exceed Utilization Operations Panel (UOP) requirements for crew time for on-orbit research, upmass, downmass, middeck lockers, etc. This should include assessments of: access capability against the currently identified UOP requirements; reassessment of both ISS and Shuttle utilization requirements in light of the Columbia Accident Investigation Board findings, recommendations and return-to-flight modifications; and potential demand for future ISS and Shuttle utilization including science, commercial, education, DoD, and others.

The ISTP should also assess options for providing additional Expendable Launch Vehicle (ELV) cargo delivery to/from the Space Station. The ELV cargo capability would provide needed upmass delivery to the ISS without additional dependence on crewed vehicles. This should include an assessment of the ability to accommodate middeck lockers that require powered transport and early or late access. Near-term solutions to upmass and downmass capability should be proposed by the end of 2003. In addition, a technical assessment of the secondary impacts to users, e.g., changes in payload interfaces and launch support systems for an ELV as compared to the Space Shuttle, should be conducted.

Because cargo return capability is a potential limitation to the use of ELV cargo transportation vehicles, an initiative to conduct a critical review of utilization downmass requirements should be conducted. Current downmass "requirements" are based on the assumption that return capability is built in to the system (Space Shuttle return flights) and that on-orbit utilization equipment disposal is not possible or cost effective. In the 2004 time frame the ESA Automated

Transfer Vehicle (ATV) would provide disposal capability, although it cannot not handle very large structures, such as a full truss site payload. Alternatively, an ELV cargo vehicle could be designed to include a return capsule. A trade should be done between the cost of ELV cargo return capability and the cost of on-orbit equipment disposal.

b. Rationale for Change Strategy

Within NASA, the design of new space transportation systems has typically emphasized future vehicle design options, incorporation of new technologies, or support of future NASA missions such as exploration, rather than research requirements. Incorporating research requirements should be a standard part of vehicle concept definition if research is a part of the rationale for the vehicle and projected future vehicles should consider potential growth of research requirements in addition to current requirements.

The current Space Shuttle system provides a single-string U.S. capability with no U.S. vehicle redundancy to ensure ISS utilization mission success over the life of the ISS. When unexpected events delay or suspend Shuttle launches, the U.S. has no alternative methods for sustaining the planned human research activities on the ISS. Without alternative methods to get the research into space, NASA can't meet the expectations of the research community and this causes a loss of advocacy for NASA's research on ISS and Shuttle. Current and future expendable vehicle capabilities of our international partners can alleviate the problem but cannot sustain a robust research program during a long Shuttle stand-down and cannot completely meet the requirements of payloads that are designed to fly in the Shuttle middeck.

c. Similar Past Study Recommendations

Time Frame	**Title of Study**	**Recommendation**
2000	Biological & Physical Research Advisory Committee (BPRAC)	"The Committee noted a number of issues that are negatively affecting PI morale including low selection rates for funding, a shortage of flight opportunities, de-selection of flight experiments, and a recent 5% cut to all ongoing OBPR investigations. Such practices discourage new investigators from applying to the program and alienate established investigator."

d. How the Change Strategy Will Enable the ISSRI

Stable access to the ISS would facilitate the ISSRI's mission planning tasks, assuring that ISS utilization can continue even during a Space Shuttle stand-down. Alternate/supplemental space access would facilitate the ISSRI's support of ISS utilization and provide assurance of continued research capability.

e. Proposed Implementation of Change Strategy

Implementation Approach

The change owner, with advice from senior management, should develop a plan incorporating inputs from OBPR, OSF, and other Enterprises, as appropriate. The following table shows the proposed change strategy owner and senior advocate as well as additional implementation details.

Proposed Change Strategy Owner	**Proposed Senior Advocate**	**Resources Required**	**Potential Metrics**	**Implementation Time Frame**
OBPR Division Director, Mission Integration	NASA Space Architect	Resources are required for a six-month contracted study plus Civil Service FTEs to work with contractor to identify research/user requirements.	The percentage of ISS requirements that are met each year.	The requirements study and inputs to the ISTP should be completed by the end of CY 2003 unless the related ISTP study is extended. In the latter case, the change strategy date should be extended. The technical assessment of secondary impacts to users should be started concurrently with the ISTP study and completed soon after the ISTP study is finished. The change strategy owner should follow the progress of the subsequent vehicle study and development phases, providing inputs as required to see that research requirements are met or exceed as appropriate.

f. Challenges of Implementing Change Strategy

NASA may find it difficult to support expendable vehicle technology systems for alternate/supplemental access to the ISS in addition to the resource demands of return to flight for the Space Shuttle.

3.4.3 Change Strategy: Manifest Optimization

a. Description of Change Strategy

In light of current resource constraints, alternate approaches allowing optimization of ISS manifesting need to be assessed. This should include assessing the feasibility of an approach to manifesting which incorporates an end-user bidding process and a tool for rapid assessment of resources. The assessment should review options for a market-based approach to current ISS and Shuttle manifest process, where “rights” and “trades” are used to resolve conflicts through a bidding approach to resources. Comparison of science value for a simple ranking vs. a market-based approach would need to be assessed as part of this change strategy.

b. Rationale for Change Strategy

Today, optimization of the manifest is done manually. NASA Headquarters Enterprise Divisions and Research Integration Offices (RIOs) establish manifest priorities. Users do not have much insight to trades, which are usually performed by the RIOs at the Research Program Working Group (RPWG). Manual allocation of resources is generally time-consuming (roughly 2-4 months to generate an increment manifest). When changes occur on either the system or the research side, a time consuming manual process is used to develop a new manifest.

With a market-based system appropriately implemented, the change strategy would move the decision making process back to the individuals that have the most information, and closer to the end user or the user's representative (e.g., PI, PD, or RIO). Users "own" clearly defined resources and decide which resources are more important. Users exchange resources among themselves to enhance their own position. Users could be provided with a number of bids, based on their prioritization. Electronically based systems on the Web could be globally distributed. They would also remove the need for multiple meetings and appeals and allow rapid assessment of resource trades. This would allow Principal Investigators to make their own resource trades based on evolving needs. The process could also eliminate or reduce third party negotiations and associated meetings and appeals. Finally, if such a change proved capable of providing these benefits, it would also hold the potential for increased flight opportunities.

c. Similar Past Study Recommendations

None.

d. How the Change Strategy Will Enable the ISSRI

The ISSRI would be involved with prioritization and would have an interface with this tool.

e. Proposed Implementation of Change Strategy

Implementation Approach

The first part of implementation would require assessing existing tools. A cost benefit assessment would be conducted. As part of this assessment, to determine if a percentage increase of research throughput is achieved with the implementation of the tool verses the manual process, requirements would be established and past manifests used to run test cases where end users bid.

If such a tool is feasible, the second part of implementation is to run a pilot to work out problems and fine-tune the process. The pilot would run in parallel with the manual process. Full implementation would occur after a successful pilot is demonstrated. Team members included in the overall assessment of this tool would be assigned from all of the Research Integration Offices, and several external payload investigators, as well as the ISS Payloads Office.

The following table shows the proposed change strategy owner and senior advocate as well as some additional implementation details.

Proposed Change Strategy Owner	**Proposed Senior Advocate**	**Resources Required**	**Potential Metrics**	**Implementation Time Frame**
JSC ISS Payloads Office Manager	ISS Program Scientist	The feasibility study will require civil service and contractor FTEs. If a tool is required, both tool development and sustaining resources will be required.	The percentage of increased throughput associated with automated market-based tool versus a manual process. Time to establish and change manifest. Optimization level of manifest. Customer satisfaction.	The assessment should be performed in 2003/2004, with a full implementation to occur after pilot, if successful.

f. Challenges of Implementing Change Strategy

Implementing a concept like this could be costly. Clearly, a cost-benefit analysis and a parallel demonstration would need to be performed to determine percentage of additional science throughput that could be achieved by implementing this change strategy. The system would need to be "smart" enough to factor-in carrier requirements and balance those across multiple users bidding to fly.

Allowing the end users rather than the research integration offices to bid for their own resources is a challenge. Traditionally, the Research Integration Offices have done this bidding. Determining how bids would be allocated and whether International Partners would bid based on allocation through international agreements or whether their input would be integrated manually will all be difficult.

3.5 END-TO-END CYCLE TIME TOO LONG

Background

The current process for bringing an investigation to flight is unclear and inconsistently applied. In general, there are no defined templates for the entire end-to-end process and what is defined is not specifically tailored for the individual investigation. The current nominal template for a pressurized subrack payload shows that the entire end-to-end process is approximately eight years and that the time from proposal submission to post-flight data and hardware return to the Investigator is approximately six years and three months, twice as long as that of the SSUR Vision (figure 3.5-1). The external research/user community is frustrated with the long cycle time and NASA is losing research/user community advocacy by being nonresponsive.

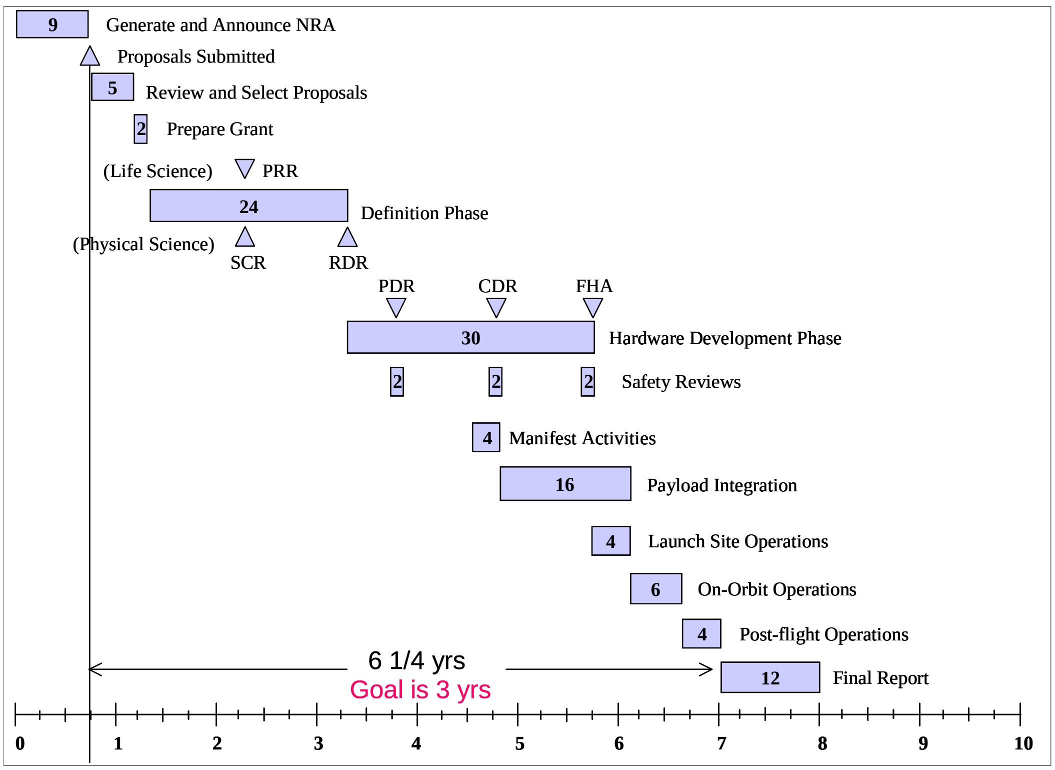

Figure 3.5-1. SSUR Proposed End-to-End Process Flow

In the future, the vision is for the ISS and Shuttle research system capabilities and research timelines to approach those of cutting-edge ground-based research. The end-to-end research process would be tailored to the investigation, flight project development would be expedited by mature research proposals, and the end-to-end process would be continually improved and streamlined. To meet requirements such as graduate student and commercial product development cycles, the process - from proposal submission to NASA's delivery of flight data to the investigator - can be accomplished in three years. Selected-for-flight to ready-for-launch can be accomplished for many payload types within a 12-month cycle.

Subteam Methodology

A number of the past study recommendations and focus groups identified a common frustration within the research/user community, that the end-to-end cycle time is too long. To quantify the average cycle time and to determine the reasons for the extended cycle time, two major efforts were undertaken. The first was formulation of the end-to-end process flow, or Program Evaluation and Review Technique (PERT), chart for a typical medium-complexity pressurized subrack payload. The first observation from this task was that the end-to-end process had not been previously documented; only the Integration Phase for both ISS and Shuttle had a predefined template. To develop a process flow, documented processes from GRC, ARC, MSFC, JPL, JSC and KSC were reviewed and a number of Research Integration Office representatives and payload developers were interviewed. This effort highlighted the fact that each discipline operates to different processes and variability within each discipline is the rule.

Once the overall process flow was completed, durations for each task were determined through discussions with the experienced members of the team. The timeframe from proposal submittal to post-flight data /hardware return was selected for the end-to-end process as this represented the research/user community's view of the time interval controlled by NASA.

The second major effort was to collect and analyze actual cycle time data for payloads that are either complete or are currently in the system. This cycle time data was not readily available and had to be pieced together from data collected by individuals at GRC, ARC, MSFC and KSC. The historical data collected represented approximately 60 different payloads dating back to 1991; however complete end-to-end cycle time data were only available for a total of 11 payloads. The other 49 payloads had data for only a portion of the overall process. For each phase in the process, the average, best and worst case was determined, and presented in figure 3.5-2.

These data were then compared to the template timelines determined previously. This comparison is shown in figure 3.5-3. The biggest difference between the developed template and average timelines (best and worst case) was found to occur in the definition phase. An assessment was performed to determine the drivers for the extended cycle time. Factors contributing to this extended cycle time include: research proposal maturity, funding instability, assembly sequence slips, reduced flight rate in 2001, and unexpected Shuttle launch delays (figure 3.5-3).

To potentially reduce the definition/development phase duration, the feasibility of a concurrent engineering process was considered. The team toured the JPL Payload Design Center. Representatives from Team X, Advanced Project Design Team, and Team I, Optical Instrument Development Team, briefed the SSUR team and discussed the PDC concept's applicability to the Utilization payload development process. It was noted that other applications of the concurrent engineering process exist at other NASA Centers and were worthy of study.

	Average (Months)	Best Case (Months)	Worst Case ((Months)	Standard Deviation (Months)	Number of Data Points
Proposal – Grant	**6**	**2**	**14**	**3**	**23**
Definition (Complete)	**26**	**6**	**79**	**19**	**37**
Definition (In Progress)	**68**	**N/a**	**162**	**33**	**15**
Development (Complete)	**12**	**1**	**57**	**15**	**12**
Development (In Progress)	**37**	**N/a**	**55**	**12**	**4**
FHA – Launch (Complete)	**22**	**8**	**31**	**9**	**10**
FHA – Launch (In Progress)	**22**	**N/a**	**31**	**9**	**10**
Grant – Launch	**48**	**28**	**100**	**22**	**11**

Figure 3.5-2. Cycle Time Data

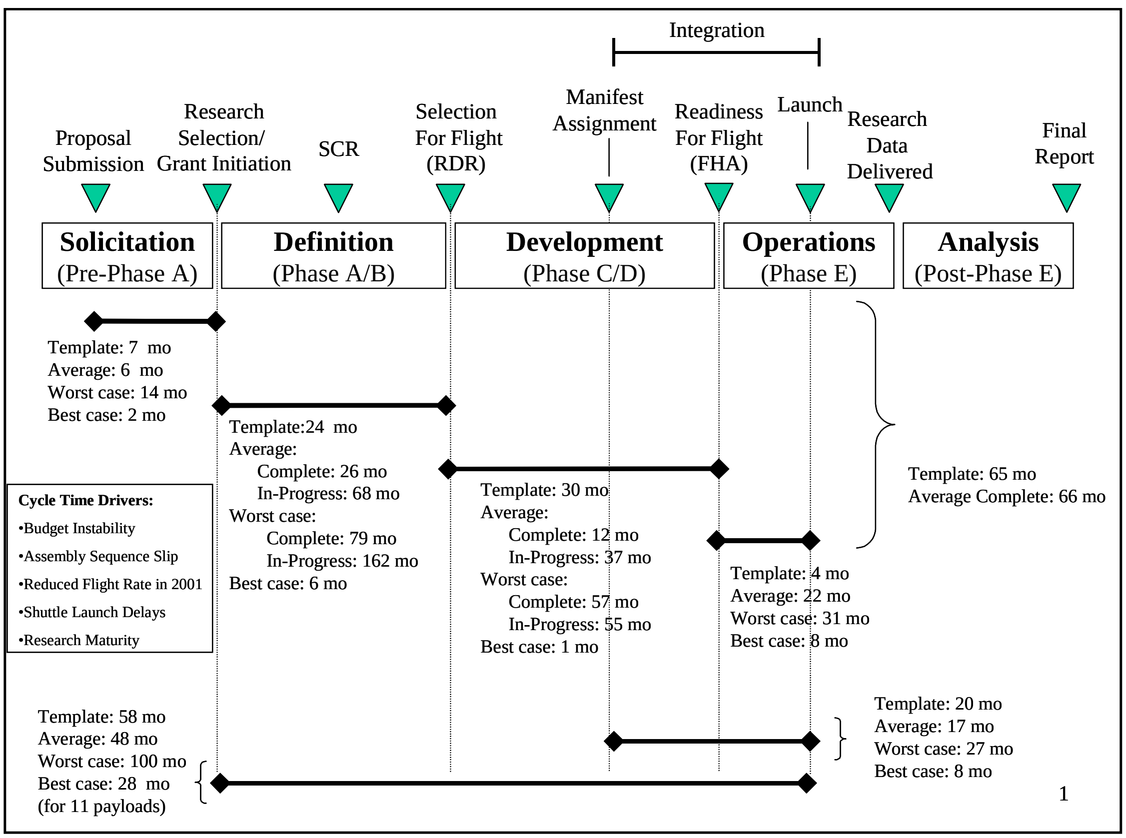

Figure 3.5-3. Comparison of Cycle Time Deviations From Template

In addition, Principal Investigator/Payload Developer feedback from focus groups, previous studies, and survey data were reviewed to establish factors driving end-to-end cycle time. Process complexity was identified as a key driver associated with cycle time. This resulted in subteam review of ongoing process improvement activity in the ISS Payloads Office to determine if this effort was adequate to improve overall cycle time.

As a result of these activities, the following change strategies were formulated:

(1) Maturity of Proposals.

(2) Timelines Tailored to Experiment with Payload Classification.

(3) Reduced Process Complexity.

(4) Concurrent Payload Development and Integration.

3.5.1 Change Strategy: Maturity of Proposals

a. Description of Change Strategy

This change strategy discusses the steps necessary to ensure the Agency selects investigations that have sufficient maturity to warrant selection for space flight.

A mature proposal should be defined as one where the project will reach the end of the formulation phase within a year of selection. Proposals that lack this maturity of definition could be selected for ground-based maturation if the science merits such action. Proposal teams that are not selected could be provided with the reasons their investigation was not selected. Maturation in the ground-based program may require NASA assistance to aid the investigator in reaching a point where a mature proposal can be constructed.

To encourage mature proposals, NASA research solicitations must be regular and predictable. This allows investigators to plan graduate student programs, make teaming arrangements, and prepare in advance for such solicitations. To encourage participation in the program and to allow recuperation from an unsuccessful bid, the solicitations in a given research field should occur, at a minimum, once (preferably more) a year. Very clearly defined expectations on the required level of maturity should be included in the solicitation.

When unique hardware needs to be developed, options within the solicitation process should enable and encourage the proposer to partner with other scientists and/or a payload developer to facilitate mature proposals that include a hardware development concept and cost estimate.

The process changes should include a reduced number of peer reviews; ideally only one proposal peer review. A second review at the end of the formulation phase should focus on the ability of the project to meet the science needs. If necessary, a science panel may participate in that review to examine the scientific compromises that were made. Serious effort should be taken to prevent a new "clean sheet" review of the already approved science. In the event such a panel is required, use of members of the original review is encouraged.

Establishing upfront, at selection, realistic expectations for the investigator is crucial to establishing good relationships with the science community. Evaluation of the likely deployment opportunities for promising investigations should be made prior to selection. This should be possible for sufficiently mature proposals. Selections for flight should be made only if a realistic flight opportunity window can be identified. Over-selection of investigators to ensure maximum utilization of the vehicle should be resisted. Instead, the goal should be to provide a predictable and reliable window of opportunity for the investigator to fly their experiment. Historically, events have generally reduced available NASA resources, both programmatic and technical, below projection. This would combine with some delays in experiment development to ensure a reasonable flow of investigations without undue delay to a specific investigator.

Requiring increased maturity in spaceflight experiment proposals places an additional burden on the investigator to devote more time and effort into developing the proposal. While the new effort would be more consistent with the proposal effort required for other agencies, additional resources need to be provided by NASA to aid the proposers' effort. To assist in the proposal process, a comprehensive list of existing equipment, capabilities, and options for using that equipment should be developed and provided as a part of the research solicitation.

b. Rationale for Change Strategy

The current practice for solicitation of OBPR science research is to request and accept many levels of science idea maturity. While this practice is conducive to encouraging the receipt of new and novel ideas, it frequently results in an "open-ended" formulation phase when a component of the research is a spaceflight experiment. Lacking a reasonable, defined period of experiment definition frequently results in unrealistically optimistic expectations by the investigator. The end result is a dissatisfied investigator. In addition, the "open-ended" formulation phase hinders the tactical planner's ability to determine the most likely deployment time for the resulting spaceflight experiment and increases the overall cost of the experiment. Increasing the maturity of the accepted proposals would result in a variety of improvements.

(1) Timesaving.

- A specific and immediate cycle time reduction of at least one year can be realized.

(2) Superior Science with Fewer Reviews.

- Because the experiment definition is very mature, the proposal peer review can be more comprehensive. The review includes not only the science idea, but also the experiment concept, the requirement set, and in some cases the instrument feasibility. As a result, the number of additional science peer reviews can be reduced. The ultimate goal of that reduction is the proposal being peer reviewed only. This is consistent with the number of scientific peer reviews imposed by other Governmental science agencies such as the NSF and NIH.

- Because of the high level of maturity of the experiment concept and resulting requirements set, the probability of meeting the investigator's proposed requirements is dramatically increased.

(3) Improved Tactical Planning.

- Having mature proposals to work from would allow for selection of the probable development and integration schedule that should be used. This allows for an early determination and a more realistic expectation of probable manifest options. This results in a more realistic expectation by the PI and NASA on the deployment and potential completion of the experiment. This also enables better planning of multiple payloads to prevent conflicts, backlog, or serious underutilization of resources. The probability of a correct match between the number of selections and the number of flight opportunities is therefore increased. The result is better control over the throughput of the program and a better balance between investigators entering and exiting the system.

- The SSUR team discovered that the formulation phase has been used as a "holding bin" for an excessive number of investigators in the program. Eliminating the "open-ended" formulation time also reduces the probability of this type of abuse of the investigators in the program.

(4) Improved Teaming.

- Upfront emphasis on pre-proposal teaming results in a better customer focus by the payload development teams. By allowing the investigator team to provide a mature proposal, including hardware usage or development, part of the burden of control and risk accountability is shared by the investigator.

c. Similar Past Study Recommendations

Time Frame	**Title of Study**	**Recommendation**
1997	Payload Engineering Processing Study Phase A & B	• Experiments should not be placed in flight path until they are adequately defined. • Experiments should stay in the ground-based program until they are mature enough for flight. • Limit the growth of science requirements through the A/B phases of a project. • If there are no identified flight possibilities, either delay the experiment selection until manifest possibilities exist or if already selected, deselect as necessary. • Decrease the number of reviews commensurate with the complexity of the hardware.

Time Frame	Title of Study	Recommendation
1999	Office Of Life and Microgravity Sciences and Applications Microgravity Research Program Study	• Provide more timely response, or conditional approval to a PI's proposal evaluation/selection.

d. How the Change Strategy Will Enable the ISSRI

One of the primary functions of the ISSRI is to provide a key interface with the scientific community. In this regard, the ISSRI could take the lead in developing, publishing, and maintaining the comprehensive list of existing equipment, capabilities, and options for the use of that equipment. In addition, the ISSRI personnel would play a key role in assisting potential investigators in understanding the NASA process and making the appropriate contacts within the NASA organizations to ensure a well-developed, mature proposal.

e. Proposed Implementation of Change Strategy

Implementation Approach

Several actions need to be taken to facilitate mature proposals:

(1) A five-year solicitation and selection schedule must be established and published. The solicitation and selection schedule must be firm and specific to the day or week. One or more solicitations per year for each research area are recommended.

(2) Language on the level of maturity expected must be developed and included in all solicitations. Language that allows investigators to team with other scientists and hardware developers should be created and included in all future solicitations. Requisite changes to the review process should be determined and implemented.

(3) NASA needs to develop and publish a comprehensive list of all existing equipment, capabilities, and options for the use of that equipment. Information on typical schedules and integration requirements should be advertised. This can be done by an interactive website.

(4) A concept feasibility and maturity assessment should be defined and included as part of the proposal review and selection process. A projection of flight opportunity should be a required for that assessment. An integrated assessment process for probable flight dates should be established. The selection cycle time may need to increase to 180 days to allow the inclusion of this review.

(5) Policy should be developed and written to establish that selection should be made without significant reduction in the proposed scope unless specifically identified by peer review. Such reductions can require a redefinition of the objectives and

proposal. That redefinition can occur during re-proposal and is feasible if the solicitation cycle is stable and held one or more times a year.

(6) To facilitate evolution of good proposals, a process for technical feedback on "failed" proposals must be developed.

The following table shows the proposed change strategy owner, senior advocate and other implementation details.

Proposed Change Strategy Owner	**Proposed Senior Advocate**	**Resources Required**	**Potential Metrics**	**Implementation Time Frame**
OBPR Deputy AA for Science	OBPR Associate Administrator.	Civil Service and Contractor resources are required to document the process and develop and maintain a catalog of all hardware capability	Average time a research project spends in the formulation phase. Instances of PI/NASA teaming. Instances of engineering support referred to ground-based proposals.	FY04 solicitations

f. Challenges of Implementing Change Strategy

If payload developers at NASA Centers team with the PIs on writing the proposal, they cannot participate in the proposal evaluation. The ISSRI, however, could do this evaluation. The current NASA philosophy assumes NASA involvement only after selection. This mindset will need to change. The ability to provide regular predictable solicitations is highly dependant on a well-defined and stable budget. NASA has historically had difficulty in maintaining a stable research budget.

3.5.2 Change Strategy: Timelines Tailored to Experiment with Payload Classification

a. Description of Change Strategy

This change strategy would customize, through negotiations with each investigator, the specific process plans and schedules for each unique spaceflight experiment. It also includes formalizing the resulting agreements and holding both NASA managers and the investigators accountable for meeting those agreements.

The resulting agreement would form the "timeline" for completing the spaceflight experiment. That timeline or process plan would address documentation requirements, number of reviews, development schedule, risk management, and other appropriate characteristics. General examples of different timelines include: 1) "fast-track", 2) simple sub-rack, 3) complex sub-rack, 4) Shuttle sortie, 5) re-flight, 6) facility/rack, and 7) sub-pallet payloads.

The contents of such an agreement should be considered during the selection process and should be formalized bilaterally at the completion of the formulation phase.

During the selection process, a feasibility and maturity assessment of each promising flight proposal should be conducted. During this assessment, the most likely development template and a probable flight opportunity window should be identified. This should be possible for sufficiently mature proposals. The most likely template may be one provided in the proposal. Selections for flight should be made only if a realistic flight opportunity window can be identified.

After such an assessment is made and the proposal selected, the initial development template would be further negotiated with the investigator and customized during the formulation phase for the specific experiment development, integration, and flight. The resulting flight opportunity window should be an agreement with the Investigator. Deviation from that commitment should be considered a serious breach of agreement. Caution should be applied to not "reprioritize" individual experiments in such a way that the bilateral agreement is violated. Having NASA demonstrate the desire to meet commitments to researchers is of significant importance to attracting future high quality research talent.

To standardize and ease the identification and communicate the level of performance risk acceptance for each experiment, an Agency wide research risk classification system and methodology should be determined and published. That system should clearly define categories of acceptable levels of risk for research and supporting hardware utilizing ISS and Shuttle. A research risk classification system would include a graduated set of requirements that could ease the development path for smaller and/or less complex payloads. That system would provide guidance on experimental design, experiment operations, documentation and performance verification, and supporting hardware reliability. Recommended levels of acceptable risk should be based on factors including total cost, ISS/Shuttle resource requirements, ease of re-flight, and criticality to Agency strategic goals. This system would be independent of the safety evaluation process. A similar system, *NMI 8010, "Risk Classifications for NASA Payload,"* was in use within NASA several years ago, but was discontinued. While this predecessor document is a reasonable example, modifications to bring more specificity for Shuttle and ISS payloads are required.

A specific effort should be made to create and maintain a "fast track" for certain types of experimentation and investigations. That template should service "exploratory" or high-risk simple investigations that can use a "glovebox" or "precursor" environment to rapidly meet experiment objectives. This "fast track" process would include a shortened proposal cycle and would use an expedited peer review process. This process should be limited and highly controlled to ensure that the preponderance of NASA research is rigorously peer reviewed.

b. Rationale for Change Strategy

Managing researcher expectations, meeting commitments, and including the researcher in experiment planning are major steps towards increasing the efficiency of the process and motivating high quality investigators to participate in the program.

Currently, the process followed to bring an individual investigation to spaceflight is not identified and agreed to early in the experiment's lifetime. What is defined is not specifically tailored for the individual investigation. This results in confusion, inaccurate expectations, and customer dissatisfaction.

Early negotiation of a "timeline" or process plan results in a more realistic expectation by the PI on the probable completion of the experiment and the amount of effort required. Tailoring during the formulation phase results in shortening of the cycle time, invokes a customer friendly environment, and gains investigator acceptance of the schedule. Such negotiated tailoring establishes mutual accountability for fulfilling the agreement. A specific timeline tailored to each payload raises the visibility of the development progress of the investigation to a level that metrics can be applied. Agency-level attention to the execution of the plan exhibits NASA interest in the individual project and mitigates a "lost in the system" feeling on the part of the researcher.

Tailoring the timeline increases development and integration team awareness of experiment requirements. The ability to properly staff and provide resources to support developing payloads can be better estimated and executed. Problems can be more readily identified and fixed. The result reduces workload, cost, and time for each development.

Instituting a well-developed risk classification system would allow systematic cost-benefit analysis during the development of process plans. Through the classification process, investigators and their payload developers would be brought into the process and allowed to take as much control as possible and desired in developing their hardware, software, and experimental protocols.

Depending on the performance risk acceptance associated with the assigned classification, not all experiments would be held to the same extensive verifications and testing of a high visibility, high cost payload. Positive effects for researchers and payload developers could include delegation of responsibilities and approval to a lower management level. The system would also help to standardize practices between NASA Centers.

c. Similar Past Study Recommendations

Time Frame	**Title of Study**	**Recommendation**
1991	Space Station Freedom Continuous Improvement Customer Support Team	• The Agency must define the NASA program and customer responsibilities for mission success and payload success in the form of a NASA Management Instruction (NMI) or appropriate policy directive.
1997	Payload Engineering Processing Study Phase	• NASA must review the requirements being imposed on the PD, and allow the determination of the level of

Time Frame	Title of Study	Recommendation
	A&B	reliability and quality requirements to shift to be the responsibility of the funding organization. • Expand the payload classification system within the payload training implementation plan to address complexity differences within the current classifications. Training requirements and equipment fidelity should be documented sufficiently to address all payloads. Criteria should include experiment complexity, ISS resources and crew time requirements.
1997	Payload Engineering Processing Study Phase A & B	• Decrease the number of reviews commensurate with the complexity of the hardware. • The ISS payloads office should revisit the planning process to distinguish between requirements need dates for facility and sub-rack class payloads. • ISS payload office should reexamine the payload integration process, including the template time of the user's involvement after ISS flights commence. The ISS Program process improvement team needs to include the Space Shuttle Program due to it recent template reduction effort. • Expand the payload classification system within the payload training implementation plan to address complexity differences within the current classifications. Training requirements and equipment fidelity should be documented sufficiently to address all payloads. Criteria should include experiment complexity, ISS resources and crew time requirements.
1999	ISS Operations Architecture Study	• These plans should establish payload categorized templates that are responsive to research area needs, can influence the payload hardware design, and can standardize the scenarios in which ISS facility-class payloads and onboard operational racks are in service.
2002	POCAAS	• Reexamine the template dates and only ask for data in a time frame that NASA can provide the appropriate personnel to review this information.

d. How the Change Strategy Will Enable the ISSRI

This change strategy would help the ISSRI to better understand the Agency's risk philosophy by "standardizing" research risk. The ISSRI's ability to describe the NASA process and conduct realistic discussions with potential investigators would be enhanced.

e. Proposed Implementation of Change Strategy

Implementation Approach

Establish a team to develop a structure from which to tailor cycle time, in conjunction with risk classification. Standard process plan templates should be defined for 1) "fast-track" payloads, 2) simple subracks, 3) complex subracks, 4) Shuttle sortie, 5) reflight, 6) facility/rack, 7) subpallet. These templates would vary the documentation requirements, number of reviews, speed of development, and other factors to provide the right level of risk and insight into the process. These "standard" templates would be used for initial classification of experiments during the proposal process and would serve as a basis for initial negotiations with individual investigators. This information should also be published in a forum that is widely available to potential proposers.

Language on the level of maturity expected must be developed and included in all solicitations. Language explaining this change to researchers should be created and included in all future solicitations. Requisite changes to the review process should be determined, implemented, and published.

Any necessary documents, policies and procedures should be revised, including issuing a revised "Risk Classification for NASA Payloads" document that addresses ISS utilization payloads.

A concept feasibility and maturity assessment should be defined and included as part of the proposal review and selection process. A projection of flight opportunity should be a requirement of that assessment. A process for an integrated assessment of probable flight date should be established. Note that the selection cycle time may need to increase to 180 days to allow the inclusion of this review.

The formulation phase of the project should include tailoring of the "generic" templates to a specific customized timeline for the particular investigation. This would require the attention of the payload developer and the integration manager early in the process. Completion of the formulation phase should require developing such a timeline. Modification to the NASA training activities must be made to properly communicate this change.

A specific "fast track" team should be established to further develop and encourage the use of a very short and flexible timeline. This team, consisting of representatives from all science and commercial partners, would provide consistency and make the selections and prioritization of those investigations. The team should further develop a specific template for "fast track" experimentation and investigations. That template should service investigations that are "exploratory," or high-risk simple investigations that can use a "glovebox" or "precursor" environment to rapidly meet experiment objectives. This "fast track" process would include a shortened proposal cycle and would use an expedited peer review process. Specific budget targets should be set to both encourage and limit this path.

The following table shows the change strategy owner, senior advocate and other implementation details.

Proposed Change Strategy Owner	**Proposed Senior Advocate**	**Resources Required**	**Potential Metrics**	**Implementation Time Frame**
OBPR Deputy AA for Programs and JSC ISS Payloads Office Manager	OBPR Associate Administrator.	Civil Service and Contractor resources are required to develop processes and templates for the various types of payloads.	Ability of the selected investigators to reach the first milestone of "confirmation review" in one year. Ability to meet schedule milestones. Specific customer feedback on cycle time expectations. A measure of the number of steps or amount of time saved by the new process. Performance of payloads developed under this process versus the standard process.	One year to establish the generic template process plan structure and corresponding selection process changes. For payload classification, begin October 2003; Complete document and appropriate sign-offs within six months. Appropriate Programs and Centers begin training as soon as document approved. Full implementation within one year for new projects, with option for existing projects to also use it.

f. Challenges of Implementing Change Strategy

Parts of the payload classification system methodology are already captured in existing (or draft) guidelines (e.g., NPG 8010, in revision at this time and SSP50431) and it may be difficult to incorporate everything into a single document without conflict with current guidelines.

Creating a new document can create more bureaucracy if the document policy is not implemented properly. If not properly implemented these changes could take away flexibility that payload development teams have today.

3.5.3 Change Strategy: Reduced Process Complexity

a. Description of Change Strategy

To simplify the overall process for ISS and Shuttle end users, a concentrated effort must be initiated to review the end-to-end data deliverables, requirements, and reviews imposed on the end user to get to flight. This can be accomplished through two parallel activities. The first part continues the current ISS Payloads Office process improvement activity that addresses timing of deliverables, excessive requirements in the integration phase of the cycle, data deliverables, and simplicity of the integration process.

The second part expands the process improvement to the beginning of the end-to-end process, from solicitation through payload development. The strategy recommends establishing a Research Integration Office working group to reduce data requirements and apply best practices. In addition, the principal investigator would have a consistent interface throughout the end-to-end research process for both ISS and Shuttle payloads.

Part 1

Over the past two years, a number of improvement efforts have been underway in the ISS Payloads Office. In October 2002, to move more rapidly to a customer service organization with streamlined processes, the ISS Payloads Office initiated a significant effort focused on simplifying the integration process. An improvement approach was initiated using an Applied Research and Engineering Sciences Corporation consultant team applying Lean Six Sigma techniques to help expedite this process improvement initiative. Lean Six Sigma is a dual approach used to reduce cycle time (Lean) and reduce variation (Six Sigma) to increase process execution speed and quality and reduce costs. See figure 3.5-4 for the improvement approach associated with Lean Six Sigma. This effort, which included teams at MSFC, KSC, and JSC, and Payload Developers included reviewing all phases of payload integration, including planning, manifesting, operations, astronaut training, interface and verification analysis, and telescience (remote operations of investigations, such as at a university site, rather than a centralized control Center). A number of significant forward actions were established and are being implemented with a targeted completion in December 2003. These forward actions are listed on the ISS Payloads Office website:

http://iss-www.jsc.nasa.gov/ss/issapt/payofc/payoff.html.

Data requirements reduction was one of the most important focus items. An ISS Payloads Office Data Manager and a comprehensive data dictionary were established as of October 2002. A comprehensive review of all requirements associated with integration on ISS was performed, resulting in over 30% reduction. Deletion of requirements is currently underway through the ISS Payloads Control Board. Future requirements additions would be tracked through the Payloads Control Board to avoid requirements creep.

Several key forward actions were established to strengthen the payload investigator/payload developer interface. To facilitate communication and provide the payload investigator with one place for process questions, data collection, and tailored information, an information CD and web portal was developed (http://stationpayloads.jsc.nasa.gov/). The primary interface to the payload investigator/payload developer is the Payload Integration Manager. To strengthen this interface, consistent service standards were established and are being implemented.

To measure customer satisfaction and continue to improve the customer interface, a closed loop customer satisfaction process was implemented (see figure 3.5-5). As part of this effort, post increment survey and customer service help lines were established. This provides the necessary metrics to know if the continued process improvements are achieving the desired results.

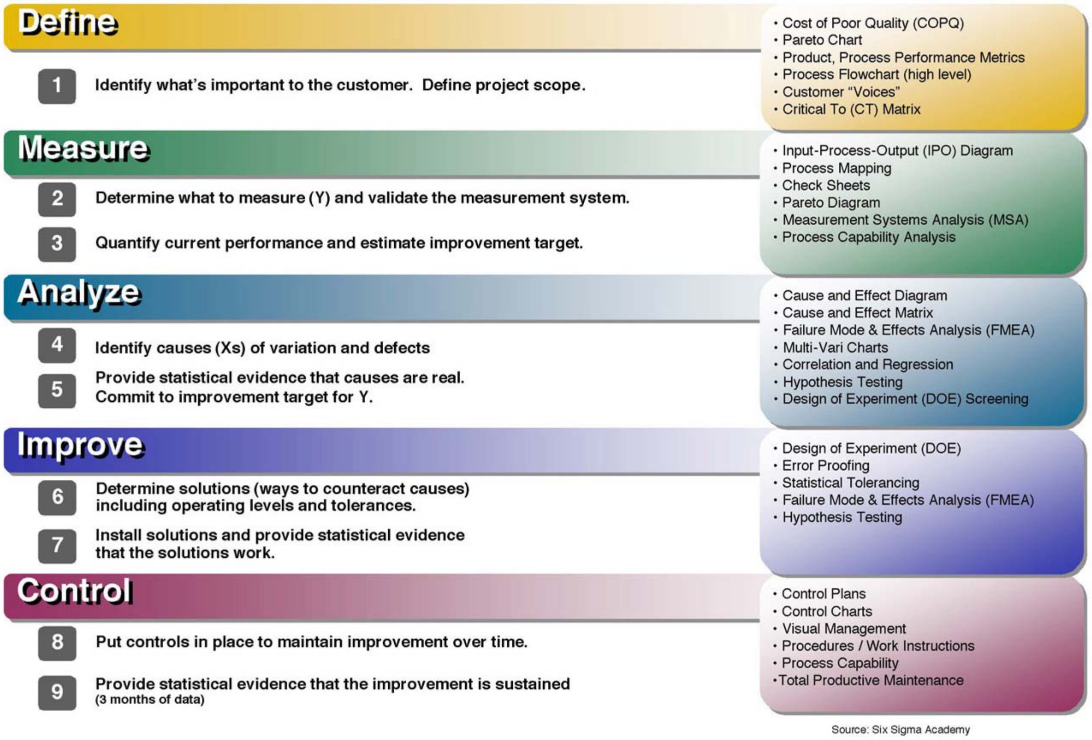

Figure 3.5-4. Improvement Approach

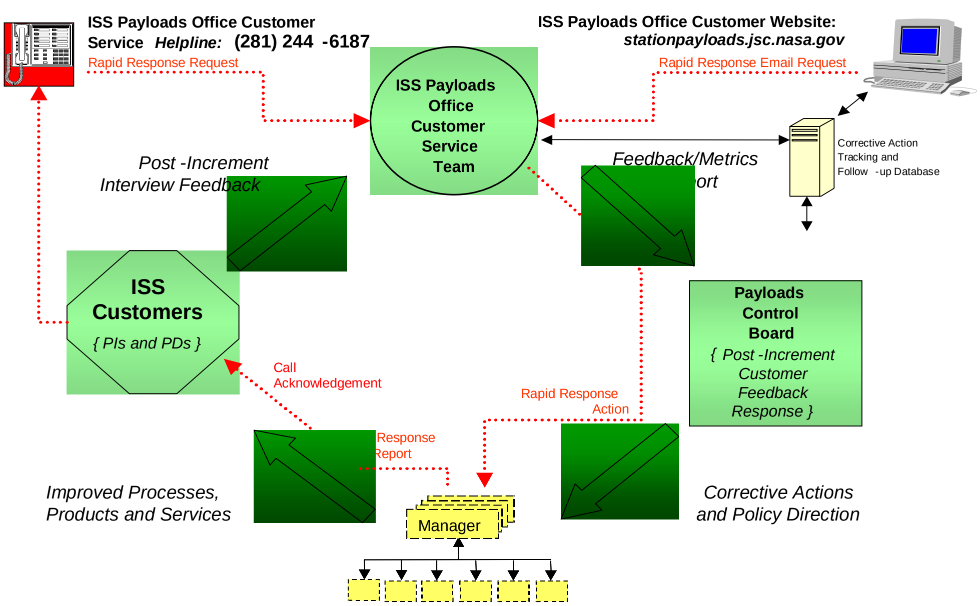

Figure 3.5-5. Closed-Loop Customer Satisfaction Process

In concert with the change strategy discussed in section 3.1.2 “Integrate Utilization at JSC”, the change strategy recommends extending the current ISS Payload Office process improvement activity to incorporate Shuttle payloads.

Part 2

The second part of this change strategy expands the process improvement in Part 1 to the beginning of the end-to-end process, from solicitation through payload development. It establishes a Research Integration Office working group to reduce data requirements and apply best practices. An assessment of data requirements and reviews on a Payload Developer/Payload Investigator for the upfront phases of the process would be performed utilizing a focused team of representatives across multiple development Centers. To ensure success, best practices would be established and shared for streamlining requirements and processes that impact the Payload Developer and Principal Investigator.

In addition, following the “One NASA” philosophy, the Centers would develop Center-to-Center reciprocity, such that certifications or review by one NASA Center or prequalified Research Partnership Center would be accepted unconditionally by another Center. Strengthening Center-to-Center reciprocity by developing policies and procedures (e.g., Inter-Center Agreements and Memorandums of Agreement) would allow any given NASA Center or Research Partnership Center to accept the analysis, technical specifications, review results and certifications of another Center.

Finally, the Principal Investigator would have a consistent interface throughout the end-to-end research process for both ISS and Shuttle payloads. Initially, the NASA Headquarters Sponsor will assist the PI through the solicitation process. Once selected, the Sponsor will hand off the interface role to the Research Integration Office (RIO), or equivalent, responsible for that PI’s specific research discipline.

The RIO will guide the PI and their payload developer throughout the ISS payload development and integration process from selection, through payload development and integration, to on-orbit science operations, and post-flight data delivery. The RIO maintains ultimate accountability to the PI, but will delegate primary responsibility to the appropriate functional area in the process, e.g., to the Project Scientist during the Definition Phase. A Payload Integration Team (PIT) would be formed by the RIO in the Phase B timeframe. This team would be comprised of all the primary members from the NASA centers that will interface with the PI and the Payload Development team. Figure 3.5-6 describes the PI’s primary interfaces throughout the investigation’s life cycle.

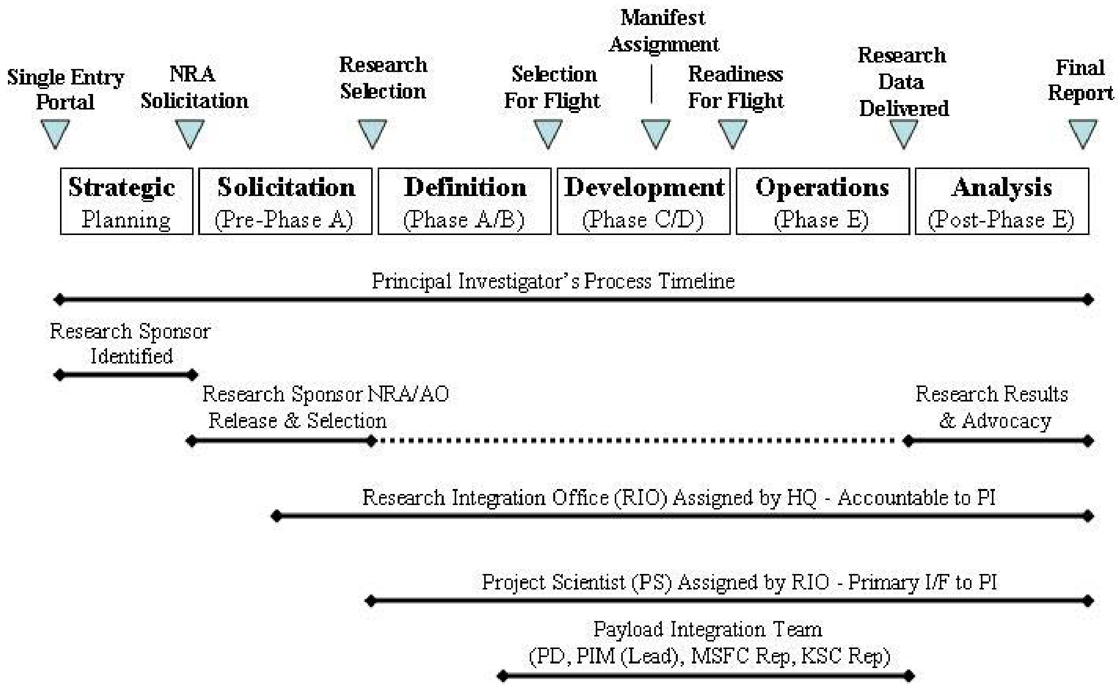

Figure 3.5-6. PI's Process Timeline and Primary Interfaces

b. Rationale for Change Strategy

SSUR Team Payload Investigator focus groups, payload investigator feedback, and customer surveys consistently identified excessive requirements and documentation as a problem with the end-to-end process. Customer feedback data dating back to 1991 identified this area as needing major change.

There are many organizations involved in the overall process. NASA must integrate these processes into one simplified, cohesive, and clearly defined process for all end users. There should be consistent processes established between Payload Development Centers that incorporate best practices. Currently, different organizations involved in the process develop requirements for each phase of the process. Overall data required are not reviewed in an integrated manner for overlap or ways to simplify for the individual researcher. This can cause multiple submissions of the same data, extra cost for the end user, and can lengthen cycle time

All NASA Centers have sound practices and processes for design, development, integration and test of flight hardware. By embracing the "One-NASA" concept, many of the analysis and test products should be accepted without reverification or revalidation by the receiving Center. This same approach has already been successfully employed in a number of areas. JPL and GSFC follow this model as they work together on many missions where one Center is responsible for Spacecraft and the other for instruments. Center-to-Center reciprocity has been demonstrated at MSFC and JSC, and MSFC and GSFC through the materials processes.

A single entity accountable for customer satisfaction (the RIO or equivalent) must be established to provide a single interface (the Project Scientist) for the researcher throughout the payload development, integration and operations processes. This would provide a 'fixed' team that guides the researcher through the end to end development, integration and operations activities with a focus that is "research oriented" a key element of success for other NASA Programs (e.g., ELV, Spacelab) appears to come from being "mission oriented" with a fixed team in place throughout the process. By establishing this entity, a consistent approach through development, integration and operation of a researcher's investigation would be instilled, thereby shielding them from the process complexities and large number of interfaces, while still meeting their requirements.

c. Similar Past Study Recommendations

Time Frame	**Title of Study**	**Recommendation**
1991	Space Station Freedom Continuous Improvement Customer Support Team	• Reciprocity between the NASA field Centers must be established in the major engineering disciplines for standards/requirements which are levied on the customers. This effort should be coordinated by HQ
1997	Payload Engineering Processing Study Phase A & B	• ISS payload office should reexamine the payload integration process, including the template time of the users involvement after ISS flights commence. The ISS Program process improvement team needs to include the Space Shuttle Program due to it recent template reduction effort.
1997	Payload Engineering Process Study	• Work the Points of Contact functions to better define PIMs and PMI with emphasis that these roles should assist the user in streamlining the process to flight.
1997	Payload Engineering Processing Study Phase A&B	• Perform the reviews with a core team of technical specialists to provide quality to the reviews." Payload Engineering Processing Study Phase A & B Nov-97. • "The number of safety reviews should be minimized whenever possible. Where safety reviews are conducted by Centers or mission management organizations the safety packages should be formatted identically as required by the intended final reviewer/approver. This will minimize the rework required by the payload hardware developer.
1999	ISS Operations Architecture Study	• NASA should begin planning for simple to complex payload integration timelines. NASA should immediately begin developing research integration plans for the Operations Phase of the ISS Program. These plans should establish payload categorized templates that are responsive to research area needs, can influence the payload hardware design, and can standardize the scenarios in which ISS facility-class payloads and onboard operational racks are in service. As a goal, conducting research on the ISS should be no more difficult than conducting research in a ground-based facility, except for

Time Frame	Title of Study	Recommendation
1999	Office Of Life and Microgravity Sciences and Applications, Microgravity Research Division	• Develop material that clearly describes the purpose and requirements for all project documentation. Also, consider documenting appropriate "lessons learned" for new PI's. • Standardize approach and content for design reviews.
2001	KSC Customer Survey	• Customer drops off the face of the earth after launch – no interface to test team and management post mission.
2001	Salzman Findings	• Lack of standardization – non-responsiveness to user inputs.
2002	POCAAS	• Reengineer and streamline the payload integration process, including payload operations. • Considering the interaction among all payload integration activities, and the researcher issues, reduction in payload operations cost should be undertaken as part of a larger streamlining of ISS Payload Integration.
2002	Freedom to Manage	• PI/PD must interface with overlapping groups with complex processes. • Create a central website location for customers to access information concerning the details of flying on the ISS, Shuttle or ELV.
2002	POCAAS Study	• Ideally the Research Program Office should be solely responsible as the interface between the PD and ISS, or the RPO should delegate all technical authority to the PD.
2002	Cocoa Beach User Workshop	• Need to know who is in charge – have one focal point.
2002	JSC Customer Needs Assessment	• When someone moves on, there is not necessarily someone there with the same knowledge and experience.

d. How the Change Strategy Will Enable the ISSRI

Part 1

The ISSRI can function better if it interfaces with a streamlined and smoothly functioning NASA system..

Part 2

The ISSRI would be the "RIO" for the Guest Investigator Program. The opportunity to participate as a "ghost" member of a select number of Payload Integration Teams would enhance the ISSRI's understanding of the processes required to integrate and operate an investigation on ISS/Shuttle.

e. Proposed Implementation of Change Strategy

Implementation Approach

Part 1

Endorse current ISS Payloads Office process improvements to reduce complexity, reviews, and documentation. Include Shuttle sortie middeck requirements in current ISS web portal in coordination with consolidation of Shuttle and ISS Utilization Offices at JSC.

Part 2

Establish a team comprised of Research Integration Offices, HQ Program Executives, Payload Developer/Principal Investigator, ISS Payloads Office, and Space Shuttle Program Integration to:

(1) Conduct a process improvement effort for the proposal, selection, definition, and development phases (front-end) of the end-to-end process, and develop a forward action plan.

(2) Share best practices for streamlining requirements and processes that impact the Payload Developer and Principal Investigator.

(3) Develop policies, procedures and agreements between NASA Centers to accept each other's analysis, technical specifications, review results and certifications to strengthen Center-to-Center reciprocity. Extend to Research Partnership Centers as appropriate.

(4) Document and maintain new streamlined requirements and processes to ensure consistency.

(5) Develop a process and service standard to ensure the Principal Investigator has a consistent interface throughout the end-to-end research process for both ISS and Shuttle payloads. A specific Research Integration Office (RIO), or equivalent, would be accountable to the Principal Investigator from beginning to end. A Payload Integration Team (PIT) would be established to facilitate the integration process. The PIT would interface with Payload Investigators/Payload Developers on design for human space flight integration and safety requirements, acting as a pool of expertise to optimize and create a more efficient design, integration and flight life cycle. PIT roles and responsibilities would be clearly established.

The following table shows the proposed change strategy owner, senior advocate and other implementation details.

Proposed Change Strategy Owner	Proposed Senior Advocate	Resources Required	Potential Metrics	Implementation Time Frame
OBPR Deputy AA's for Programs and Science & JSC ISS Payloads Office	OBPR Associate Administrator and the NASA Chief Engineer	Requires Civil Service and Contractor FTEs to perform a lean 6 sigma or equivalent analysis on the front end of the process. Contractor and Civil Service FTEs from Payload integration and RIOs are also required to provide support to the PI, starting at Phase B and continuing until the end of the process.	Build upon current established customer feedback system established in Part 1 of this change strategy. Customer feedback will determine if process changes are achieving the desired results. Data reductions should be tracked and reported at OBPR Monthly reviews. MOAs pertaining to Center-to-Center reciprocity should be tracked and reported to OBPR.	October 2003 through March 2005

f. Challenges of Implementing Change Strategy

There are many challenges that would make it difficult to implement this change strategy. With many owners of requirements at multiple Centers on the front end of the process it may be difficult to streamline and consistently reduce requirements across all Centers. History between some Centers may have created a perception that another Center's design, development, and test processes or philosophies are not based on sound practices. The NASA Chief Engineer should facilitate the process of establishing consistent design, development, test and verification methods, processes, and standards that can be adopted across the Agency.

3.5.4 Change Strategy: Concurrent Payload Development and Integration

a. Description of Change Strategy

The objective of this change strategy is to demonstrate the feasibility of applying concurrent engineering processes to the design, development, and integration of Shuttle and ISS utilization payloads. Successful demonstration of this approach would establish the capability for performing concurrent design and integration in a more automated and efficient manner across all payload development.

b. Rationale for Change Strategy

By adopting a concurrent engineering design process, the Agency could streamline the design and development process, improve communication, and eliminate duplication of tasks during the development and integration phases of the end-to-end process. The concept of concurrent engineering has been successfully implemented in several areas within the Agency such as Jet Propulsion Laboratory's Team I, Optical Instrument Development Team; Goddard Space Flight Center's Mission Design Center, and Marshall Space Flight Center's Collaborative Engineering Environment. In addition, external organizations have also implemented this approach, including Boeing, Lockheed-Martin, SpaceDRUMS®, and the Department of Defense's system level procedure. Based on these examples, it is anticipated that concurrent payload development and integration can result in reduced cycle time.

c. Similar Past Study Recommendations

None.

d. How the Change Strategy Will Enable the ISSRI

Concurrent payload development and integration would reduce the end-to-end cycle time, improve research throughput and productivity, and increase the research/user community satisfaction; thus enabling the ISSRI's success.

e. Proposed Implementation of Change Strategy

Implementation Approach

The OBPR Division Directors would determine the appropriate Research Integration Office to conduct a pilot study of concurrent payload development and integration for a Shuttle and/or ISS utilization payload. The appropriate RIO would then select a payload for the pilot program to determine the feasibility of using concurrent engineering to design, develop, and perform integration in a more parallel fashion. The pilot program could consist of three steps:

(1) Work within an existing concurrent engineering design Center environment (such as: JPL Team I, Optical Instrument Development Team; GSFC, Space-DRUMS® or DoD system level procedure) to develop a conceptual design with the Principal Investigator, the payload development team, and the JSC payload integration manager and engineering staff.

(2) Based on the conceptual design developed through the design Center, have that same team work concurrently to design and integrate the payload using a manual concurrent engineering process and explore the feasibility of using concurrent engineering tools to facilitate the process.

(3) If additional software tools are required, recommend modifications of existing software tool or acquisition of required software application tools for use with ISS and Shuttle utilization payloads. Work with the Office of the Chief Engineer to identify opportunities to support development and application of required concurrent engineering tools.

The following table shows the proposed change strategy owner, senior advocate and other implementation details.

Proposed Change Strategy Owner	**Proposed Senior Advocate**	**Resources Required**	**Potential Metrics**	**Implementation Time Frame**
Research Integration Office as selected by OBPR Division Directors	OBPR Associate Administrator and NASA Chief Engineer.	Resources should be defined by OBPR and Office of the Chief Engineer (OCE).	Measure whether the concurrent process reduced the template time for payload design, development and integration. Measure the number of design and development activities, documents, and requirements reduced by the concurrent engineering process.	October 2003 through October 2008

f. Challenges of Implementing Change Strategy

Concurrent engineering design process at JPL and other Centers is used today primarily for conceptual design and not for development, design to build, and integration.

Change in design process may be difficult to adopt unless a clear benefit can be identified.

The initial investment needed to modify JPL tools or tools for other design Centers for ISS and Shuttle payload development and integration is approximately $500K. Support for these efforts could be worked through joint sponsorship with the Office of the Chief Engineer.

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4. SUMMARY AND CONCLUSIONS

NASA management established the Station and Shuttle Utilization Reinvention Team to develop strategies for improving the utilization process and increasing responsiveness to the user community. The team's research verified that intractable problems exist within the system and that improvements recommended in many previous studies, dating back to 1991, were usually not implemented. One major exception is the process improvement effort initiated in 2000 and currently in progress at the ISS Payloads Office.

Five major problem areas within the end-to-end utilization process were identified as those most needing improvement: 1) lack of customer focus, 2) insufficient utilization capacity, 3) end-to end cycle time too long, 4) complex business structure, and 5) unclear research accountability.

Fifteen change strategies were developed to solve those problem areas. After internal and external reviews, the top eight strategies were chosen and recommended to the NASA Executive Council along with a recommendation for an "owner" and "senior advocate" responsible for implementation. The team recommended that each change strategy should be treated as a project with an implementation plan and schedule. The Enterprise Council endorsed the eight strategies, with minor modifications, and the recommended implementation approach. The Associate Administrator for Biological and Physical Research was assigned to coordinate periodic reports back to the Enterprise council on implementation progress.

The top eight change strategies described in this report are:

(1) **Unified Station and Shuttle Utilization Process:** Establish a senior management position and board to oversee end-to-end utilization process.

(2) **Reduced Process Complexity:** Expand ongoing, highly respected, payload integration process improvement activity to include the complete end-to-end utilization process.

(3) **Emphasize Agency's Focus on Research:** Increase focus and priority on the research/user community throughout NASA.

(4) **Alternate/Supplemental Space Access:** Assure that utilization requirements are thoroughly considered in the Integrated Space Transportation Plan trade space.

(5) **Principal Investigator Decision Maker for Research:** Increase flexibility for the PI to change and mature research ideas.

(6) **Integrate Utilization at JSC:** Combine Shuttle Payload Integration and International Space Station Payloads Office and, later, assess implementation of a separate utilization program for the combined offices.

(7) **Increase Utilization Funding Stability:** Improve grant management processes and develop strategies to mitigate utilization funding instability at all levels.

(8) **Maturity of Proposals:** Revise NASA's flight projects solicitation process to ensure that selected projects are sufficiently mature to successfully meet planned flight schedules.

The seven additional recommended strategies that could be implemented when appropriate are:

(9) **Agency Research Success Philosophy:** Recognize the difference between research success and mission success and measure each appropriately.

(10) **Expand Scope of ISS Research Institute:** Expand the ISSRI to support ISS and Shuttle utilization payloads for all Enterprises.

(11) **Timelines Tailored to Experiment with Payload Classification:** Customize research investigation processes and ease the development path for less complex payloads.

(12) **Improve Research Advocacy:** Implement an integrated approach for research advocacy.

(13) **Concurrent Payload Development and Integration:** Conduct a pilot program for concurrent payload development and integration.

(14) **Agency Approach to Commercial Use:** Provide a single Headquarters focus for commercial utilization.

(15) **Manifest Optimization:** Assess the feasibility of using a market-based tool for payload manifest optimization.

The future success of the Station and Shuttle utilization process will also be dependent on the success of the ISS Research Institute (ISSRI) currently under development. Many of the change strategies will directly or indirectly streamline interfaces to the ISSRI and enhance the utilization process that the ISSRI will advocate to new users.

It is noted that this study was conducted and the change strategies were approved prior to release of the Columbia Accident Investigation Board Report. While the SSUR team does not believe that any of the actions outlined in the change strategies are strongly influenced by the findings of the CAIB report, the OBPR and OSF should, as a follow on, assess the entire SSUR report fully informed by the CAIB results.

NASA management and SSUR Team members recognize that change is not easy. The “owners” of the change strategies face real challenges as they manage these changes while concurrently managing their ongoing responsibilities. The SSUR Team members have pledged to remain available as consultants, on an as needed basis, throughout implementation. The SSUR Team believes that implementing these changes is vital to the Agency's future, and the outcome worth the extensive effort required.