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GODDARD HANDBOOK FOR MANAGEMENT OF PROGRAMS - PROJECTS - PRODUCTS

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Flight Programs and Projects Directorate

GODDARD SPACE FLIGHT CENTER

GREENBELT, MARYLAND

Responsible Office: 401 Mission Integration Office

Title: GODDARD HANDBOOK
FOR MANAGEMENT OF
PROGRAMS – PROJECTS – PRODUCTS

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GODDARD HANDBOOK FOR MANAGEMENT OF PROGRAMS – PROJECTS – PRODUCTS

- Volume 1 – The NASA Program/Project Environment
- Volume 2 - Program Management
- Volume 3 - Project Management
- Volume 4 - Product Management

Purpose

This Handbook is designed to aid all GSFC personnel assigned to a program – project – product. The Handbook encompasses the Program - Project – Product management environment, and how to successfully meet its demands and take advantage of its flexibilities, such as tailoring requirements to produce products which:

a. Meet intended and specified customer requirements.
b. Conform to NASA requirements for technical performance, schedule, budget, and management processes, including ISO 9001.
c. Support the NASA initiatives for Faster – Better – Cheaper products.

Applicability

The Program – Project – Product Handbook applies to the hardware, software, material, and services delivered to customers as a result of the following NASA/GSFC core processes at both the Greenbelt and Wallops facilities:

a. Science Enabling –The grants process; providing data to the science community; science support tools; the proposal support process; and the science research management process;
b. Systems Development – Space flight systems; balloons; sounding rockets; aircraft experiments; ground systems; and data systems;
c. Program/Project Management – Cost, schedule and technical control; review and reporting; budgets; procurement; contracts; and safety and mission assurance;
d. Technology Enabling – New concepts studies; investment strategies; crosscutting developments; mission specific products; transfer; and commercialization;
e. Mission Operations – Customer service commitments, including Project Service level Agreements and Project Commitment Documents.

Authority

GPD 7120.4 – Goddard Policy for the Conduct of Programs, Projects and Products.

References

NPD 7120.4 – Program/Project Management
NPG 7120.5 – NASA Program and Project Management Processes and Requirements
GPG 7120.1 – Program Management
GPG 7120.2 – Project Management

Preface

The Goddard Space Flight Center (GSFC) formulates and implements programs and projects, and produces products (such as spacecraft, instruments, flight and ground systems, raw and analyzed data, images, and electronic modules) within the scope and in accordance with the direction of NASA's Enterprise strategic plans and management directives. These plans and management directives are often broad in scope, but are precise in terms of requirements for technical goals and objectives, schedules, management and institutional relationships, and resources authorized. This information and direction flowing from the strategic plans and directly from management take the form of:

- NASA and Enterprise Strategic Plans
- NASA Policy Directives (NPD's)
- NASA Processes and Guidelines (NPG's)
- Program Commitment Agreements (PCA's)
- Other directives and statements issued from Enterprise and institutional authorities

Goddard, in the formulation and implementation processes, provides additional policies and guidelines for the conduct of work at the Center, in accordance with ISO 9001 Standards, in the form of:

- Goddard Strategic Implementation Plan
- Goddard Procedures and Guidelines (GPG's)
- Directorate Procedures and Guidelines (PG's)
- Project and Organizational Work Instructions (WI's)

This Handbook is designed to aid all GSFC personnel assigned to program – project – product by providing practical guidance in the application of detailed NASA and GSFC directives. It was developed by a Centerwide team and will be maintained by the "process owner," the Flight Programs and Projects Directorate, with input from each of GSFC's directorates. The Handbook addresses the Program – Project - Product Management environment, and how to successfully meet its demands and take advantage of its flexibilities, such as tailoring requirements to produce products which:

1. Meet intended and specified customer requirements.
2. Conform to NASA requirements for technical performance, schedule, budget, and management processes, including ISO 9001.
3. Support the NASA initiatives for Faster-Better-Cheaper products.

This Handbook reflects the requirements of NASA/GSFC policy and process documents indicated above, especially the NASA NPG 7120.5 and the GPG's. All requirements in this Handbook have already been issued by approved NASA/GSFC directives, the Handbook adds no new requirements. Good practice and guidelines are provided by carefully avoiding the verb "shall".

Requirements are summarized in the Handbook and denoted by the verb "shall". The reader is encouraged to refer to the directives for detailed requirements not repeated herein.

ACKNOWLEDGMENT

The development of the Program – Project – Product Management Handbook has been a multi-directorate endeavor, utilizing Goddard Civil Servants and Boeing Contract personnel. The following rosters indicate the main Working Group and some of the special committees assembled to handle major changes in scope, such as the addition of product management, program management, and 2 companion Goddard management directives.

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References between GPG's and NPG 7120.5

	ISO Rqmt	GPG No.	GPG Title	Reference Paragraph Numbers in Handbook
1	4.1	GPG 1060.1	Management Responsibility	3.1.3.1, 4.1
2	4.2	GPG 8730.4	Quality System	4.1, 4.2, 4.4, 4.11, 4.13
3	4.3	GPG 1310.1	Customer Agreements	4.3, 4.4, 4.9
4	4.4	GPG 8700.1	Design Planning and Interface Management	1.4.2.1, 3.1.2.4.4, 4.4, 4.9
5	4.4	GPG 8700.2	Design Development	3.1.2.4.3, 3.1.2.4.4, 4.4, 4.8, 4.12
6	4.4	GPG 8700.3	Design Validation	3.1.2.4.4, 3.2.1.5, 4.4, 4.8, 4.12
7	4.4	GPG 8700.4	Technical Review Program	3.1.2.4.4., 3.1.2.5, 3.1.2.5.2, 4.4
8	4.5	GPG 1410.1	Directives Management	4.2, 4.5, 4.12
9	4.6	GPG 5100.1	Procurement	3.1.2, 4.6
10	4.6	GPG 5100.2	Supplier Performance Records	4.6
11	4.7	GPG 5900.1	Control of Customer-Supplied Product	4.7, 4.10
12	4.8	GPG 5310.4	Identification and Traceability of Products	4.8
13	4.9	GPG 8072.1	Process Control	4.9
14	4.10	GPG 4520.2	Incoming Inspection and Test	4.7, 4.10, 4.12
15	4.10	GPG 5330.1	In-Process and Final Inspection and Test	4.10,
16	4.11	GPG 8730.1	Calibration and Metrology	4.11
17	4.12	GPG 5330.3	Inspection and Test Status	4.4, 4.7, 4.8, 4.9, 4.10, 4.12, 4.15
18	4.13	GPG 5340.2	Control of Nonconforming Product	4.4, 4.7, 4.10, 4.11, 4.12, 4.13, 4.14, 4.15
19	4.13	GPG 5340.3	Preparation and Handling of Alerts and Safe Alerts	4.13
20	4.14	GPG 1710.1	Corrective and Preventive Action	4.9, 4.13, 4.14
21	4.15	GPG 6400.1	Handling, Storage, Packaging, Marking, Preservation, and Transportation	4.4, 4.7, 4.15
22	4.16	GPG 1440.7	Control of Quality records	4.6, 4.10, 4.16
23	4.17	GPG 9980.1	Internal Audit Program	3.1.3.3, 4.17
24	4.18	GPG 3410.2	Employee Training and Qualification	4.18
25	4.19	None	Servicing	Not applicable at GSFC
26	4.20	GPG 8070.2	Identification and Application of Statistical Techniques	4.9, 4.20

	NPG 7120.5 References within the Handbook	
	Paragraph Title of the Handbook	**Reference Paragraph Numbers of the NPG 7120.5**
	Preface	Preface
1.	Introduction	1.0
2.	Integrated Process Themes	1.3.4
3.	Introduction to Program Management	2.0
4.	GSFC's Environment	2.1
5.	Program Approval	2.2.2
6.	Program Implementation	2.2.3
7.	Unique Aspects of Program Management at GSFC	2.2.5
8.	The Program Managers Roles and Responsibilities	2.3
9.	Set the tone and character of the program	2.3.1
10.	Lead Strategic planning	2.3.3
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12.	Development of Feasible Mission Concepts	3.1.2.1
13.	New Business Committee (NBC) Approval	3.1.2.1.9
14.	Formulation	3.1.2.2
15.	Systems Analysis	3.1.2.2.1.2
16.	Technology Requirements Synthesis	3.1.2.2.1.3
17.	Develop Technology and Commercialization Project Plans	3.1.2.2.1.4
18.	Operations and Business Opportunities	3.1.2.2.1.5
19.	Assess Infrastructure and Plan Upgrades/Development	3.1.2.2.1.6
20.	Lessons Learned	3.1.2.2.1.7
21.	Formulation Products	3.1.2.2.3
22.	Approval	3.1.2.3
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27.	Design, Develop, and Sustain	3.1.2.4.4
28.	Deliver Products and Services	3.1.2.4.5
29.	Capture Process Knowledge	3.1.2.4.6
30.	Evaluation	3.1.2.5
31.	Independent Reviews	3.1.2.5.1
32.	Introduction to Product Management	4.0.
33.	Quality System (ISO 9001 Element 4.2)	4.2

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GODDARD HANDBOOK FOR MANAGEMENT OF PROGRAMS - PROJECTS - PRODUCTS

Volume 1

The NASA Program/Project Environment

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VOLUME 1. The NASA Program/Project Environment

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1.0 Introduction

Substantial changes within the National Aeronautics and Space Administration (NASA) and Goddard Space Flight Center (GSFC) have taken place since the last publication of the Flight Projects Directorate Project Management Handbook (August 1994). During the summer of 1998, the Center reorganization and its redirection made it necessary to update and expand the scope of this working document, as well as its title (i.e., The Goddard Handbook for Management of Programs – Projects - Products). Not only are those changes now a part of this Handbook, but the Handbook also brings this work into compliance with the International Organization for Standardization (ISO) 9001 requirements, the GSFC's Quality Manual (see GPG 8730.3), Goddard Procedures and Guidelines (GPG's), and NASA Program and Project Management Processes and Requirements (NPG 7120.5). Each Center is responsible for developing and implementing Center-level policies, processes, procedures, and requirements necessary to ensure successful program/project execution according to NPD 7120.4 and NPG 7120.5. (See NPG 7120.5, Para.1.4.)

The intent is to use this document as a Center-wide guide for all Program, Project and Product Managers who, as team leaders, will follow the applicable principles and direction of this Handbook. It is also for the use of all other Center personnel involved with Program – Project - Product management. The Handbook will be updated periodically to incorporate changes in NASA and GSFC directives.

This Handbook is the product of a multi-directorate team whose efforts were reviewed through various levels of GSFC management before final approval. For efficient use of this document, references are made to pertinent GPG's and NPG 7120.5, rather than to repeat their detailed requirements. Taking these documents together, the reader should be able to keep himself/herself aware of the fundamental areas and tools necessary to be successful in NASA's/GSFC's dynamic environment.

1.1 Program/Project/Product Relationship

A program is an activity within an Enterprise having defined goals, objectives, and funding, and consisting of one or more projects, reporting to the NASA Program Management Council (PMC), unless delegated to a Governing Program Management Council (GPMC). A project is an activity designated by a program and characterized as having defined goals, objectives, requirements, Life Cycle Cost's (LCC's), and a beginning and an end. The projects within the program may be independent of each other, or very dependent upon each other, in order to produce the customer-required products (see Figure 2-1 in Volume 2 for examples of independent and interdependent projects). Products include all deliverables subject to the GSFC Quality Management System (QMS), and may range from small items such as an aerospace lens brought to GSFC for polishing, to a suborbital payload and/or experiment/instrument, or major NASA spacecraft. Therefore products and services within the scope of the GSFC QMS, which includes those of flight programs and projects and elements thereof, must be compliant with GSFC QMS product requirements.

The major distinguishing features between a program and a project are as follows:

a. A program is authorized by an Enterprise through a Formulation Authorization, while a project formulation is authorized by a program. However, Enterprise approval may be individually required for projects, which are competitively selected under programs, such as Explorers and Earth System Science Pathfinder (ESSP). Also, an Enterprise may authorize a project for formulation which has not been assigned to, or designated (itself) as, a program.

b. Documentation required for programs approved for implementation includes the PCA and the Program Plan, while projects require a Project Plan and modifications to the Program Plan of which the project is an element

c. A program is reviewed by the Agency PMC, unless delegated to a GPMC, while a project is reviewed by a GPMC as designated in the Program Plan.

The duration of a program is generally long term with new projects added on a regular basis. The projects within these programs are, however, finite, with a defined beginning and an end.

1.2 Strategic Planning/Strategic Enterprises

The NASA Strategic Plan establishes a framework of four Strategic Enterprises through which GSFC implements a mission and communicates with external customers and stakeholders (see NASA Strategic Plan and NASA Strategic Management Handbook.) These Strategic Enterprises are shown in Figure 1-1.

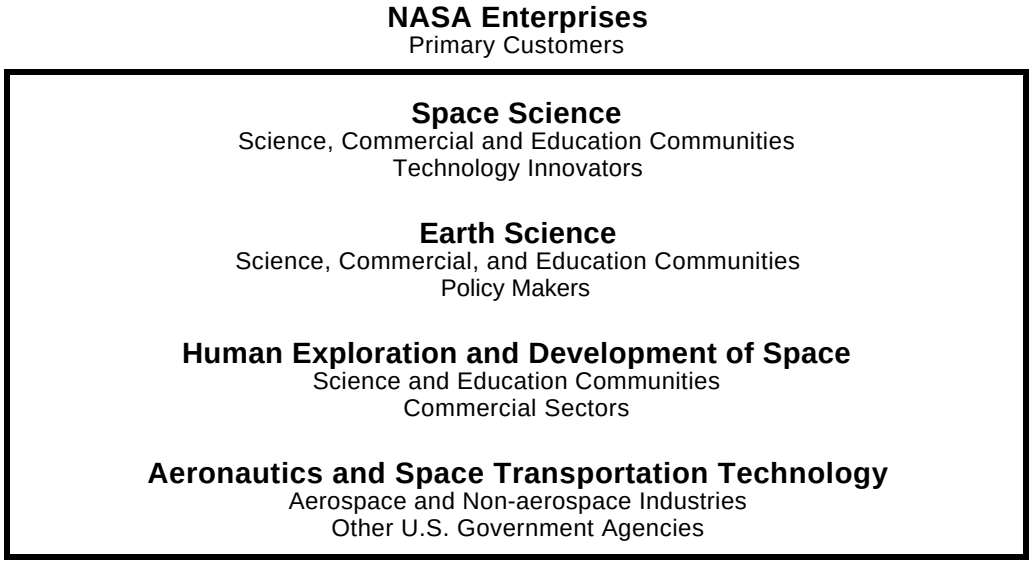

Figure 1-1. NASA's Strategic Framework

1.3 Critical Crosscutting Processes

Four Critical Crosscutting Processes (CCP's), which are the methods by which each Enterprise develops and delivers products and services to internal and external customers, are established in the NASA Strategic Management Handbook. These CCP's traverse Enterprises and the NASA infrastructure to satisfy NASA's goals and objectives that meet the needs of its customers as follows:

- Manage Strategically
- Provide Aerospace Products and Capabilities (PAPAC)
- Generate Knowledge
- Communicate Knowledge

The NASA Integrated Process Map, shown in Figure 1-2, provides a graphic illustration of these NASA CCP's and their interrelationships.

1.4 Integrated Processes

1.4.1 Critical Crosscutting Processes that Replace Phased Project Planning (PPP)

The four CCP's (Figure 1-2) are the primary activities by which NASA delivers to its customers the products and services required by the U.S. government. To more effectively provide these products and services, NASA has reengineered its framework for managing programs and projects, formerly known as Phased Project Planning (PPP). The new CCP's more broadly address NASA functions and services, and have more flexible guidelines for the conduct of their activities. The programs and projects are now managed in terms of subprocesses rather than phases.

Table 1-1 provides an overview comparison of the major elements of the new NASA PAPAC process elements with those of the former PPP approach.

The PAPAC process delivers space, ground, and aeronautical systems; technologies; services; and operational capabilities to NASA customers so they can conduct research, explore and develop space, and improve life on Earth. The PAPAC process includes both technology development to meet unique programmatic requirements and crosscutting technology development programs that support multiple applications.

Table 1-1. NASA PAPAC Subprocess Elements Overview

PAPAC Compared to Phased Project Planning

PAPAC Subprocess Elements	Former Phased Project Planning (PPP) Elements
Formulation	Pre-Phase A and Phase A (Conceptual, Feasibility, and Mission Analysis Studies) and Phase B (Definition and Preliminary Design)
Approval	Reports from Program Requirements Review (PRR); Non-Advocate Review (NAR); and such documents as the Program Commitment Agreement (PCA), Program Plan and the Program Cost Commitment (PCC) lead to project approval.
Implementation	Phases C (Design), D (Development and Operations Checkout), and E (Operations)
Evaluation	No Equivalent. Phased evaluation was conducted continually in sequential steps. The Evaluation subprocess adds systems of metrics to provide more visibility and objectivity.

1.4.2 The Four PAPAC Subprocesses in Summary

The following summarizes each of the four PAPAC subprocesses and describes the execution of the integrated process. Details on the GSFC process for implementing these subprocesses are found in paragraphs 3.1.2.2, 3.1.2.3, 3.1.2.4, and 3.1.2.5 of Volume 3 of this Handbook.

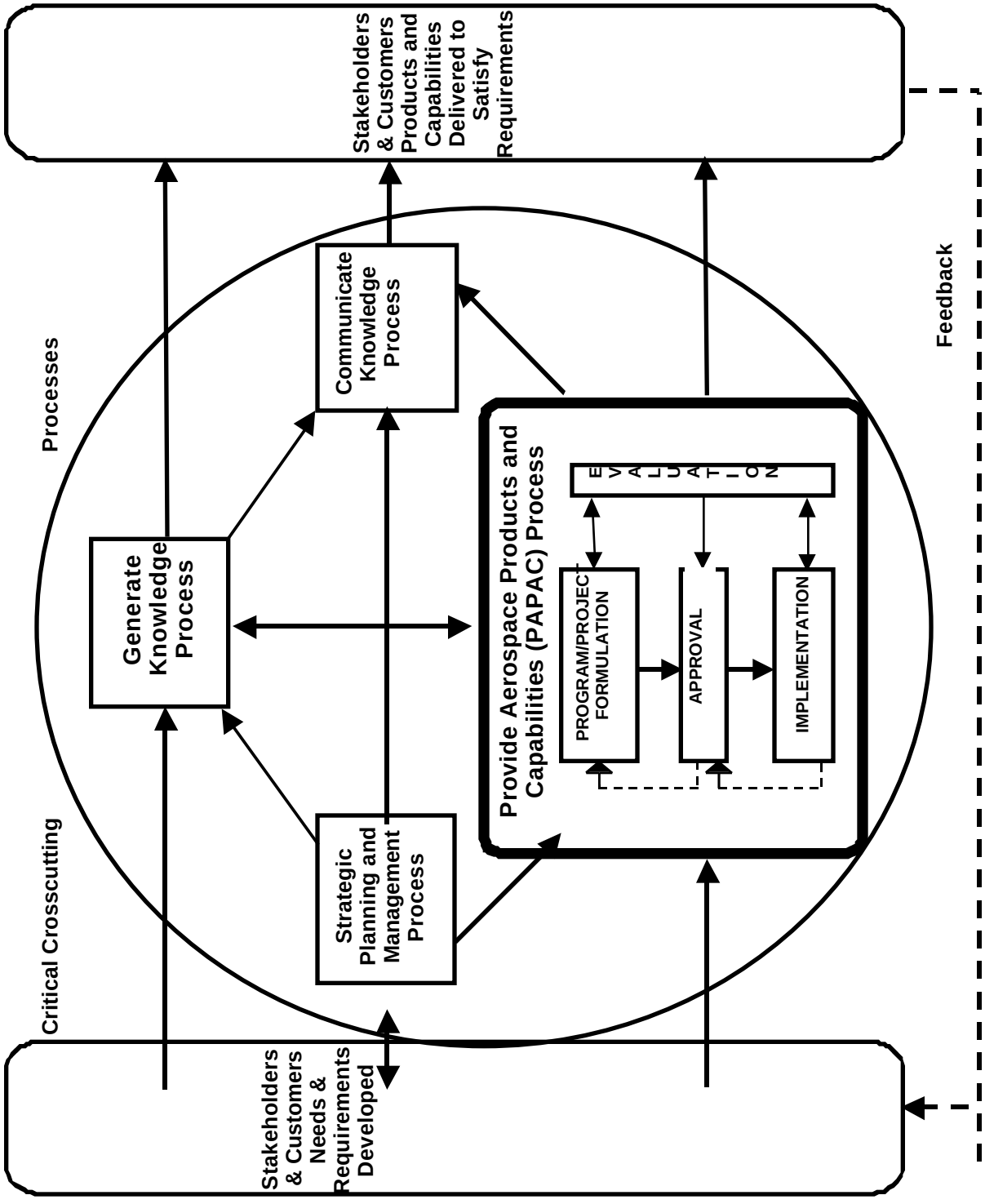

Figure 1-2. Interrelationships of Critical Crosscutting Processes

1.4.2.1 Formulation Subprocess

The purpose of the Formulation Subprocess is to define a program or project concept and plan to meet mission objectives or technology goals specified in either the NASA or Enterprise Strategic Plans. In the Formulation Subprocess, NASA/GSFC:

- Explores the full range of implementation options, including conceptual, technological, and operational approaches.
- Establishes the internal management control functions that will be used throughout the life of the program or project.
- Assesses the technology requirements and develops the plans for achieving the technology options, including options for partnering and commercialization.
- Performs Life-Cycle Cost (LCC) and performance analyses for feasible concepts.

The outcome of the Formulation Subprocess, documented in the PCA and Program/Project Plans, is as follows:

1. A comprehensive definition of program or project concepts and program/project performance objectives
2. Agreements, approaches, and plans for meeting the technical, budget, schedule, risk management, commercialization, acquisition, and related management system requirements

Throughout the Formulation Subprocess, Center-level routine reviews will inform all directorates of the subprocess status. This action is intended to satisfy ISO 9001/GPG 8700.1 requirements, and facilitate the transfer of the project between organizations as it moves from Formulation to Implementation. (Reference GPG 8700.1, especially Par. 2.8)

1.4.2.2 Approval Subprocess

The Approval Subprocess provides NASA senior management the opportunity to review and determine a program/project's readiness to proceed from Formulation through Approval to Implementation. Approval for a program or project to continue in the Formulation Subprocess may be provided where iterative formulation is required. This subprocess approves changes to the PCA and Program/Project Plans based on budgetary or technical issues or strategic redirection. NASA will only approve the baselining or rebaselining of those programs and projects that have firm cost, schedule, and content commitments. The outcome of the Approval Subprocess is as follows:

- The commitment to support the program or project as specified in the baselined or amended PCA, program plan, and project plan
- Authorization for the program or project to proceed to the Implementation Subprocess.

1.4.2.3 Implementation Subprocess

The purpose of the Implementation Subprocess is to deliver the program and project products and capabilities specified in the approved program and project requirements and plans. In the Implementation Subprocess, NASA/GSFC:

- Develops, integrates, and provides management control for the overall implementation approach.
- Works closely with customers to ensure mutual understanding of plans, objectives, and requirements.
- Converts and controls project and program requirements into implementation specifications.
- Develops the technology or systems design.
- Conducts manufacturing and testing.
- Establishes supporting infrastructure.
- Conducts operations.

1.4.2.4 Evaluation Subprocess

The Evaluation Subprocess provides independent assessments of the continuing ability of the program or project to meet its technical and programmatic commitments. These assessments are intended to add value in support of the Program – Project - Product Managers via the independent evaluations and recommendations. The Evaluation Subprocess occurs throughout the life cycle of the program or project to ensure the successful completion of Formulation, Approval, and Implementation Subprocesses. It uses the benefits of peer experiences, customer appraisal, and management expertise and tools in independent reviews of program or project concepts, plans, status, risk levels, and performance. Requirements for the reviews and assessments should be tailored, based on such factors as program and project size, criticality, and risk, and are detailed in Program/Project Plans. The outcome of the Evaluation Subprocess is a set of conclusions regarding the ability to meet commitments and recommendations for proceeding with, modifying, or terminating the program – project – product activities. Where appropriate, recommendations are also provided for enhancing overall performance.

1.4.3 Interrelationships of PAPAC to Other Critical Crosscutting Processes

Figure 1-2 illustrates the interrelationships of the four PAPAC subprocesses with each other as well as with NASA's three other CCP's. The PAPAC obtains its requirements from the Generate Knowledge and Communicate Knowledge processes (by way of scientific or technical research) and the Manage Strategically process (through strategic plans, policies, and resources). Within the PAPAC process, program and project concepts and plans, produced in the Formulation Subprocess, are evaluated and submitted for Approval Subprocess to proceed to the Implementation Subprocess. The Approval Subprocess provides initial approval and continues to support the change process of requirements and commitments. In addition, the Evaluation Subprocess supports the initial approval and continues to provide assessments by customers, experts, and stakeholders.

1.4.4 Integrated Process Themes

Several important themes that embody principles for executing program/project management in today's process-oriented environment recur throughout this document. They are described below:

a. Tailoring the Process

The program/project processes and requirements provide managers the framework to tailor approaches for formulating and implementing NASA's increasingly diverse programs and projects. While the program/project process and all requirements shall be addressed, managers can tailor approaches consistent with legal and regulatory requirements and program or project characteristics such as size, complexity, cost, criticality, and risk. Approved PCA's and Program/Project Plans will document the tailoring decisions. Requirements are contained in the process activities and management system requirements in Volume 2 and 3 of this Handbook and GPG 7120.1 Program Management and GPG 7120.2 Project Management.

In addressing the PAPAC process and requirements, tailoring is reflected in the decision to accomplish the following:

- Use the process and meet the requirement as stated
- Modify, simplify, or show how the process is addressed in another way with supporting description and rationale, and/or
- Modify the Project Manager's tools or management system requirements with supporting rationale.

b. End-to-End Customer Involvement

Managers shall identify customers and ensure that they are actively involved in program and project activities throughout the PAPAC process. Customer participation will increase the ability of the program or project to achieve customer objectives within established constraints.

c. Comprehensive Definition and Requirements Control

NASA shall only undertake programs and projects that have clearly defined objectives, are consistent with the NASA Strategic Plan, and have a comprehensive definition of cost, schedule, and content commitments. Agreements and requirements must be controlled throughout the program or project life cycle, from formulation through completion.

d. Risk Management

The Program or Project Manager shall apply risk management principles as a decision-making tool that enables programmatic and technical success. Program and project decisions shall be made on the basis of an orderly risk management effort, including the identification, assessment, mitigation, and disposition of risks throughout the PAPAC process.

e. Missions Enabled Technology

Enterprise objectives will be used to drive crosscutting technology programs by conducting end-to-end systems analyses of generic, reference missions. New technology products will expand mission horizons, and missions will evolve from a convergence of enterprise objectives and technology. This will promote development and rapid infusion of cutting-edge technology to enhance performance, reduce risk, and lower cost.

f. Technology Commercialization

Programs and projects will strive to enable the use of NASA technology by U.S. firms for commercial applications. Leveraging cooperative technologies and commercialization opportunities will maximize the commercial potential of new technology and its contribution to the national economy.

g. ISO 9001

NASA's priority for achieving and maintaining ISO 9001 certification reflects a commitment to implement high-quality, controlled, and defined work processes.

ISO 9001 complements NASA's existing quality management system. ISO 9001 provides a series of standards and guidelines that define a quality system accepted internationally. The 20 elements contained in Section 4 of the standard are:

4.1 Management Responsibility
4.2 Quality System
4.3 Contract Review
4.4 Design Control
4.5 Document and Data Control
4.6 Purchasing
4.7 Control of Customer-Supplied Product
4.8 Product Identification and Traceability
4.9 Process Control
4.10 Inspection and Testing
4.11 Control of Inspection, Measuring, and Test Equipment
4.12 Inspection and Test Status
4.13 Control of Nonconforming Product
4.14 Corrective and Preventive Action
4.15 Handling, Storage, Packaging, Preservation, and Delivery
4.16 Control of Quality Records
4.17 Internal Quality Audits
4.18 Training
4.19 Servicing
4.20 Statistical Techniques

The GSFC's Quality Manual (see GPG 8730.3) implements these elements, and their application is defined in a series of GPG's. Element 4.19, Servicing, is not within the current scope of GSFC's implementation of ISO 9001.

The PAPAC process and associated requirements provide the framework that shall be supported by these GSFC-certified processes.

GODDARD HANDBOOK FOR MANAGEMENT OF PROGRAMS – PROJECTS – PRODUCTS

Volume 2

Program Management

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VOLUME 2. Program Management

2.0 Introduction to Program Management

NASA Policy Directive (NPD) 7120.4 states NASA's policy on Program/Project Management, establishing the management system by which we formulate, approve, implement and evaluate all programs and projects for development and operation of aeronautical and space ground and flight systems and technologies. NASA Procedures and Guidelines (NPG) 7120.5 went on to define programs as major activities within an Enterprise that have defined goals, objectives, requirements, and funding levels, and consist of one or more projects. Although GSFC manages many projects and products, the number of programs is limited to a handful. (E.g. Explorers, the Earth Observing System (EOS), Earth Probes (EP), Solar Terrestrial Probes (STP), Hubble Space Telescope (HST), Networks Mission Services, International Projects, New Millennium, Polar Operational Environmental Satellite (POES) and Geostationary Operational Environmental Satellite (GOES)). This volume of the Handbook is designed to specifically address the management of GSFC programs. The focus of this volume is on the uniqueness of GSFC Program Management, adherence to NPG 7120.5, and compliance with ISO 9001.

An integral part of the Program – Project - Product Handbook, this volume is intended only as a *guide* to Program Management at GSFC. Familiarity with NPD 7120.4, NPG 7120.5, the rest of this Handbook, and the GSFC Quality Management System (QMS) is expected. Programs shall meet all applicable requirements of NPG 7120.5 and Goddard Procedures and Guidelines (GPG). However they can be tailored to meet specific program needs and flexibilities.

The Program Management Volume is presented in three main sections:

- Section 2.2 addresses the GSFC environment, discussing history, culture, and current environmental factors.
- Section 2.3 addresses the Program evolution processes including formulation, implementation, approval and the unique qualities and processes that make GSFC a significant leader in program management.
- Section 2.4 addresses the roles and responsibilities of the Program Manager, discussing such topics as strategic planning, communications, program synergy, advocacy and counseling.

2.1 Summary of Roles and Responsibilities for the Program Manager and Senior Scientist

2.1.1 The Program Manager Responsibility List

The Program Manager is responsible for:

a. Program planning, including recommendation of program objectives, requirements, Implementation guidelines, budget and milestones, and preparation of Program Plans and supporting development of PCA's.
b. Developing, recommending, and advocating program resources.
c. Allocating budget to projects.
d. Establishing support agreements.
e. Executing and overseeing the Program Plan.
f. Controlling program changes.
g. Approving Project Plans and associated changes.
h. Establishing project performance metrics.
i. Integrating the planning and executing of individual projects or programs composed of multiple interdependent projects.
j. Reviewing and reporting program/project performance.
k. Complying with applicable Federal law, regulations, executive orders, and NASA directives.

In pursuit of these responsibilities, the Program Manager is required to develop and maintain a close relationship with the Project Manager(s) and other GSFC officials on the program utilizing sound technical and managerial judgement.

2.1.2 A Responsibility List for a Senior Scientist

The Senior Scientist assigned to a Program Office is typically responsible for:

1. Achievement of scientific goals and objectives of the program, for dealing with the scientific community, and interfacing with the Project Scientist(s).
2. Participating in the development of the AO and obtaining the necessary coordination and approval for the AO. He/she recommends appointments to the Ad Hoc Advisory Subcommittee of the steering Committee and is responsible for preparation of necessary documentation.
3. Forming a team with the Project Scientist(s) and the program/project advocacy and to inform the public of the importance of the program/project.
4. Working together with the Project Scientist(s) to ensure that science objectives of the program/project are met.

2.2 The GSFC Environment

This section discusses the unique implementation aspects of program management at GSFC. It reflects a program management process that is defined by the GSFC history and culture, core competencies, and an organization that enables the Center's program and project implementation.

GSFC is a customer-focused organization with extensive background in program and project management and significant management, technical, and infrastructure resources to apply to its efforts. GSFC is a world leader in research and technology development, and in space flight design. The Center's diverse set of customers and partners includes organizations that are novice through expert in the aerospace market, small to large in size, and located worldwide. These customers, partners and stakeholders can be found within GSFC organizations, at other NASA Centers, other government agencies, academia, industry, and foreign governments.

GSFC is recognized as a world class expert in project management. It manages more individual projects than any other NASA Center. These projects are widely diverse in size, cost, and technical complexity. They are in response to direction from the Earth Science, Space Science, and Human Exploration Enterprises at NASA Headquarters. This expertise has been demonstrated through the successful completion of a large number of missions. GSFC's breadth of technical expertise is a significant contributor to this success. The Center has extensive experience in all aspects of mission/project management, design, development and operations. This capability includes, but is not limited to, spacecraft, instruments, launch vehicles, ground systems, and operations. GSFC's experience involves all aspects of mission/project evolution from a scientist's idea to the final delivery of the data to that scientist, and, frequently, others who utilize the data.

The science interface of the program office with the science community and Headquarters is very strong since GSFC's core competencies include scientific research in Earth and Space Science. This strong interface makes the scientific customer interface more effective, ensuring that customer requirements are understood and met throughout the Program/Project life cycle processes.

In order to enable spaceflight missions, GSFC has significant experienced core competencies in program/project management, end-to-end mission systems engineering, and development of advanced technologies. There is a large civil servant workforce involved in support of this critical work, with extensive industry resources available as needed. GSFC's excellent facilities are available

to meet the diverse needs required for the design and development of flight systems and the enabling of advanced technology.

In order to focus resources on the customer's needs and be responsive to a changing environment, GSFC is organized to be responsive to the delegation of program management responsibilities to the Centers from NASA Headquarters, the need to increase focus on advanced technologies, and the redesign of NASA's processes. The NASA Strategic Plan, the GSFC Strategic Implementation Plan, and Goddard's organization share the same Enterprise structure, processes, and objectives.

The GSFC organizational structure is set up to support the conduct of major programs. Space and Earth Science Directorates (Codes 600 and 900) provide the scientific customer representation on site, while all Goddard directorates support the Formulation, Approval and Implementation Subprocesses. A matrix organization is utilized to optimize the conduct of the individual processes and functions, while each program is supported as a customer by each directorate. The Flight Programs and Projects Directorate (FPPD) is structured to focus the efforts required for this increasing program management activity and the implementation of GSFC's projects. The Applied Engineering and Technology Directorate (AETD) combines the discipline engineering resources at GSFC into an efficient and responsive structure that allows for supporting the growing technical activities with the same quantity of resources, enabling advanced technologies required to meet our customer's goals, and the development of a world class technical workforce. The Systems Technology and Advanced Concepts (STAAC) Directorate, focuses GSFC's systems engineering resources, leads the project formulation activities, manages instrument development, and supports NASA's technology planning and commercialization efforts.

GSFC's program management has been a key to the successful achievement of many of the Agency's strategic goals and objectives through the planning and implementation of programs. The program management role at GSFC varies as a function of the type of program. The variation of program integration with project interdependency within a program is described in Figure 2-1, using a number of NASA programs as examples. For programs with interdependent projects (e.g., HST), the Program Manager provides a high level of program integration to ensure all project interfaces. Other programs have independent projects with common elements (e.g., EOS) and a medium level of integration is required at the program level. For programs with multiple independent projects (e.g., Explorers/Earth Probes), the role of the Program Manger is one of initiating and fostering the projects, and assisting Center management and Headquarters in program implementation. For these types of programs, there is minimal need for cross-project integration.

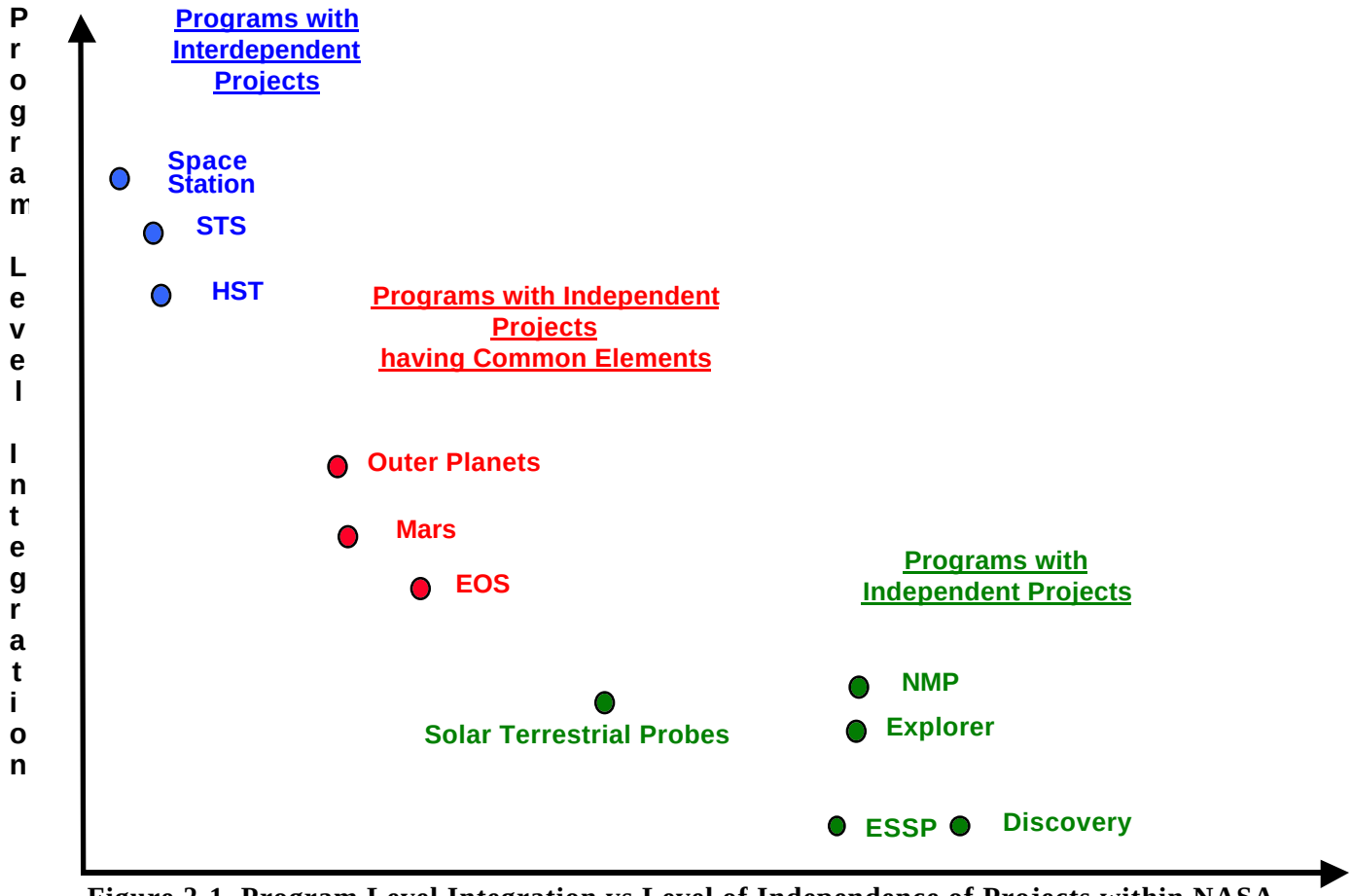

Figure 2-1 Program Level Integration vs Level of Independence of Projects within NASA Programs

2.3 Program Lifecycle Processes

The following section describes the life cycle of a program at GSFC from the initial Formulation through Approval and Implementation, with emphasis on unique aspects of program management at GSFC.

2.3.1 Program Formulation

The Formulation of a new program requires close interaction between the Enterprise Office (normally at NASA Headquarters) and the GSFC Office of the Associate Director (OAD). These are very important events that may involve the establishment of a new budget for a program with strategically defined projects (e.g., Earth Probes). The Formulation of new programs requires considerable attention at NASA top management, Enterprise, science and user community, industry, Administration and Congressional levels. The longstanding impact of a program requires a very careful and thorough Formulation to ensure that:

- Strategic objectives are understood and can be met with planned resources
- The process is in place to deal with new technologies required
- The widest range of possible business opportunities have been explored
- The timing for Formulation of the new program, is correct, the need is compelling, and the capability to implement the program is available.

· Strong interfaces with customers, partners, and stakeholders are developed to assure input to program/project processes.

Program Formulation is led by Associate Center Director (ACD), with support from various GSFC Directorates. The ACD may delegate program and project management responsibility for applicable programs or projects, including authority to appoint program and/or project managers, to the Director of Suborbital Projects and Operations.

The Formulation effort begins officially with the Formulation Authorization (FA) document sent to GSFC from the Enterprise Office. Prior to the issuance of the FA, the ACD appoints a Program Integration Manager (PIM) in the OAD to coordinate the expected program formulation support with the Enterprise and GSFC directorates. There is no clear path for the early coordination of a new program. The OAD coordinates with the relevant science community, Enterprise management, Center management, and key technical and administrative offices who can assist with establishing the program. This coordination ensures a level of understanding between the Enterprise and GSFC that the proposed program is supportive of the Enterprise Strategic Plan and is capable of being formulated with a successful budget initiative.

Following the FA issuance, the Formulation Subprocess begins with enabling activities that are similar to those conducted in the Formulation of a project. The major distinction is the longer life and integration of the program versus a project, which has a distinct beginning and end, and the resulting consideration for the coordinated Formulation, Approval, Implementation and Evaluation of projects during the life cycle of the program. When the range of program options is sufficiently well understood that the Formulation Subprocess can focus on the effort to definitize the program, and a program plan can be produced at GSFC, supported by a Program Commitment Agreement (PCA) at Headquarters, the program enters the Approval Subprocess. A Program Manager is assigned at the beginning of the definitization effort to take responsibility for making program commitments for Approval and Implementation. The new program must adhere to NPG 7120.5. The tailoring of the management of each program is documented in the Program Plan. The additional support plans required for the Approval Subprocess are similar to those required in Formulating a project.

Throughout the creation of a new program, the Formulation effort requires a high level of advocacy and a very close coordination with the Enterprise Office and the science/user community or customer of the program.

2.3.2 Program Approval

The Program Formulation Subprocess for a new program creates the PCA and the Program Plan in accordance with the NPG 7120.5 formats. These two documents shall be available and maintained for the Non-Advocate Review (NAR) and ready for signature at the time of the approval review within the NASA PMC. (A review by the Goddard PMC is likely to occur prior to the NASA PMC approval review.) The results of the NAR and/or Independent Assessment (IA) are also presented to the NASA PMC, by the Enterprise Associate Administrator (EAA). The approval review provides the decision regarding the initiation of program implementation, or the continuation of program formulation, and resubmission of a program for approval at a later date. If necessary, agreements (PCA and Program Plans) shall be modified, reviewed by the NASA Program Management Council (PMC), and signed by the approving official upon resolution of NASA PMC recommendations.

The Program Plan is the key vehicle for defining the program objectives, responsibilities, resources and GSFC commitments as well as establishing any other key agreements, such as tailoring of requirements and procedures, among the Program Manager, Center Director, and EAA. The Program Manager should lead the drafting of the document and the negotiations with Center and Enterprise managers. NPG 7120.5 provides a recommended outline and content for the Program

Plan. The Center review draft should be reviewed at the Center and Directorate levels before forwarding it to Headquarters. All affected directorates must be given an opportunity to review and comment. Each of the directorates that provide comments should be provided feedback as to the action taken and the rationale. While an informal advanced copy can be shared with the Headquarters office, the official Headquarters review draft must be approved by the Center Director before submittal to Headquarters.

2.3.3 Program Implementation

At this point, a self-contained program, which has defined projects, proceeds with implementation. Program level integration is provided to ensure the interfaces. For the implementation of a program which involves a continuum of projects, new projects can be in various stages of Formulation, Approval, and Implementation, which then require an adjustment to the current program Life-Cycle Cost (LCC). This activity requires the program office to conduct concurrent processes where new projects are being formulated, integrated and advocated for approval, while approved projects are being implemented. This parallel activity is illustrated in Figure 1-3 from NPG 7120.5. The approval of these projects is described in Volume 3 of this Handbook. The Program Plan and PCA are amended, as appropriate, for the addition of each new project.

The program office represents all projects throughout this life cycle to the Governing Program Management Council (GPMC). The GPMC may be at Headquarters or at a Field Center, if designated by the NASA PMC, as documented in the Program Plan. The continuation of a program will require advocacy on the part of the program office to adapt to the changing environment in the Administration, Congress, NASA management, new technology, etc. This advocacy is closely coordinated with the Enterprise to ensure the continuing vitality of the program and the new projects that comprise the program.

2.3.4 Program Evaluation

The evaluation of a program and its projects is specified in the Program Plan. Independent evaluation consists of the NAR and possibly an IA (if directed by Headquarters or requested by the program office) during program approval, and one or more Independent Annual Review's (IAR's) during program implementation. Special reviews, such as External Independent Readiness Review (EIRR) may be directed by the EAA as required. The reviews, specified by the program for the projects, are also conducted as part of the Evaluation Subprocess. In this regard, the program office is evaluating the performance of the individual projects and presenting monthly status to the GPMC, while the program office is assisting and stabilizing the environment for the conduct of the project within the program.

2.4 Program Manager Roles and Responsibilities

The Program Manager should view her/himself as the one person in NASA who is responsible for the program and must ensure overall effective management. It is a critical leadership position. Within a Program, the Project Managers manage the individual projects; the Program Manager manages their environment and adjusts the focus of projects to produce integrated program results to ensure customer satisfaction.

No attempt to reinterpret NPG 7120.5 is made here; rather the key roles of a Program Manager as a leader, and some insights regarding their fulfillment, are offered. The key roles of a Program Manager are:

- Set the tone and character of the program.
- Advocate the program and its projects.
- Lead strategic planning.
- Plan and integrate the program budget
- Confirm program and projects are meeting their commitments
- Ensure program-wide efficiency and synergy.
- Promote effective communication to and from the environment.
- Establish consistent policies and procedures.
- Help Project Managers focus on their projects.
- Advise and counsel Project Managers.

The following paragraphs address each of these roles.

2.4.1 Set the Tone and Character of the Program

The tone and character of a program are its "personality" and influences how people react to and support the program. The Program Manager must establish in his/her own mind the vision, values, and principles on which his/her leadership of the program will be based. Discussions with customers (e.g., science community), Center management, Headquarters EAA management, and one's peers can validate or modify these internal ideas and influence the perceived character of the program. Even if taking over in the middle of the program, this role is important to establishing one's leadership as well as others' future support and expectations for the program.

The tailoring of NPG 7120.5 requirements and processes, in conjunction with the Center Director and EAA, is one of the key methods that a Program Manager can use to define the character of the Program. While the Program Manager can initially influence the tone and character of the program by advocacy and communication, over the long-term it will be influenced mostly by his/her decisions and actions.

Projects within a program may be formulated and managed at other Centers. The Program Manager should take the extra effort to learn and understand the management structure and people at that other Center and, in return, provide clear communication of the program tone and character, policies, expectations, and integration. Personal involvement in formulation of projects managed at other Centers is particularly important to help bridge any organizational communication gaps.

2.4.2 Advocate the Program and Its Projects

The Program Manager must gain an in-depth understanding of the purpose of the program as defined by the benefits to the customer community, NASA, the nation, and, perhaps, the world. The Program Manager should use this understanding to advocate (promote and defend) the program, the appropriateness of its resource requirements, the logic of its project set and how it achieves program goals, and the relationship of the projects to one another. The Program Manager advocates the elements of his/her program by such activities as strong participation in NASA and external committees and developing support relationships within the Programs/Projects.

Clearly, the Program Manager is not alone in this advocacy or there wouldn't be a program. The Program Scientist (often from Headquarters) and GSFC Project Scientist are key advocates and spokespersons for science programs. Non-science programs typically have similarly knowledgeable members of the customer community who want to help advocate the program. The EAA management team at Headquarters is the prime focus of advocacy within NASA. Center management, including the OAD, FPPD, and STAAC are key allies, especially during program Formulation. The Public Affairs Office can help with outreach and educational efforts. Often other NASA Centers, other government agencies, or private industry become natural allies. The Program Manager should foster and coordinate advocacy among the broadest base possible. During program Formulation and Approval, advocacy is a major role. During Implementation it is less prominent; but is still significant, especially during the budget cycle and during the Formulation of new projects within the program.

2.4.3 Lead Strategic Planning

During program Formulation, strategic planning is the Program Manager's primary role. He/she must establish program objectives, requirements, and resources; structure and organize the program; identify and recruit key personnel; build strong interfaces with the customers, partners, and stakeholders; facilitate development of the PCA and Program Plan; and plan for Formulation of the initial project(s).

The program organizational structure and associated roles and responsibilities within the program depend strongly on the interdependence of the projects within the program and the scope of each project's responsibilities. The program resources management may be distributed or centralized. Each project may have greater or lesser independence or staffing. For example, the HST Program has two projects – Servicing and Operations. Each has extensive scope, yet are very interdependent. Each of the Hubble projects has a full project staff as well as collocated technical personnel. Yet the Hubble Program Office retains overall leadership as well as key control functions, such as integrated schedule management and configuration control, due to the highly interdependent nature of the projects. As an alternative example, the Explorers Program has a multitude of relatively small projects that are unrelated to one another. The project staffs vary depending on their size and the extent of in-house responsibility. The Program Office seeks synergy and consistency among the projects and manages all the resources to provide maximum flexibility among the projects, but allows each project to be managed with a high degree of independence.

One of the most far-reaching decisions the Program Manager will make is in the staffing of the key members of the program. Foremost are the Deputy Program Manager and Program Business Manager. Not all programs have a Deputy Program Manager. Some Program Managers prefer to use one of the Project Managers as a deputy and use the saved personnel allocation for another position. The Program Business Manager is a key member of the management team and should be selected in close consultation with the Deputy FPPD Director for Business Management.

The Program Manager and his/her staff should be active in new project Formulation. This ensures consistency with program requirements, resources, policies, efficiency, and synergy. It also provides the Program Manager with personal insight into each project. The exact nature of the Formulation will depend on whether the project is a directed or competed project:

1. On competed projects, the GSFC program office role is directed by the Enterprise and specified in the Program Plan and can include support of the:

    a) Preparation of the AO references for Headquarters prior to release.
    b) Proposal evaluation as ex officio non-voting members.
    c) Management of the early Formulation/enabling activities of the selected projects prior to downselection.
    d) Management of Formulation Definitization of the selected projects post downselection.
    e) Management of the Implementation of the selected projects.

Presently, Code Y requests program support for all the items above while Code S requests support for items a, c, d, and e. Additionally, Code S support for item c is presently under review where a GSFC proposal is included in the downselection process.

2. On directed projects, the STAAC Directorate plays a major role. The Project Formulation Manager (PFM), from the STAAC Mission Development office, leads the formulation team. The PFM reports to the Program Manager, as the customer of STAAC. With the concurrence of Headquarters and the GSFC Director, the Director of FPPD, supported by the STAAC Director, appoints a Project Manager no later than the beginning of the Definitization activity to lead the effort through the remainder of the Formulation Subprocess and then the Implementation Subprocess. No matter the specifics of the Formulation Subprocess, it is important that the Program Manager clearly communicate overall Formulation/Implementation requirements and constraints to the project leadership.

Throughout program Implementation, strategic planning should continue. Regular interaction with the customer community and Headquarters management should provide opportunities to identify any evolution in customer or NASA objectives as well as their satisfaction with the program. Attendance at customer community conferences, Headquarters advisory panel meetings, or, if appropriate, occasional program workshops provide good vehicles to interact with the customer community. The Program Manager should advocate and ensure customer involvement throughout the Program and its Project. Technology and launch vehicle capabilities should be monitored to assess their potential for improving or impacting the program.

2.4.4 Plan and Integrate the Program Budget

The funding requirements given in the Program Plan are likely to be a snapshot in time. As the program is developed, funding requirements are further defined in the Program Operating Plan (POP) and will need to be justified and defined. The NASA annual budget POP process will update the specifics of the program budget levels, phasing and allocations. The Program Plan will reflect the intent to update the budget during the POP cycle or in the Program Plan, updated annually at the end of the POP cycle. Internal to GSFC, similar annual planning processes determine travel and manpower budgets for the program. As part of these resource-planning efforts, the program office will have to integrate the requirements from the different projects as well as its own, and advocate the required budget(s). Once a program allocation is received, the Program Manager will have to decide on project-level resource allocations.

2.4.5 Confirm Program and Projects Are Meeting Their Commitments

As the one person responsible for program success, the Program Manager leads the evaluation process to confirm that the program and projects are meeting their commitments during Implementation. The vehicle for defining Program Evaluation is the Project Plan for each project. Personal and customer involvement, informal meetings with the Project Manager's, program staff meetings, monthly review preparations, active participation in the GSFC budget planning approval and execution process, and independent reviews are candidate methods a Program Manager can apply to fulfill this role. Care should be taken not to over-tax the projects with oversight. Agreements should be documented with each Project Manager in the Project Plan and adhered to. Depending on the agreements in the PCA and Program Plan, the program and/or projects may undergo independent Center or Headquarters evaluation reviews such as the IAR and EIRR.

2.4.6 Ensure Program-wide Efficiency and Synergy

From where he/she stands, the Program Manager can see the gamut of projects under his/her management. This visibility puts the Program Manager in the unique situation of being able to find ways to leverage the projects so that common elements will benefit all. Since programs are generally made up of projects having similar scientific disciplines (e.g., Earth Sciences, Space Sciences, Technology), there are many facets of these projects that are similar, in addition to those of general management. One way that a Program Manager can leverage his/her projects is by sharing resources. This can be done for programs with interdependent projects as well as those with independent projects.

With budgets becoming increasingly smaller and the need to be more efficient, the Program Manager must exercise leadership in ensuring that similar project requirements are met with the same or similar implementations when advantageous. While every project within a program need not necessarily look like every other one program management it provides an opportunity to investigate areas of system, hardware, document, personnel, process and procedure commonality. In addition, management control tools such as scheduling, planning, resource allocation, and configuration control should be considered for common implementation. Finally, by maintaining good communications within the program elements, common solutions to technical problems can be adopted where appropriate. Of course decisions to implement common solutions must be based upon the requirements of each project. It has been shown, however, that when Project Managers are willing to keep an open mind in looking at these areas of shared resources, significant synergism among projects occurs. These lead to savings of time and/or dollars.

2.4.7 Promote Effective Communication To and From the Environment

In order for a program to be successful, the Program Manager needs to be mindful of the external environment at GSFC, Headquarters, other NASA Centers, the science and technology communities, etc. Open communication to and from that environment is especially important. Impediments to a free flow of information must be avoided. On the other hand, Project Managers must be sure that the Program Manager is aware of significant discussions, meetings, agreements, etc. Surprises to management should be avoided.

The Program Manager is dependent on external organizations for the political, programmatic, financial and technical support to properly execute the program. This is true whether or not the projects within the program are directly managed by GSFC, by another NASA Center, or by a Principal Investigator (PI) in the PI mode. There is no room, in a properly managed program or project, for supporting organizations and personnel not to be aware of what is happening and to not have them be part of the decision-making process when it is appropriate to do so. This is particularly true for customers or stakeholders, without whose support most programs would not exist.

The customer or stakeholder should be a part of every project team and should be in the communications loop. Their support is invaluable and they should be considered a resource for the Program or Project Manager. The Program Manager, in setting the tone and character of the program, must ensure that communications to and from all parts of the external environment are properly established and implemented.

2.4.8 Establish Consistent Policies and Procedures

In order to make the program more streamlined and efficient, the Program Manager should take the time to investigate areas of system, hardware, NASA Information Technology (IT), documentation, process and procedure commonality between his/her projects. Management control tools such as scheduling, planning, resource allocation, and configuration managment should also be considered for common usage. In addition, the Program Manager should strive to have a GSFC QMS compliant program/project management system with Safety Requirements & Quality Assurance (SR&QA) that is essentially common to all projects. Tailoring to meet the specific requirements of each project should then be done. Project policies must be clear and concise. Program Managers directing new projects should consider elements of other projects while integrating their own projects' activities. The Program Manager must ensure that Project Plans contain program-compatible requirements.

Policies and procedures for the development of program/project budgets and the methods for tracking and reporting against them should be made consistent over the entire program, including conformance to GSFC procedures for contractor financial management reporting, contingency and Allowance for Program Adjustment (APA) and LCC's. Exceptions can be made if warranted and clearly defined.

Most projects require similar documentation. In order to make review by the Program Manager and upper management effective and efficient, a boilerplate for documentation and reporting should be established and adhered to as closely as possible. All Project Managers should know what the Program's documentation requirements are (see GPG 1060.2). The Program Manager must ensure that they do.

2.4.9 Help Project Managers Focus On Their Projects

The Program Manager should never attempt to micro-manage. Rather, the Program Manager should act as a filter and facilitator. Unwanted interference or distractions coming from the external environment should be prevented from reaching the Project Managers as much as possible. The Project Managers should be able to count on the support of the Program Manager in advocating and fighting for budgetary, manpower and facility resources.

There are other requirements imposed on projects from GSFC, Headquarters and the "community" at large. The Program Manager should relieve the Project Managers of these unwanted tasks by taking responsibility for managing these requirements directly when possible. He/she should do everything possible to ensure that requirements that do not add value to a project are not allowed to distract the Project Managers from their primary objective, i.e., successfully managing their projects.

2.4.10 Advise and Counsel Project Managers

In addition to being a filter and facilitator, the Program Manager should nurture and council his/her Project Managers when needed. Since not all Project Managers are equal in their experience or ability, the Program Manager must act as a teacher to those Project Managers that require the additional support. Conversely, the Program Manager should not interfere with Project Managers who do not require additional care and counseling.

Since the Program Manager has oversight of all the projects within the program, he/she also has the ability to assist the Project Managers whenever the situation demands it. By acting as a "deputy" Project Manager, on an ad hoc basis, the Program Manager can provide enormous relief to the Project Manager.

GODDARD HANDBOOK FOR MANAGEMENT OF PROGRAMS – PROJECTS – PRODUCTS

Volume 3

Project Management

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PROGRAMS – PROJECTS - PRODUCTS

VOLUME 3. Project Management

VOLUME 3. PROJECT MANAGEMENT

3.0 Introduction

Every project is an element of a program—in rare cases, one project constitutes the only project of a program. GSFC projects range in size from relatively small Shuttle Attached Payloads to Explorers and ESSP-class missions to great observatories such as Hubble Space Telescope (HST). However, regardless of size, cost, complexity, or scientific or schedule priority, each project is guided and directed by the same management principles embodied in the NASA and GSFC policies, processes, procedures and guidelines. Projects shall meet all applicable requirements of NPG 7120.5 and Goddard Procedures and Guidelines (GPG's), however, these processes and procedures can be tailored to the specific project's need, NASA program authorization and direction, and GSFC management's implementation of the project. Volume 3 of this Handbook emphasizes NPG 7120.5 Project requirements and guidelines; Volume 4 concentrates on the GSFC QMS GPG requirements, particularly those necessary for ISO 9001 compliance for GSFC products and services provided to customers. Therefore, all products and services within scope of the GSFC QMS, which includes those of flight programs and projects and elements thereof, must be compliant with GSFC QMS product requirements.

Every GSFC directorate supports the project management process, including the following contributions:

- Office of the Director (Code 100) - Center executive management, Office of the Chief Counsel, the Chief Financial Officer, the Human Resources Office (HRO) functions, and participation in all Provide Aerospace Products and Capabilities (PAPAC) Subprocesses.
- Management Operations Directorate (Code 200) - Institutional support, including procurement, security, facilities management and personnel safety.
- Office of Flight Assurance (Code 300) - Centralized performance assurance and quality assurance functions, including performance analysis and reliability consultation, and strong participation in the PAPAC Evaluation subprocess.
- Flight Programs and Projects Directorate (Code 400) - Flight Project planning and management, including support to the PAPAC Formulation, Evaluation and Approval subprocesses; Implementation subprocess leadership, specific guidance and direction in management, and project-unique institutional support.
- Applied Engineering and Technology Directorate (Code 500) – Goddard-wide applied engineering, discipline support, and technology development.
- Space Sciences Directorate (Code 600) - Space science research, including planning, science management and direction, and development of selected instruments or sensors.
- Systems, Technology, and Advanced Concepts Directorate (Code 700) - Advanced technology and systems engineering, Access to Space (ATS), and PAPAC Formulation Subprocess leadership.
- Suborbital Projects and Operations Directorate (Code 800) - Sub-orbital, Shuttle (and potentially Space Station) Attached Payload, balloon flight, research aircraft and sounding rocket planning, management, support and execution.
- Earth Sciences Directorate (Code 900) - Earth science research, including planning, science management and direction, and development of selected instruments or sensors.

A project is an activity designated by a program and characterized as having defined goals, objectives, requirements, LCC's, and a beginning and an end. The minimum required documents for NPG 7120.5 project compliance are the following:

- Program Commitment Agreement
- Program Plan (which includes the specified project)
- Project Plan (authorized by specific inclusion in the Program Plan)

3.1 Goddard Project Environment

3.1.1 GSFC Organization: Reengineered Roles

Led by NASA's Administrator, NASA Headquarters made a number of organizational and management changes to facilitate the improved processes embodied in the Strategic Plan and Strategic Management Handbook. Among them was the move to establish four Strategic Enterprises and the shift of the Program Manager and most Program Scientist roles to NASA Field Centers. This shift improves the Field Centers' abilities to respond to their customers – the NASA Strategic Enterprises, the public, and other specific entities.

In concert with the NASA Headquarters' reorganization into Strategic Enterprises and program-level responsibilities at Field Centers, GSFC responded with an extensive reorganization to align with the key Strategic Enterprise activities for which it is responsible. Therefore, many traditional roles at GSFC changed, such as the emergence of new directorates**:** the System Technology and Advanced Concepts (STAAC) Directorate and the Applied Engineering and Technology Directorate (AETD). Generally, STAAC takes the leading role in Project Formulation and Approval, while the Flight Programs and Projects Directorate (FPPD) supports Project Formulation and generally leads Goddard's Project Implementation, with the exception of those delegated to the Suborbital Projects and Operations Directorate (ref. Volume 2, Para. 2.3.1). FPPD, AETD, and the Science directorates share a partnering role in the Approval activities to ensure continuity and project success. The Science directorates, STAAC, and AETD support the project during Formulation and Implementation, providing necessary science and engineering leadership.

3.1.2 Development of a Project

A project is an organization established to assemble a mission and integrate a set of goals and objectives. The development of a project proceeds Pre-formulation, then through the PAPAC subprocesses of Formulation, Approval, Implementation and Evaluation. Evaluation is ongoing throughout the development of a project.

Missions concepts developed at GSFC vary in definition and maturity. In all cases, it is necessary to understand the commitment of resources the Center is making in supporting each customer. Achieving this understanding may require developing feasible mission concepts, in Pre-formulation, supporting New Business Committee (NBC) briefings, formulating a specific project, or developing a specific proposal in response to an AO. This support will be provided to the customer by identifying a Project Formulation Manager (PFM) who acts as the lead for Pre-formulation, project formulation, and potentially proposal development. It is the policy of GSFC to provide continuity of key personnel throughout definition, design, and development whenever possible. Based on the recommendation of the Chief of the Project Formulation Office, appointments of PFM's will be made jointly by the Directors of STAAC and the Director of Flight Programs and Projects Directorate (FPPD), with the concurrence of the Program Manager and the customer. Instrument Manager (IM), appointments will be by the Flight Instrument Development Office, and will require concurrence of the Chief, Mission Integration Planning Division, and the customer.

Missions may enter Pre-formulation through one of several methods. An Enterprise directed mission enters Pre-formulation immediately. Innovative Concept Development (ref SED PG) occurs within the Systems Engineering Division of the STAAC. Concepts with sufficient majority are presented to the Pre-formulation for approval to enter Pre-formulation. Customers may also bring mission concepts directly to the NBC for approval to enter Pre-formulation

An Enterprise-directed mission is formulated at the request of some element of an Enterprise with the expectation of funding via a new start in the POP process. These missions do not compete for

funding via an AO, although project elements such as investigations may be competed and funded by a mission-unique AO. The mission is integrated into a program as a project after source selection. A PFM manages the development. These missions may be undefined at the beginning of formulation and thus require a lengthier and more extensive process than the typical competed mission. The AETD and the System Engineering Division (SED) within STAAC support both types of missions for system and discipline and system engineering. A further discussion of directed and missions can be found in Supplemental Volume 5 of this Handbook.

PROGRAM/PROJECT LIFE CYCLE OVERVIEW
Within the Provide Aerospace Products and Capabilities (PAPAC)

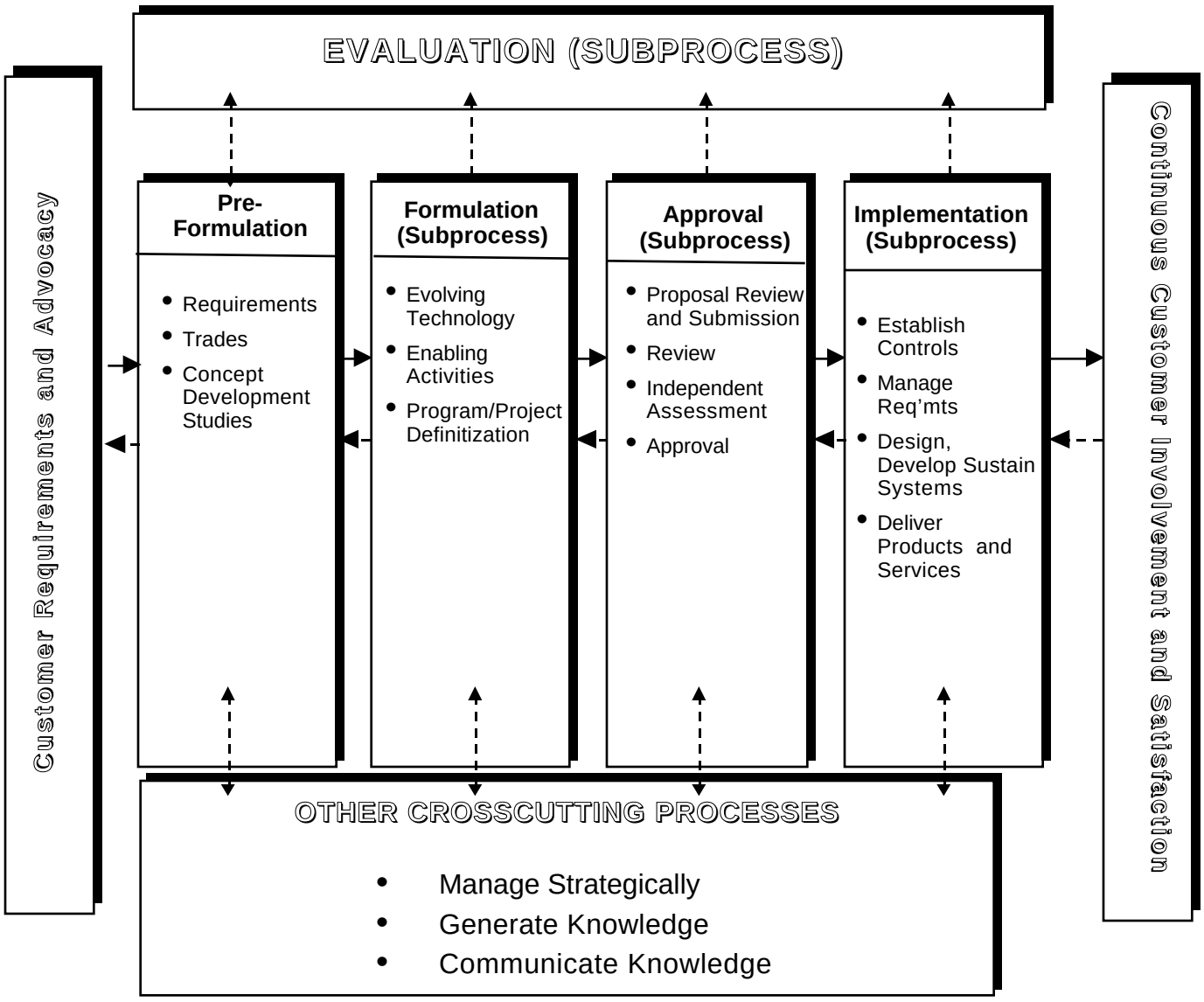

Figure 3-1: Program/Project Life Cycle Overview

3.1.2.1 Pre-formulation

Pre-formulation concept development and the subsequent formulation of a new project at GSFC is a customer-focused, seamless process, managed in accordance with GPG 7120.2. Pre-formulation begins with a customer's suggested science and/or technical concept. Through the leadership of a PFM, the concept gains the GSFC support required to pursue the formulation of a project and its subsequent implementation. The key steps are displayed in Figure 3-2 and described in the subsequent sections.

- ❶ Assign team to develop a feasible mission concept
- ➡ Initiate partnerships
- ➳ Develop science and/or technical requirements and mission objectives to achieve mission goal(s)
- ✝ Define the associated option set
- ❼ Develop preliminary mission concepts
- ⑨ Develop new roadmaps and/or mapping to existing roadmaps
- ✝ Define the scientific or technical benefits
- ✝ Define the opportunities to leverage research, commercialization, new technology, and education
- ✝ Prepare for the New Business Committee

Figure 3-2. Steps in Feasibility Mission Concept Development

3.1.2.1.1 Team Development ¾ When the customer approaches GSFC for support in developing Enterprise-directed feasible mission concepts, a PFM will be assigned as the manager along with the project scientist. They will review the suggested science and/or technical advanced concept and determine the team structure best suited for Pre-formulation concept development. Initial development may emphasize any or all of the following:

- Systems Engineering
- Specific Engineering Disciplines
- Enabling Technologies including Demonstrated Technologies/Advanced Technologies
- Evolutionary Concepts
- Revolutionary Concepts
- Instrument Focus
- Spacecraft Focus
- Ground Systems Focus
- Urgency and Priority

Determination of the emphasis will drive the initial structure of the concept team. Members of the concept team should be individuals who are comfortable in a dynamic visionary environment that may demand a rapid evolution of ideas and involvement with senior management at GSFC and with the customer. Team members are drawn from GSFC directorates as required.

In this volume, for the purpose of simplicity, the term PFM will be used for both PFM and IM.

3.1.2.1.2 Partnership ¾ Partnerships may develop at any time throughout the life cycle of the project. These may develop for technical, economic, administrative, or other reasons. The emphasis of the suggested science and/or technical concept, capabilities of GSFC and its customer, and availability of technical resources may determine the need to pursue partnerships early in the development of the mission. Partnerships may be formed through competitions [e.g., a NASA Research Announcement (NRA)] or through direct contacts. The PFM and the lead scientist will approach organizations that may mutually benefit from such a relationship. These partners may be pursued based on recommendations from the customer, based on shortcomings in the GSFC experience base, or due to their leadership roles in areas critical to the mission concept. Partners may be found in government agencies, industry, or academia, either in the U.S. or elsewhere. Initial agreements will be generated to define the roles and responsibilities of the organizations during Pre-formulation. The development of strategic and national and international partnerships is conducted with the Enterprise if the agreement is signed at the Enterprise administrative level. These agreements will become the basis for agreements to support the Formulation Subprocess.

3.1.2.1.3 Development of Science Requirements and Mission Objectives ¾ Pre-formulation is initiated by an approved customer-suggested science and/or technical concept. In order to effectively support the customer's request to develop a mission concept and pursue formulation of a project, the concept team must determine the baseline science and/or technical requirements and mission objectives. These requirements and objectives will evolve throughout Pre-formulation. At completion of this process a preliminary set of requirements and objectives will be used as the basis for the Formulation Subprocess.

3.1.2.1.4 Defining the Trade Space ¾ During Pre-formulation it is important to capture all possible options that could be used in implementing the concept. The inclusive list of possible options, called the Trade Space, will become the baseline for tracking the evolution of options considered during Pre-formulation, formulation, and implementation. This baseline Trade Space with appropriate backup information will be actively maintained through completion of the project. Through this documentation, the team members will be able to determine the options considered and the basis of the decisions made regarding the options at any time in the project's life cycle.

3.1.2.1.5 Development of Preliminary Mission Concepts ¾ Using the set of requirements and objectives, the concept team will develop several preliminary mission concepts that demonstrate the feasibility of the customer's suggested science and/or technical concept. In developing these feasible mission concepts, the team will take full advantage of concept development tools, such as the Integrated Mission Development Center (IMDC), Access To Space (ATS) database, Resources Analysis Office (RAO), etc. In addition to these tools, a strong systems engineering function is an integral part of the process. Demonstration of feasible mission concepts that may meet the customer's needs is critical to gaining approval to proceed with formulation of a project.

3.1.2.1.6 Enterprise Strategic Planning Roadmaps for Science, Missions, and Technology ¾ The customer's suggested science and/or technical concept and possible technology options to be considered may be elements of existing and Enterprise-approved NASA roadmaps. The relationship to existing roadmaps must be factored into Pre-formulation. During Pre-formulation, the concept team may need to facilitate the updating of existing roadmaps or generate and seek approval for new roadmaps to include elements of the evolving concept. These roadmaps provide the strategic basis for Enterprise-defined missions and the science focus for competed missions.

Note: Universal Resource Locators (URL's) to Strategic Plan roadmaps are identified in Appendix D.

3.1.2.1.7 Defining Scientific, Technical, and/or Economic Benefits ¾ The expected outcome of the entire process of Pre-formulation, formulation, and implementation of a project is to provide a scientific, technical, and/or economic benefit to the customer and/or the government. These benefits may be evolutionary or revolutionary in nature, but should be understood and documented within the objectives of the mission. These benefits should be stated in such a way that their applicability to government, academia, and/or industry is easily derived.

3.1.2.1.8 Defining Opportunities For Leveraging ¾ In this context, leveraging is defined as taking advantage of current and/or future activities external to the mission in order to enhance or enable the mission. In addition to the scientific and/or technical benefits that may be derived from pursuing the proposed feasible mission concept, opportunities for leveraging research, commercialization, new technology, and education must be defined. This list of opportunities for leveraging should include the area of leverage, relevant organizations and their level of involvement, level of interest and commitment, impact of the proposed concept to the opportunity, and actions required to achieve the benefits of leveraging.

3.1.2.1.9 Pre-formulation Product ¾ The product of Pre-formulation is the Project Formulation Plan. This plan defines the formulation relationships between the formulation Project, customers, partners, the Program, NASA Headquarters, GSFC organizations, and other Centers as appropriate. Also defined are the expected schedule and reporting for formulation, the expected formulation products, and the resources required to complete formulation.

3.1.2.1.10 New Business Committee (NBC) Approval ¾ Approval from the NBC to proceed to the Formulation Subprocess commits the Center to provide the necessary resources to formulate a project that meets the defined requirements and objectives. The NBC presentation documents the development methodology of the feasible mission concept process. The NBC requires that there exist, and is documented, a proposed Formulation team, proposed partnership arrangements, a preliminary set of requirements and objectives, an option set, preliminary mission concepts, a set of scientific and/or technical benefits, a mapping to existing roadmaps, and defined opportunities for leveraging research, commercialization, new technology, and education. The material presented to the NBC for approval is defined as part of the NBC process, and includes the Project Formulation Plan.

The appropriate Enterprise Associate Administrator (EAA) is responsible for Program Formulation (NPG 7120.5, paragraph 2.1.c) which is executed through a Formulation Authorization (NPG 7120.5, Appendix E-1). This form may be used for authorization of Project Formulation, consistent with the Program Plan. Authorization must occur before Formulation can begin. Responsibility for project Formulation is defined in the Program Plan (NPG 7120.5, paragraph 3.1.c) for missions assigned to a program.

3.1.2.2 Project Formulation

Projects are significant activities that have defined goals, objectives, requirements, LCC's (see NPG 7120.5, paragraph 3.1.2(f)), and a beginning and an end. Projects very significantly in their complexity, cost, and criticality. The PFM's are responsible for the successful accomplishment of projects from Pre-formulation through Formulation and customer satisfaction with the products delivered.

The PFM is responsible for the cost, schedule, and technical performance of the project during Formulation, but there are other major responsibilities. Forming the study team, financial and acquisition management, risk management, performance management, and safety and mission assurance are critical functions under the cognizance of the PFM. The PFM must be knowledgeable in all these areas and call on experts throughout GSFC and NASA to assist in activities leading to project approval.

As the project progresses, the emphasis in these areas will vary. The early enabling activities (see paragraph 3.1.2.2.1 below) will focus on exploring the trade spaces defined Pre-formulation. During the Definitize Project process(the final step in the Formulation Subprocess) (see paragraph 3.1.2.2.2), the PFM will focus on the generation of products required for project approval. Key elements shall be addressed such as NASA Information Technology (IT) (see reference NPG 7120.5, paragraph 4.1.3), Safety and Mission Success, (see reference NPG 7120.5 paragraph 4.5.1) environmental concerns (see reference NPG 7120.5, paragraph 4.5.5) and Security/Emergency planning, training and response (see reference NPG 7120.5, paragraph 4.5.4).

Projects are generally a subset of larger efforts known as programs. A Project may not be assigned to a Program until late in formulation however, the PFM develops a cooperative and performance-oriented team that supports the Program Integration Manager (PIM) in the Office of the Associated Director and the Program Manager, once assigned. The relationship between the Program Manager, PIM, and the PFM is critical to the success of each. The PFM works in concert with the Program Manager and PIM, but focuses on the day-to-day execution of the project formulation by industrial contractors, universities, NASA personnel, and other government agencies. The PIM/Program Manager must ensure that the products and services from project implementation will meet the program and/or customer needs. It is imperative that the PFM, PIM, and Program Manager be mutually supporting and empower each to do their functions with frequent and open communication.

A good PFM is the key to successful development of GSFC products and services through the formulation and approval of projects. A PFM's ability to draw the best from the participants and manage all aspects of the project is essential. He/she obtains support from senior management. The process discussed in this chapter and in Supplemental Volume 5, Project Manager's Tools, is the foundation for innovation and success for the project formulation team.

3.1.2.2.1 Enabling Activities ¾ Enabling Activities, the first step in Formulation, is initiated by STAAC at the end of Pre-formulation with approval of the NBC. Enabling Activities is an evolutionary process for defining a project that will allow implementation within the constraints of the customer and GSFC. The focus should be on refining the options available to accomplish the mission and through a structured process defining those most applicable. During this activity, per NPD 2570.5, frequency spectrum management must be addressed.

The objective is to define an affordable project concept and plan to meet mission objectives or technology goals specified in the Program Plan. The PFM and team will:

a. Explore the full range of implementation options, including concept, technology availability, and technology needs; (See Figure 3-3a for an overview of types of projects frequently considered at GSFC)
b. Establish the internal management control functions that will be used throughout the formulation of the project;
c. Assess the technology requirements and develop the plans for achieving the technology options, including options for partnering and commercialization;
d. Perform LCC and performance analyses for concepts deemed to have a high degree of technical and operational feasibility, and
e. Identify estimated project reserves, including reserves associated with risk management.

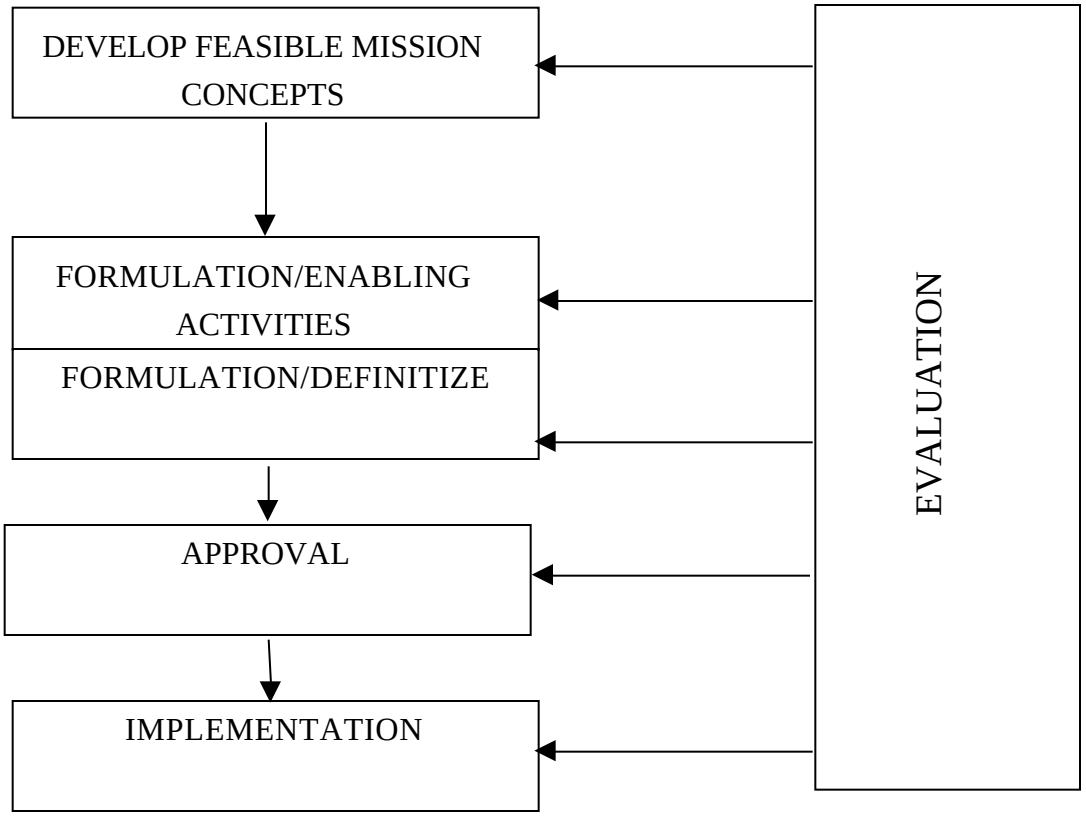

Figure 3-3a: GSFC Program/Project Process Management

Products of the Enabling Activities process, displayed in Figure 3-3b, include a detailed definition of the project concept, and a full understanding of the agreements, approaches, and plans required to meet the technical, budget, schedule, risk management, commercialization, acquisition, and related project requirements and performance objectives. The Enabling Activities process is an iterative activity rather than a discrete set of linear steps. Many times, it is interactive with concurrent execution of the activities until the products have matured and are acceptable to the Program Manager and/or customer. Primary inputs to this process are derived from the Program Plan, which specifies the mechanism to authorize the formulation of projects. The Enabling Activities are planning, systems analysis, technology requirements synthesis, technology and commercialization plans, operations and business opportunities, assess infrastructure, and plan upgrades/development, and lessons learned.

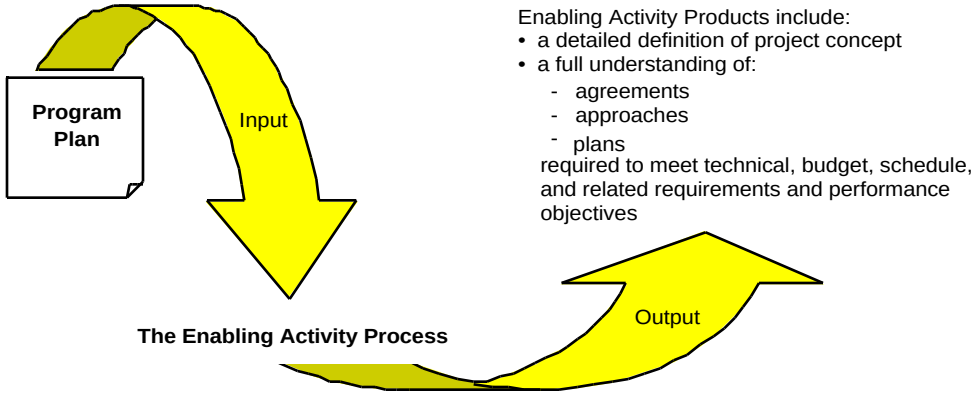

Figure 3-3b. Products of the Enabling Process

3.1.2.2.1.1 Project Planning ¾ This activity develops the detailed definition of project requirements and establishes project control to manage the Formulation Subprocess. The PFM shall establish oversight and reporting systems, which integrate the cost, schedule, and technical performance of the project. He/she supports the annual POP cycle by providing assessments of affordability as input to the program's funding requirements. This enables a firm program commitment to accomplish the project and program goals and objectives on schedule and within budget. He/she also supports the annual in-house workforce planning and control process by providing assessments of Civil Service and support service contractor labor necessary to support mission formulation and implementation.

The project control activity provides the PFM with project control and oversight of performance. The project obtains its formal external direction and provides formal internal direction through project planning. To accomplish project planning, the PFM shall perform the activities defined in NPG 7120.5, paragraph 3.1.1.

3.1.2.2.1.2 Systems Analysis ¾ In conjunction with the Systems Engineering Division (SED) and AETD, this activity provides the systems analysis and LCC analysis necessary to produce feasible concepts and explore a wide range of implementation options to meet project objectives. The PFM considers technology alternatives, frequency spectrum authorization, operations, business opportunities, schedule, and infrastructure for the project. Risk assessment planning identifies risks and plans risk mitigation. To accomplish systems analysis, the activities defined in NPG 7120.5, paragraphs 3.1.2, shall be accomplished.

3.1.2.2.1.3 Technology Requirements Synthesis ¾ This activity examines the project concepts and assesses the technology requirements for feasibility, availability, technology readiness, opportunities for leveraging research, and new technologies. Technology synthesis defines which technologies should be incorporated into the project and which should be considered as crosscutting technology projects to enable future NASA endeavors. The activity involves interfacing with the GSFC Level II NASA Technology and Planning Integration Office (Code 710) and the AETD Chief Technologist (Code 500). Technology is in the following two general categories:

a. **Project-specific Technology**: Those technologies that provide fundamental capabilities without which certain project-specific objectives cannot be met. These technologies generally represent more project-specific needs that are tied to detailed mission objectives. Project-specific technology development activities are managed by the project requiring that technology.

b. **Crosscutting Technology**: Those crosscutting technologies that reduce cost or risk to such a degree that they enable completely new mission options. Those technologies represent multi-mission applications, resulting in aggregate cost savings and/or higher performance. Crosscutting technology must be applicable to two or more enterprises to be funded under the Crosscutting Technology Program. Crosscutting technology projects have Formulation and Approval Subprocesses separate from the projects which will eventually use those technologies, and are executed consistent with the processes described in this document.

Technology requirements synthesis, as defined in NPG 7120.5, paragraph 3.1.3, shall be performed. In addition, technology customers should be identified and involved to ensure that the crosscutting program will satisfy the customer's needs.

3.1.2.2.1.4 Develop Technology and Commercialization Project Plans ¾ This activity plans the technology options that satisfy candidate concepts' identified needs. It also develops options for partnering and commercialization. The Technology Commercialization Office (Code 750) should be consulted for assistance with commercialization activities. Further, this activity provides for the development of plans and the establishment of partnerships to transfer technologies, discoveries, and processes with potential for commercialization. Plans may be developed for technologies that are at a sufficient level of readiness to be an integral part of the project. Multi-use technology, which has been identified as important to a mission, can be recommended as a technology project to the Crosscutting Technology Program. Technology and commercialization planning, as defined in NPG 7120.5, paragraph 3.1.4, shall be performed.

3.1.2.2.1.5 Operations and Business Opportunities ¾ In this activity, the PFM identifies business opportunities for partnerships in the development and operational elements of the project. (e.g., Launch Vehicles, SOMO, Spacecraft Systems, Instrument Technologies, Science Data Processing, etc.) In searching for partnering opportunities, the PFM will accommodate agreements and partnerships formed at the program level, and remain consistent with the strategic direction issued by the EAA. Partnering opportunities and relationships identified through these activities will be assessed for feasibility through completion of the final agreements. This assessment, as defined in NPG 7120.5, paragraph 3.1.5, shall be performed.

3.1.2.2.1.6 Assess Infrastructure and Plan Upgrades/ Development ¾ The PFM assesses the capability, suitability, and availability of the NASA-wide infrastructure to satisfy project requirements. Resources in other government agencies, industry, academia, and international entities will also be considered to minimize program LCC. Plans are developed for any required upgrades and development that may minimize multi-program or multi-project LCC. This assessment, as defined in NPG 7120.5, paragraph 3.1.6, shall be performed.

3.1.2.2.1.7 Lessons Learned ¾ This activity consists of collecting and evaluating the Formulation process performance, and determining effectiveness and efficiency with which the process is being executed. Lessons learned shall be developed for improvement of the process. This activity is required by NPG 7120.5A paragraph 3.17 Capture Process Knowledge.

A history of the Enabling Activities and Definitize Project processes shall be maintained which includes significant events, options studied, tradeoffs made, resources expended, time consumed, and any other performance information that may improve the process.

3.1.2.2.2 Definitize Project ¾ The Definitize Project activity is the final and most formal step of the GSFC Formulation Subprocess that leads to project approval and subsequent implementation. It is during the Definitization Project process that GSFC organizations prepare to commit to the project cost, schedule, and performance baseline. It is initiated when work starts on the formal

generation of the approval package required for Approval to Implement. Within two years of approval for the project to enter the implementation process a Project Manager is selected jointly.

Definitize Project is the process of converting the preliminary systems design into an optimized, technically-unique design, which becomes the technical baseline for the generation of all resource and support requirements, schedules, and other information in preparation for project approval. Definitization is performed using both in-house efforts from the supporting GSFC directorates and out-of-house contractors and partners resulting from competitive actions. It is based upon resource availability and policies/constraints/methods affecting resource utilization. It is essential, before implementing a project, to have a full understanding of the scope of work to be performed, which can only be accomplished by complete and penetrating project definition.

This activity covers the full range of technical, management, resource, facility, and procurement assumptions and acquisition strategy and contractor reporting. Also covered are ground rules, plans, procedures, and documentation of an end-to-end verified and customer-validated flight/ground system which meets or addresses, through tailoring, all NASA requirements, including frequency spectrum authorization. There will be a Project Plan developed in preparation for project approval. Mission objectives, requirements, and justification will be fully reviewed. Technical plans will be reviewed, updated, and defined in detail to support the anticipated mission, which should include a proper balance between the hardware and software complexity of the flight and ground segments. Alternate designs will be analyzed to allow selection of an optimum flight and ground systems approach considering technical performance, cost, schedule, and other factors such as technology availability, risks, and the potential for commercialization.

The resulting baseline design will be totally identified, investigated, and documented including all significant interfaces and system/subsystem/component specifications for the flight and ground systems. Full implementation plans, including major make-or-buy decisions, specific-and-detailed WBS, and work packages will be identified with the specific responsible personnel and organizations identified, schedules defined and coordinated, and resources, facilities, and materials specified. In the final stages of the Definitize Project, the Project Plan will be completed and the project will be validated.

3.1.2.2.3 Formulation Products ¾ The products to be produced by the Formulation Subprocess are in accordance with NPG 7120.5, Appendix E.4, as shown in Figure 3-4. The formats of these plans are tailorable appropriate to project end-item requirements.

- Project Plan
  - Systems Plan
    - Technology Requirements Plan
      - Technology and Commercialization Plan
        - Operations and Business Opportunity Plan
          - Infrastructure and Upgrades Development Plan
            - Capture Process Knowledge Plan
              - Independent Assessment Results (ASREQ)
                - Non-Advocate Review Results or Mission Design Review

Figure 3-4. Project Formulation Products

3.1.2.3 Project Approval

A project enters the Approval Subprocess to proceed from Formulation to Implementation (see NPG 7120.5, paragraph 3.2.). The Approval Subprocess may also provide approval for a project to continue in Formulation when iterative formulation is required or provide approval for significant change(s) to its Project Plan based upon budgetary or technical considerations. Significant changes in budget or the program, changes in criteria used to approve the project, or changes within the project that violate the original approval criteria necessitate project reformulation and reevaluation for approval. Approval consists of the following:

a. Successful approval reviews.
b. A signed commitment letter.
c. Commitment of full funding (as defined in the POP process) through project completion.
d. Modification of the Program Plan. (See NPG 7120.5, paragraph 3.2.b, and the Approval Signature Matrix, shown in Table 3-1.)

The set of approval reviews for directed missions typically consists of a NBC review and a NAR (NPG 7120.5, Appendix F) or a MDR/MCR. The NAR is required by NPG 7120.5 for programs and selected projects in order to proceed to Implementation. It is conducted by an independent review team, and coordinated by the IPAO at Langley Research Center (LaRC), paragraph 3.1.2.5.1. The NAR results are reviewed by the NASA PMC, with final approval by the NASA Administrator.

Table 3-1 Approval Signature Matrix
(Denotes Required Signatures Only)

Documents	Administrator	Enterprise Associate Administrator	Lead Center Director	Center Director	Program Manager	Project Manager
Formulation Authorization		✓				
Program Commitment Agreement	✓	✓				
Program Plan		✓	✓		✓	
Project Plan		(Requires Program Plan Mod: NPG 7120.5, par. 3.2b)		✓	✓	✓

Projects not selected for a NAR must have an MDR/MCR. An MDR provides the same information for review as a NAR, but the results are reviewed by the GPMC at the MCR, with approval by the appropriate EAA.

In requesting approval for proceeding to implementation, the Project Manager must obtain a commitment of GSFC resources from the NBC if the project meets or exceeds the thresholds established for NBC review (reference: GSFC Director's New Business letter dated 4/14/98). Information presented to the NBC consists of:

a. Description of the opportunity
b. Roles and responsibilities of the partner and GSFC for implementation
c. Schedule
d. Science impact
e. Technology content
f. Customer advocacy

g. Workforce and budget needs
h. Why GSFC should be involved, addressing the Strategic Plan

The Directed Mission (Project) enters Implementation after the commitments are signed and a successful NAR or MCR is achieved.

3.1.2.4 Project Implementation

NASA's Implementation Subprocess, as described in NPG 7120.5, paragraph 3.3, Project Implementation, encompasses the Design, Development, and Sustainment of a project, or the former Project Planning Phases C, D, and E (Design, Development, Operations: see Volume 1, Table 1-1). A project enters the Implementation Subprocess upon successful completion of the Approval Subprocess. Implementation is outlined in Figure 3-6.

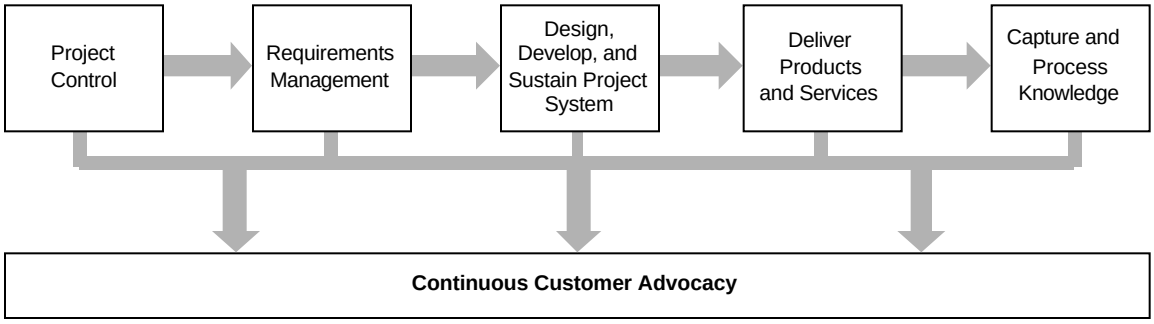

Figure 3-6. The Project Management Implementation Subprocess

GSFC projects range in complexity from balloon flights and sounding rocket missions to instrument, ground station, operations center, and small and large spacecraft builds. GSFC's Implementation Subprocess, therefore, varies from project to project. There are, however, several key concepts common to most projects' Implementation Subprocesses as described below.

3.1.2.4.1 Project Control ¾ This activity, as required by NPG 7120.5, paragraph 3.3.1 unless otherwise noted, involves the Project Manager's responsibility to exercise control and overall direction of the project budget, schedule, and procurement. Every GSFC project shall have baseline agreements and documentation such as contracts, Task Plans, Customer Agreements, and/or Memorandums of Agreement (MOA), which fully describe the work authorized (See NPG 7120.5, paragraphs 1.4, 3.3.3, 3.3.4, 4.3) including scope, schedule, and budget. These documents are the basis upon which all work on the project is performed and evaluated. When applicable, the Project Manager shall work closely with the Contracting Officer (CO) and the Contracting Officer's Technical Representative (COTR) to ensure that documents are sufficient to fully encompass the work to be performed on the project and that the contractor is in compliance with its terms and conditions throughout the Implementation Subprocess. A single project may have multiple contractual documents and/or agreements.

The Project Manager shall also work closely with the customer identified in the Formulation Subprocess to be sure that the contractual documents meet the customer's needs. Once the contractual documents are approved by the appropriate authority, the Project Manager shall manage and execute all procurement activities and agreements (including intra-agency and external). The FAR or the NASA FAR Supplement generally determines approval authority.

One of the Project Manager's fundamental tools for tracking the project is the Work Breakdown Structure (WBS). The WBS is developed before the Implementation Subprocess and is of sufficient detail to allow insight into every significant project design and development activity and subsequent

reporting. Every GSFC project shall use a WBS of some form, which includes a description of work to be performed under each WBS element. The extent of detail necessary in a WBS is left to the judgment of the Project Manager. The WBS is included as a portion of the Project Plan. Once a WBS is developed along with its WBS dictionary, individuals responsible for each element should be identified, along with a basic milestone schedule of accomplishment. Critical project milestones should be part of the contractual documents. The milestone schedule should then be used to develop need dates for work to be performed and a scheduling system used to track work performed versus need dates. The system and its complexity are choices left to the discretion of the Project Manager.

Once the WBS and schedule milestones and relationships are established, cost estimates can be made for labor, materials, and associated cost elements for each activity and then added to the plan as a resource requirement. There are many tools which can be utilized for this integration of work, schedule, and cost. The most critical aspects of this process are: (1) identify individuals for each activity, (2) fix responsibility for meeting technical performance, schedule, and cost commitments, and (3) employ an ongoing method for monitoring detailed and aggregate performance versus plans to meet that commitment. Planning for a contractor or in-house effort should map to the POP budget planning and be tracked on that basis. The Project Manager and supporting Resources Managers determine which system is most appropriate, given the magnitude of the effort, contract type, program risk, and other factors.

The most sophisticated tools for the integration of project control information fall under the area of Earned Value Management (EVM), which has evolved from the old NASA Performance Analysis Report and the newer Performance Measurement System. EVM now represents an adopted NASA/DoD/Industry standard. EVM includes many tools for planning, monitoring, and forecasting. Further guidance can be obtained from NPD 9501.3, NPG 9501.4, and NPG 7120.5. There are also standard contract clauses for use with out-of-house efforts in process at this time. The first major Project activity for EVM is an Integrated Baseline Review conducted by the project with EVM Focal Point assistance. EVM does not impose a particular system, but provides guidelines for what any planning, tracking, and forecasting system being utilized should contain. Many off-the-shelf packages can be tailored for this purpose.

The combination of cost, schedule, and work performed are critical in allowing the Project Manager to assess progress during design and development, and they provide the detail necessary to determine when corrective action is necessary. The Project Manager continually assesses the status of project reserves and executes project risk management plans described in the Project Plan to determine when reserves should be used. The Project Manager shall also develop and track performance metrics to assist in this determination. See NPG 7120.5, paragraph 4.3. These metrics must include cost, schedule and work performed metrics. All other reporting requirements including content, format, and frequency shall be defined in the Project Plan and the contractual document.

The Project Plan shall be updated as required (See NPG 7120.5, Paragraphs 3.1, 3.2 and 3.4), to maintain compatibility between the plan and the resources available. Full participation by the Project Manager in budget planning approval and execution process is required. Changes in budget, the program, and criteria used to approve the project, or significant changes within the project that violate the original approval criteria, would necessitate project reformulation and reevaluation for rebaseline or termination. The approval may be simplified by focusing on the element that caused reevaluation.

The Project Manager should maintain the project within the scope defined in the contractual document(s) and, in any event, lead and direct the project to meet its commitments in the Project Plan and the PCA. Project scope includes cost, schedule, technical performance, and work to be performed. Contracts are to be administered in conformance to NASA/GSFC procedures for financial management reporting, contingence and APA, and LCC's. Any proposed changes to project scope require a project to re-enter the Approval Subprocess. This subprocess is described in Volume 1, paragraph 1.4.2.

The Project Manager has several other responsibilities in controlling the project. Throughout all design, development, delivery, and operations activities, the Project Manager shall ensure establishment and maintenance of an effective safety and mission success activity. The Project Manager shall ensure that all required enabling technology and NASA IT resources are provided as planned (see reference NPG 7120.5, paragraph 4.1.3). The Project Manager shall assess and document the performance of the entire Implementation Subprocess, and respond to customer and Evaluation Subprocess assessments and recommendations.

3.1.2.4.2 Customer Advocacy ¾ The Project Manager is to proactively consult and involve the customer throughout the Implementation Subprocess to ensure customer satisfaction with the delivery of safe, quality products and services within performance, budget, schedule, and other program and project commitments. (See NPG 7120.5, paragraph 3.3.2.)

3.1.2.4.3 Requirements Management ¾ The Project Manager shall ensure that requirements developed during the Formulation Subprocess are properly divided and incorporated into detailed implementation documentation sufficient for successful project design, development, and operations. In order to track this documentation, each project shall have a Configuration Management System (CMS). The choice of a CMS is left to the discretion of the Project Manager. All project requirements and performance specifications shall be under configuration control. The CMS shall also maintain traceability to all program requirements. The Project Manager shall review and finalize all agreements, update technology requirements and commercial agreements, as well as prepare resource requirements to implement the total set of project requirements including LCC's. (See NPG 7120.5, paragraph 3.3.3. and GPG 8700.2.)

3.1.2.4.4 Design, Develop, and Sustain ¾ Technology development and project design, development, and sustaining activities shall be accomplished in accordance with the validated processes described in GPG 8700.1, 8700.2, 8700.3, 8700.4, to ensure quality products and services. The Project Manager manages the design and development of the project system, including hardware design and manufacture, software development, and all testing and verification activities (i.e., component, subsystem, and system level) needed to demonstrate the appropriate level of confidence and risk mitigation in the design. Where necessary and consistent with the baseline project, technology research and development shall be performed in order to meet requirements, as specified by the requirement management activity described in paragraph 3.1.2.4.3. (See NPG 7120.5, paragraph 3.3.4.) This Implementation activity also notes sustaining activities, including operations, engineering, logistics, and establishing and/or upgrading the supporting infrastructure as required.

To accomplish the Design, Develop, and Sustain activity, the Project Manager shall have an orderly system of insight/oversight, review, evaluation, documentation, and reporting. See NPG 7120.5, Section 3.3.4.2. These functions include the following:

a. Conduct architectural, functional, system, and subsystem design reviews as specified by the Project Plan.
b. Execute acquisition plans and contracts with surveillance insight/oversight of contractor(s) and/or supporting staff.
c. Maintain traceability of requirements to system designs and specifications.

d. Ensure the accomplishment of system verification and acceptance testing.
e. Provide performance metrics, visibility, and status per Project Plan and project direction, including any project variance with cause, impact, and corrective action.
f. * Design, develop, test, and verify technology materials and information for delivery to the Agency, the scientific community, and commercial customers or partners per agreements in NASA's technology plans.
g. * Conduct technology infusion and/or transfer in accordance with project technology and/or commercialization plans, including incorporating new technology and commercialization as available and where appropriate per approved plans. Technology commercialization plans should be updated annually.
h. Provide for discipline and system engineering for the design, implementation, and sustain technology, and its commercial, upgrades to existing infrastructures that deliver cross-project/program operations products and services to the project.
i. Provide sustaining engineering for efficiency enhancements and for safety and obsolescence plan development and execution.
j. Use technical standards and guidelines with preference to voluntary consensus standards where practical.
k. Use the International System of Units (Metric System) measurement system, where practical.
l. Ensure the generation, identification, control, distribution, and reporting of all engineering and technical management information generated during project formulation and implementation.
m. Ensure that design and sustaining activities provide cost-effective logistics support, including operational delivery of services and products to the customers.
n. Ensure that hardware system verification includes the use of practical and cost-effective software, and is in compliance with NASA independent verification and validation requirements.
o. * Document the design and development of any new technology developed as part of the project to ensure legal protection of new intellectual property.

* These support NASA's high priority to develop and transfer new technologies.

3.1.2.4.5 Deliver Products and Services ¾ The culmination of the project is the delivery of the programs, products, services, and technology to the customer. See NPG 7120.5, paragraph 3.3.5. These include: (1) deliverable hardware, software, infrastructure, documentation, and training, (2) operations of delivered systems, (3) production of intellectual products for science and technology customers, and (4) process knowledge.

For both mission and technology projects, the purpose of this activity is the delivery of committed Project Plan products and services to all customers. Specific products and services in each of the four categories above are as follows:

a. Deliverable Hardware, Software, Infrastructure, Documentation, and Training:
   - Project flight and ground systems, including spares, logistics, and ground support equipment.
   - Scientific breakthrough and new technology through data, information, products, and services per agreements in the project technology plans.
   - Space operations infrastructure upgrades for cross-program/customers.
   - Agency labs and technology infrastructure upgrades.
   - System maintenance and operating procedures and training.
   - As-built documentation.

b. Operations of Delivered Systems, and Production of Intellectual Products for Science and Technology Customers:
   - Perform operational readiness tests for project end-to-end system readiness and support integrated program testing to execute the Operations Plan and to deliver customer products and services.

- Launch, operate, and maintain project flight and ground elements to deliver customer products and services per the approved Operations Plan.
- Provide customer support services, including the delivery of materials and information to commercial customers. Develop and deliver user guides, training, and simulation support for customers.
- Maintain configuration management of mission and operations plans, including upgrades.
- Collect, analyze, and report operations performance metrics including Technology and Commercialization Plan performance data and status.
- Develop maintenance and operations requirements for new systems/upgrades and support sustaining engineering activities.

c. Process Knowledge:
- Report contractor performance assessments to contractor and record for future source selection (see NPG 7120.5, paragraph 4.4.4.2).
- Develop technology capability forecasts, and identify synergistic commercialization opportunities.
- Develop information and materials for the use of non-aerospace and commercial customers, such as outreach materials.
- Record project history and lessons learned/send to the NASA Chief Engineer.

d. Mission Termination:
Operating space systems are terminated in accordance with NASA Management Instruction (NMI) 8640.2B.

3.1.2.4.6 Capture Process Knowledge ¾ The Capture Process Knowledge Activity supports continuous improvement of the Implementation Subprocess through assessment of process performance metrics. See NPG 7120.5, paragraph 3.3.6. In support of this activity, the Project Manager shall be responsible for the following:

a. Collection and analysis of project process metrics and the identification of areas of exceptional or substandard performance.
b. Performance of root-cause analyses in identified problem areas.
c. Development of recommendations for correcting deficiencies and/or adopting better processes.

The Project Managers shall establish an ongoing mechanism to collect and evaluate process performance and identify lessons learned during all activities of Project Implementation (GPG 8730.3). Lessons learned should be considered by Project Managers for their own projects. Lessons learned with broad application or utility to other Project Managers will be submitted to the NASA-wide Lessons Learned Information System (LLIS). Lessons learned identification should be a formal product of major reviews (e.g., NAR, Confirmation Review (CR), Preliminary Design Review (PDR), Critical Design Review (CDR), Mission Operations Review (MOR), Mission Readiness Review (MRR), Flight Readiness Review (FRR), and Independent Annual Reviews (IAR)) and submitted to the LLIS as deemed appropriate by the Review Board. The URL for the LLIS can be found in Appendix D.

3.1.2.5 Project Evaluation

The Evaluation Subprocess provides an independent assessment of the continuing ability of the project to meet its technical and programmatic commitments using the experiences and perspectives of customers and other experts independent of the project (See NPG 7120.5, paragraph 3.4). The Evaluation Subprocess is applied throughout the life cycle of projects and consists of the planning and conducting of reviews and assessments during the Formulation and Implementation of a project.

Evaluation during Formulation ensures that programs and their projects support NASA's goals and strategic plans and that the project can be successfully conducted within allocated resources and applicable constraints. Evaluation supports the Approval Subprocess by developing recommendations from supporting reviews, evaluations, and tests, as described in GPG 8700.4, before proceeding with succeeding project life cycles or terminating the project. Evaluation during Implementation ensures that projects are being successfully executed according to plans, and provides recommendations for enhancing the technical and programmatic performance of projects.

At GSFC, there are typically two types of reviews: those held by groups external to GSFC, and those held by the project in conjunction with the SRO (Code 301). Reviews are chaired and staffed by personnel independent of the project. The GPMC chair reviews proposed assessment team membership to ensure that review and assessment teams incorporate knowledgeable experts, both internal and external, including customer representatives. External reviews recommended for consideration are described in NPG 7120.5, paragraph 3.4.1 and Appendix F. These are the IA, the IAR, EIRR and a NAR. Each of these reviews is held at the discretion of the PMC, except the EIRR which is held at the discretion of the EAA. All other project reviews are tailorable and are held at the discretion of the Project Manager, GSFC senior management, or NASA Headquarters. The timing, content, frequency and potential combination of reviews may be tailored to meet the needs of the individual project.

The conduct of each assessment and review shall be coordinated with the Project Manager to minimize project disruption. Where practicable, reviews should be combined in order to reduce total numbers and costs.

Projects that report to the NASA PMC may be required to have an independent review. Independent reviews may be held at the program level and will, to some extent, involve the assessment of the program's projects. Independent reviews for projects which report to other PMC's are held at the discretion of either the GSFC PMC or the other appropriate PMC.

For projects with exceptional risk, higher cost, or high visibility, the EAA may establish an EIRR to validate the project's performance against the program-level requirements and objectives set forth in the Program Plan for the project. The EIRR results will be reported to the EAA, who will report the results to the GPMC.

Requests for additional review and assessment of projects may arise outside the normal process. Requests may come from Congress, NASA's Inspector General, the General Accounting Office (GAO), advisory groups such as the Space Science Advisory Committee, and other similar sources. NASA's Chief Engineer will coordinate responses to external review requests, work in concert with the EAA (the office responsible for management controls) and GSFC to disposition such requests, and coordinate scheduling of additional reviews and assessments, when required.

3.1.2.5.1 Independent Reviews ¾ Details of the Evaluation reviews are given in Supplemental Volume 5, Project Manager's Tools, Section 5.4, and Appendix F of the NPG 7120.5. Concurrent with the Formulation Subprocess, Evaluation must include a MDR/MCR, which include an LCC and Independent Cost Estimate (ICE). The MDR/MCR determine the readiness of the project, either to proceed with further Formulation or to request approval to enter Implementation.

If a project is also designed as a program, then the MDR/MCR is replaced by a NAR. An Independent Review Team, as specified in the Project Plan, then coordinates the NAR of a program. The review is conducted by the IPAO for projects reviewed by the NASA PMC.

In addition, at the request of either the GSFC Director or the Program Manager, the Project Manager will support an IA of a project. The IA's are conducted by the IPAO. They consist of both technical and LCC assessments of advanced concepts, and are typically conducted during project formulation.

The IAR is the means by which the NASA PMC ensures its awareness of the status and performance of the programs and projects for which it is responsible. These reviews are held during the Implementation Subprocess, and are used to validate project conformance to the PCA.

3.1.2.5.2 Other Reviews ¾ Concurrent with the Implementation Subprocess, evaluation consists of reviews that measure project performance and compares that performance with Program and Project Plans. At a minimum, reviews assess technical achievements, adherence to schedules, projected costs, issues, concerns, plans for addressing previously unanticipated occurrences, and other project metrics. The content, number, and schedule of reviews can all be tailored according to the project needs.

Consistent with GPG 8700.4, the Chief of the GSFC SRO, together with the Project Manager, identifies the schedule and subject of system reviews in a System Review Plan (SRP). The performing directorate, the Office of Systems Safety and Mission Assurance, and the Center Director provide approval of the SRP. The SRO appoints the chairperson for the review team. The chairperson will, in turn, select independent technical experts to serve as review team members. Details concerning the SRP, review teams, and approvals can be found in GPG 8700.4.

Special purpose reviews (e.g., a Termination Review) shall be conducted at the discretion of the GPMC. Requests for special purpose reviews may come to the GPMC from customers or line organizations. In requesting a Termination Review, the GPMC will consider the anticipated inability of a project to meet the commitments contained in its controlling agreements and plans. Examples include a projected cost at completion that exceeds the costs allowed by the Project Plan, an unanticipated change in GSFC strategic planning, or an unanticipated change in NASA's budget.

The objective of the Plan and Conduct Reviews and Assessment activity is to assess the value to projects of the Evaluation Subprocess and to determine the effectiveness and efficiency with which the subprocess is executed. Lessons learned shall be developed for improvement of the PAPAC Process.

3.1.3 ISO 9001

All projects shall implement a Quality System, beginning with the Formulation Subprocess, in accordance with requirements found in GPG 8730.3, the GSFC Quality Manual.

3.1.3.1 Quality Management System (QMS) Council

The Center Director appoints a QMS Council (QMSC) consisting of representatives nominated by directorates and offices of the Executive Council. The directorate representatives interface with their respective directorate staffs, Laboratory or Division Chiefs, Project Managers and their staffs to carry out the duties in GPG 1060.1, Management Responsibility, paragraph 2.3.

3.1.3.2 ISO 9001 Implementation

Project/Product Managers shall be responsible for ensuring that his/her project (product) conforms to all applicable elements of QMS. He/she will ensure that the necessary procedures are in place, and that they are properly adhered to. See GPG 8730.3, the GSFC Quality Manual.

3.1.3.3 Internal Audits

Project/Product Managers shall support annual internal audits as described in GPG 9980.1, Internal Audit System, to verify the effectiveness of the Quality Management System.

3.2 Guidance for the New Project Formulation Manager and Project Manager

3.2.1 GSFC Program/Project Responsibilities

The Enterprise, consistent with the Enterprise Strategic Plan and the budget, authorizes programs. The Enterprise authorizes the formulation of a program by a designated Lead Center or Field Center. The PCA documents the agreement between the Enterprise and the NASA Administrator for the implementation of the program. Subsequently, the Program Plan documents the agreement between the Enterprise and the Field Center program office. These documents are presented for signature at the time of program approval.

The Enterprise identifies the Program Executive and the Program Scientist (Volume 2, Paragraph 2.4) to interface with the Program/Project Managers and Project Scientists during the formulation and implementation of a program.

Project Formulation is conducted for the program in accordance with the Program Plan and as directed by the Enterprise. The Project Plan is prepared during Formulation and signed at Approval for Implementation. The Enterprise will issue an AO for PI mission projects such as Explorers, STP, Discovery, and ESSP. The Enterprise will issue an AO for investigations in support of Enterprise-directed projects such as Upper Atmosphere Research Satellite (UARS), HST, Cosmic Background Explorer (COBE), etc.

The GSFC Project Manager is the senior NASA line official solely concerned with the execution of a particular project. GSFC invests full responsibility for mission success in the Project Manager, with scientific guidance and support provided by the Project Scientist. Within the confines of established policies and procedures, full authority and accountability are included with this management responsibility. Therefore, he/she is responsible for the effective total management of the project is accordance with the Project Plan and other applicable directives. A fundamental principle is that the Program Manager and the Project Manager each functions in his/her own sphere of management influence, and each depends on the cooperation and effectiveness of the other.

The most desirable Program/Project Manager relationship evolves when those individuals develop a cooperative team effort to ensure the completion of the project within cost, schedule, and technical performance requirements. The Project Scientist plays an important role in advising the Project Manager on all matters involving science and experiments/instruments and ensuring achievement of approved scientific objectives. The following paragraphs describe the major roles and responsibilities of the Program Manager, Program Scientist, Project Manager, Project Scientist and Product Design Lead (PDL).

3.2.1.1 Roles and Responsibilities of The Program Managers

The Program Manager is responsible for the following:

a. Program planning, including recommendation of program objectives, requirements, implementation guidelines, budget and milestones, and preparation of Program Plans and supporting development of PCA's.
b. Developing, recommending, and advocating program resources.
c. Allocating budget to projects.
d. Establishing support agreements.
e. Executing and overseeing the Program Plan.
f. Controlling program changes.
g. Approving Project Plans and associated changes.
h. Establishing project performance metrics.

i. Integrating the planning and executing of individual projects or programs composed of multiple interdependent projects.
j. Reviewing and reporting program/project performance.
k. Complying with applicable Federal law, regulations, executive orders, and NASA directives.

In pursuit of these responsibilities, the Program Manager is required to develop and maintain a close relationship with the Project Manager(s) and other GSFC officials on the program utilizing sound technical and managerial judgement.

3.2.1.2 Roles and Responsibilities of The Program Scientist

The Program Scientist is responsible to the Program Office for achievement of scientific goals and objectives of the program, for dealing with the scientific community, and interfacing with the Project Scientist(s). The Program Scientist participates in the development of the AO and obtains the necessary coordination and approval for the AO. He/she recommends appointments to the Ad Hoc Advisory Subcommittee of the Steering Committee and is responsible for preparation of necessary documentation. The Program Scientist forms a team with the Project Scientist(s) and the program/project Science Working Group Teams to formulate plans for program/project advocacy and to inform the public of the importance of the program/project. The Program Scientist and Project Scientist(s) work together to ensure that science objectives of the program/project are met.

3.2.1.3 Roles and Responsibilities of The Project Formulation Manager/Project Manager

The Project Formulation Manager/Project Manager is responsible for the following:

a. Management and dedication of the concept study/project team.
b. Preparing and maintaining the Project Plan, specifications, schedules, and budgets.
c. Establishing support agreements.
d. Acquiring and using participating contractors.
e. Executing the Project Plan in Implementation.
f. Supporting program management and integration.
g. Reporting project performance and status, including contracts.
h. Compliance with applicable Federal law, regulations, Executive orders, and NASA/GSFC directives, including the GSFC QMS.

Director of STAAC (if a PFM) or the Director of FPPD (if a Project Manager) will carry out these responsibilities within the delegated authority and in the accordance with the QMS. He/she directs and coordinates all supporting elements with other centers, NASA Headquarters, and other agencies of the U.S. government or foreign investigators, as well as all necessary contractual efforts. The PFM/Project Manager keeps GSFC and Headquarters management informed concerning the status of the study/project while developing a close working relationship with the Program Manager. He/she takes whatever additional actions are required to ensure the successful completion of the study/project, including delivery of validated end-item data and services to users (customers).

3.2.1.3.1 Project Manager Selection ¾ This is a critical function carried out by the Director of FPPD with the support of the Director of STAAC, after a consultation with the customer, and concurrence from the GSFC Center Director. This selection must be in accordance with GPG 8730.3, paragraph 2.2.1, GSFC Quality Manual. The candidate Project Manager will usually have a technical background, project experience, and training in the use of project management tools. Since he/she will interface extensively with the other Directors, the Directors of are often consulted during this selection process.

3.2.1.3.2 Project Management Transition ¾ The smooth transition of leadership is a critical element of project development. The intent is that the development of the Advanced Mission Concept (AMC), Project Formulation, and Project Implementation appear as a seamless environment to the customer and the stakeholders even though there are changes in leadership. There are programmatic, administrative, and technical personnel and resources required to take the initial suggested science concept through completion of the science mission. Normally key administrative and technical personnel should remain associated with the project from evolution of the concept through completion of the science mission when practicable.

Program/Project personnel represent the primary leadership throughout the life cycle of a project and are the key points of contact for the customer. During the development of the AMC, a Lead Scientist and a PFM are assigned. They are expected to complete the AMC, gain NBC approval to proceed to Formulation, complete the Enabling Activities, start generation of the approval package for Implementation, and definitize the project. The Lead Scientist, PI and the Project Manager are expected to implement the project as defined within the allocated resources, maintain an active customer interface, manage any changes required, and develop the transition of the mission to an operational organization.
The transition of the project from the PFM position to the Project Manager position needs to be smooth to minimize the impact to the process and the relationships with customers or stakeholders. The transfer of formulation ownership from the PFM to the Project Manager is critical to the success of the process and mission implementation. The Project Manager will be appointed before the Definitization activity of the Formulation Subprocess begins. The specific assignment of personnel to these positions will be addressed as the project evolves through Formulation to Implementation. There are many options available to STAAC and FPPD for assignments throughout the process. Generally assignments proceed as follows, in accordance with GPG 7120.2:

a. Assignment of a PFM for Formulation from existing STAAC personnel.
b. Matrix of FPPD employee to STAAC for assignment as a PFM. FPPD employee will be rebadged to STAAC if this assignment occurs more than one year prior to the start of the Definitization activity.
c. Rebadging of the assigned STAAC PFM to FPPD to continue as the Project Manager or other project management position such as Deputy Project Manager, Observatory Manager (OM), or Instrument Systems Manager (ISM) or Operations Manager.
d. Assignment of a Project Manager from FPPD and reassignment of the (STAAC) PFM to another STAAC position.

None of the options will be considered as standard, since each situation will need to be decided based on several factors including the scope and complexity of the project, experience and capability of individuals, and inputs of customers and stakeholders. The options concern Enterprise-Directed Projects, but options c. through d. should also be considered for Competed Projects.
Appointments of PFM's and Project Managers are complex considerations which follow these ground rules:

a. The Director of STAAC with the Director of FPPD jointly appoints a PFM for flight project studies after receiving recommendations from the Chief, Project Formulation Office and the Program Manager.
b. With the concurrence of Headquarters and the Goddard Center Director, the Director of FPPD, supported by the STAAC Director, appoints a Project Manager no later than the beginning of the Definitization activity of Formulation to lead the effort through the remainder of the Formulation Subprocess and the Implementation Subprocess.

3.2.1.4 Roles and Responsibilities of Project Scientist

The Project Scientist is responsible for ensuring the satisfactory accomplishment of the scientific objectives of the mission. He/she reviews the Implementation of the project to ensure that the total system is consistent with the overall project scientific objectives and the validation of science products takes place with customer involvement. He/she, as a senior member of the project team, advises on other project activities. He/she provides leadership in ensuring that the scientific data are effectively used, and that scientific results of the mission are expeditiously produced. The Project Scientist evaluates all scientific requirements placed on the Project Manager and others involved in the program.

The Project Scientist manages scientific aspects of the project, acts as the scientific advisor to the Project Manager, is the scientific spokesperson for the project and for the investigators, and chairs the Project Science Working Group (PSWG) or team. The Project Scientist represents the PI or the Team Leader in their relationships with the Project Manager, maintains the science integrity of the mission within the agreed-upon time and funding constraints, and maintains cognizance of individual as well as overall science investigations included in the project. He/she reviews and makes recommendations to the Program Scientist for the approval or disapproval of proposed modifications to investigate science objectives or instrument change proposals, and assists in resolving conflicting requirements between scientific instruments and the spacecraft and between different instruments. The Project Scientist reviews the science budget and all other resources including spacecraft power, weight, etc., and advises the Project Manager on their disposition. He/she reviews data analysis plans and programs in order to ensure timely and adequate analysis of spacecraft data and is responsible for validation of the final data set. The Project Scientist assists and cooperates with the Program Scientist in carrying out his/her roles and responsibilities. He/she ensures public dissemination of scientific results through professional groups, and the Office of Public Affairs, and ensures the archiving of scientific data.

The Project Scientist further ensures that feedback is provided to NASA Headquarters and GSFC management regarding his/her assessment of mission success. Mission objectives to be used in making the assessment are set forth in the Project Plan.

3.2.1.5 Roles and Responsibilities of Product Design Lead (PDL)

The PDL is responsible for establishing goals and objectives, as well as establishing the basic approach for meeting goals and achieving objectives. As leader of the Product Design Team (PDT), the PDL is responsible for defining the team organization and responsibilities, assigning duties and responsibilities to qualified personnel, developing a schedule and budget, determining logistics support requirements, and establishing communications among organizations supporting the product design effort. In order to ensure the integrity of the design effort, the PDL is responsible for establishing a method for defining and documenting each technical interface; documenting and maintaining design plan information; and developing a validation plan per GPG 8700.3, which addresses environmental tests, functional tests, plans for final analysis and reviews which address customer participation in all aspects of validation, product release, and maintenance of validation records. Finally, the PDL is responsible for ongoing evaluation of the design, and updating of the validation plan as necessary.

3.2.2 GSFC Principles of Project Management

While technical expertise and sound management practices are major keys to success for Project Managers and projects, there are other elements such as dedication, hard work, self-discipline, perseverance, and patience which are of equal importance in the overall scheme. However, the most important characteristic of a successful Project Manager is a firm, positive attitude towards the immediate/future work. This is exemplified by a "CAN DO," attitude while focusing on ways to overcome difficulties in accomplishing the technical work on time and within costs. In other words, the successful Project Manager plans his/her work and works his/her plan with confidence. The best-planned project will, however, have certain elements of risk. The "CAN DO," Project Manager is aware of these risks, and will strive to offset them by parallel technical and management paths, adjusting activities to offset risks such as by modifying the project schedule or adding funding contingency.

Another major ingredient for successful project management is teamwork. The Project Manager provides the leadership in formulating an effective team. Additionally, he/she must provide leadership at all levels and aspects of the project. In a true team effort, all project personnel must work together in the process, striving for excellence in the delivery of the end product or service. The successful Project Manager instills in his/her team a commitment to meet technical requirements, as well as cost and schedule, and the need for constant and clear communication with all participants. While each team member strives for excellence in his/her own area of work, he/she additionally supports (with a critical inquisitive mind) all other members of the team by asking appropriate questions and volunteering information or advice. This continual critique of one's own work and that of other team members (always looking for a flaw in the assumptions, concepts, or design) often uncovers areas of concern or potential problems that another team member may fail to recognize because he/she may be "too close to the trees to see the forest." The Project Manager should promote and encourage a team environment in the project, realizing that goals and objectives which may seem difficult or insurmountable to an individual are quite often achievable by the team.

The following are key considerations in managing a Project:

a. The foremost principle of project management is the identification and integration of project requirements and constraints into a complete set of project requirements, which can be implemented within an agreed budget and schedule.
b. The Project Team must have a clear understanding of the roles and responsibilities of each project group or contributing functional group. In addition, those with responsibility for ensuring performance must understand their limitations and respond accordingly to those who have other management responsibilities.
c. The functions of project management, systems management, systems engineering, integration, and project control must be well understood. The Project Manager must make the best possible use of the skills of his/her personnel.
d. The Project Manager must manage the outward interfaces without stifling communications, while providing effective leadership within the project.
e. The benefits and limitations of a matrix management system must be understood.
f. The Project Manager must establish an organization a climate that fosters cooperation and goal achievement.
g. The NASA management values of planning and control, promoting achievement, understanding and supporting others, and managing interpersonal relations must be understood to promote the project group interactions that have been so successful in the past.

3.2.3 GSFC Project Organization and Support

3.2.3.1 Sample Project Organizations

Figure 3-7 illustrates a sample program/project organizational structure. It should be viewed as a starting point when forming the project organization. However, the individual project organizational structure should be tailored to meet and reflect unique project goals and needs, and thus may vary from the "sample" structure. In general, the majority of GSFC flight projects will be located organizationally within the FPPD (Code 400). Flight projects are organized to be compatible with the work to be performed, and variations do occur. The Systems Assurance Manager (SAM) and Procurement Manager are normally collocated with the project. The Project Scientist may or may not be collocated with the project. The top-level project organization is composed of a group of senior managers selected for their capabilities in their areas of expertise. They form the nucleus of the project organization and are collocated so that they function as a close-knit team for optimum project control and management. Those engineering and support positions below the systems manager level normally are only collocated if their support to the project is full time or nearly full time. If they support more than one project they are normally located at their home directorate. On an exception basis, some of these positions may be deemed to be critical enough to warrant collocation or even reassignment to FPPD (Code 400).

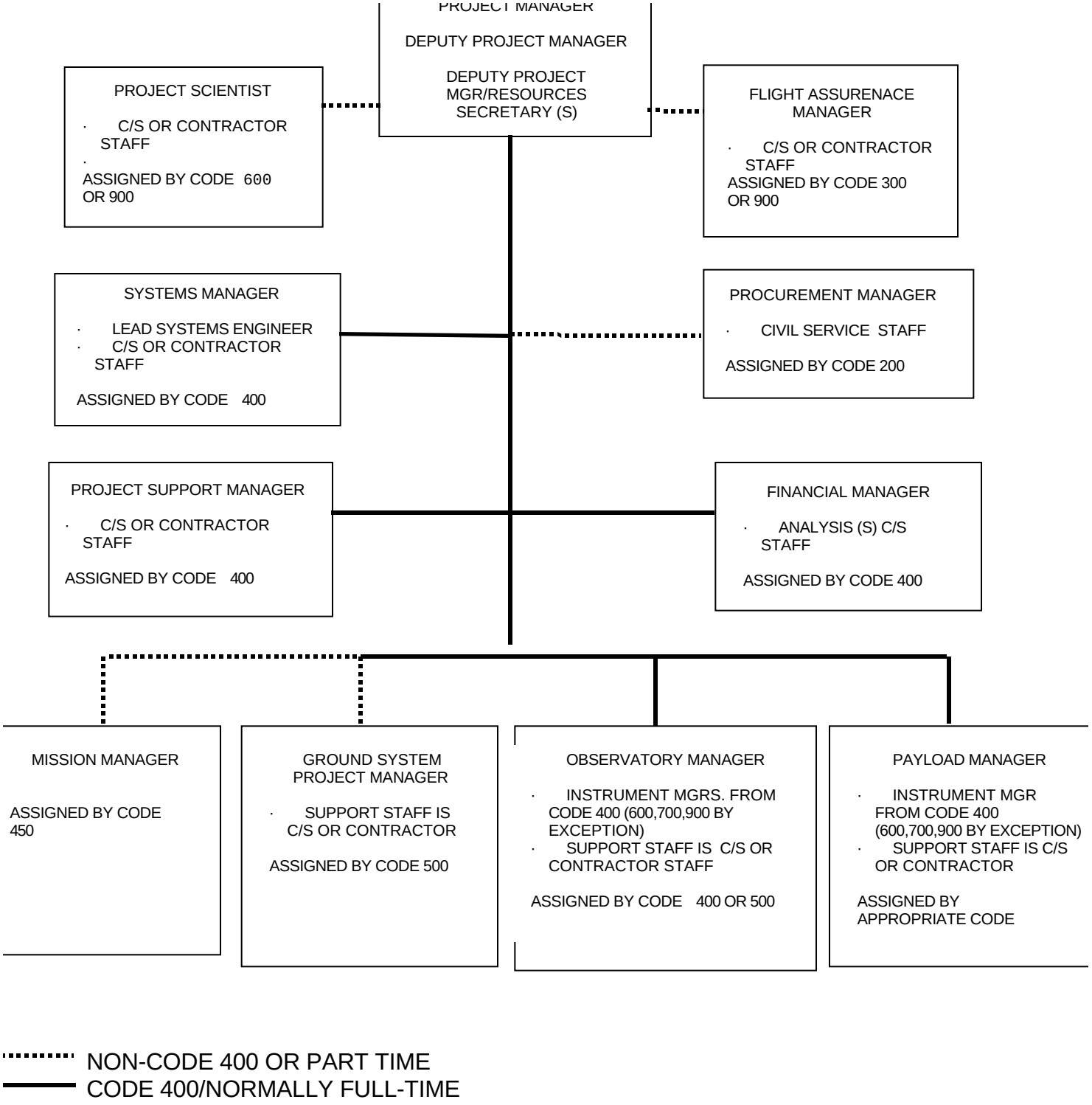

Figure 3-7a Classic Project Organization Chart

3.2.3.2 Typical Key Project Personnel

Figure 3-7a and 3-7b shows the organization structure of a sample project and also shows the organization structure of a sample PI-mode project. Upon approval of the Project Plan, the unique project organization and management roles will have been established and approved.

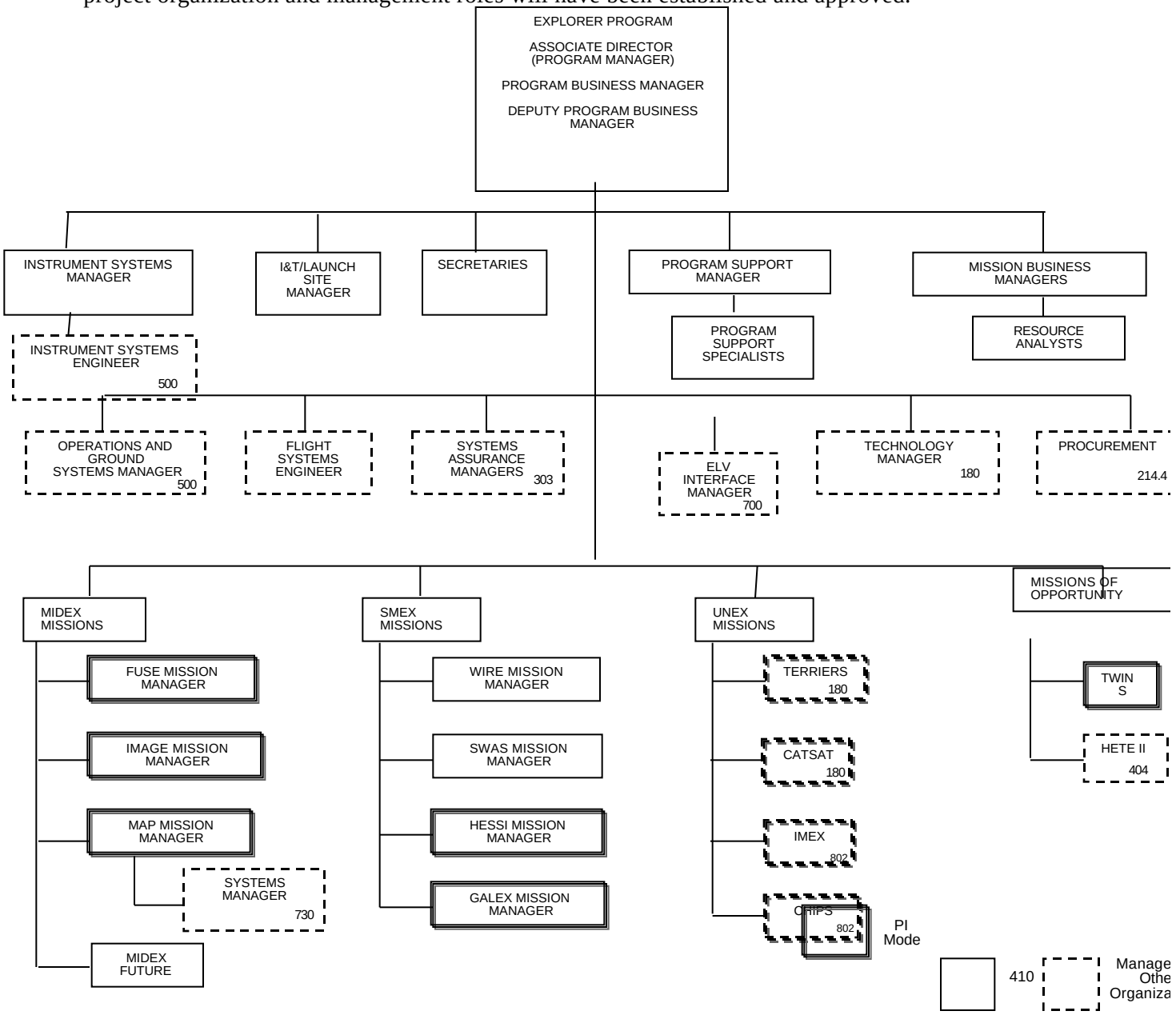

Figure 3-7b. Sample GSFC Program/Project Organization including PI Projects

3.2.3.2.1 Senior Project Management

a. The roles of the Project Manager and Project Scientist are defined in paragraphs 3.2.1.3 and 3.2.1.4.
b. Deputy Project Manager – The Deputy Project Manager is responsible to the Project Manager and is an integral member of the management team for the project. He/she supports the Project Manager in directing all phases of the project, and has project-wide responsibility for planning and evaluating all project activities on a day-to-day basis. He/she provides technical management to the team of technically skilled specialists and their supporting personnel in order to meet performance cost and schedule commitments. In the absence of the Project Manager, the DPM assumes full responsibility for project management.
c. Deputy Project Manager for Resources – The Deputy Project Manager for Resources is responsible to the Project Manager and is an integral member of the management team for the project. He/she contributes business management expertise to the establishment of technical program/project objectives and is responsible for the application of business and financial management techniques to the accomplishment of project objectives. The Deputy Project Manager/Resources manages a team of specialists in the areas of finance, budget, procurement, scheduling, pricing, configuration management, QMS management, etc., and is responsible for the application of sound business techniques to the accomplishment of project objectives. In the absence of the Project Manager and the Deputy Project Manager, the Deputy Project Manager for Resources acts for the Project Manager.

3.2.3.2.2 Systems Assurance Manager ¾ The Systems Assurance Manager (SAM), from the Office of System Safety and Mission Assurance (OSSMA) (Code 300), is responsible for coordination of and follow-up on the System Safety and Mission Assurance disciplines for the project to ensure that the flight system and ground data systems will meet intended performance objectives. These disciplines include reliability, quality assurance, design review, system safety, range safety and requirements definition, and environmental testing.

3.2.3.2.3 Mission System Engineer ¾ The Mission System Engineer (MSE)is responsible for optimizing all systems aspects of the flight and ground segments. He/she is responsible for developing the systems design of the flight segment and for ensuring that it is compatible with the scientific instruments, launch vehicle, communications system, ground segment, reliability objectives, and end products. He/she establishes interface constraints and requirements for subsystems, resolves interface and system-level performance questions and problems, reviews and approves for manufacture the electrical/mechanical flight hardware designs, and oversees the electrical/mechanical integration and test of the spacecraft. He/she reviews performance data and measurements throughout the project to ensure that flight and ground segments meet stated requirements and objectives including verification and validation of scientific end-products and services.

Specifically, the MSE has review and sign-off responsibilities for all major system-level functional performance and design specifications; he/she performs risk assessments and evaluates design margins and adequacies; reviews all major test plans and procedures; compares predicted and actual performance of the system; reports routinely to the Project Manager on the status of system engineering activities; serves as chairperson for major failure review committees, and advises the Project Manager as to major critical aspects of his/her assignment. He/she is responsible for suggesting the use of new technical approaches to the project after having determined the risk involved.

3.2.3.2.4 Software Systems Manager -- The Software Systems Manager is responsible for the integrity of the total software systems used on the project. Typically reporting to the MSE, he/she supports the Project Manager by monitoring and overviewing the Flight, Integration and Test, Ground Support Equipment (GSE), Reliability-based Logistics, Ground Operations, Ground Data

Processing Software Systems, their respective interfaces, the scientific investigators, interfaces and their interfaces to the scientific community. He/she puts particular emphasis on the project outputs' usefulness to the whole scientific community and other probable users. Software personnel within the specific functional organization they are supporting develop individual software systems. The existence of this position in a project is dependent upon project needs.

3.2.3.2.5 Mission Manager ¾ The Mission Manager from Networks and Mission Services Project (Code 450) is responsible for the development of the Project Service Level Agreement (PSLA), which contains operational ground system requirements. As a member of the Code 450 staff, he/she is responsible for the SOMO-provided operational ground system support integrity, including defining project requirements and overviewing the development of the complete operational ground system. As documented in the PSLA, before launch the Mission Manager is responsible for interfacing with SOMO and ensuring that operational requirements are achieved, including all necessary tests and validations of the operating system. After launch, he/she is responsible for the operation of the spacecraft to fulfill the mission objectives, including production of scientific data and end-item services.

3.2.3.2.6 Ground System Project Manager (GSPM) ¾ The GSPM is responsible for the development of the data processing ground system. As a member of the project staff, matrixed from Information Systems (Code 580), he/she is responsible for the total data processing ground system support integrity, including converting and interpreting requirements from the Experiment/Instrument Systems Manager and overviewing the development, test, and evaluation of the complete data processing ground system. The data processing ground system consists of all of the necessary hardware, software, communications support, and required facilities necessary to produce an acceptable data set for the experimenter/instrumenter/user/customer.

3.2.3.2.7 Spacecraft/Observatory Manager ¾ The Spacecraft/Observatory Manager marshals and directs the efforts of a team of government and industry specialists in identifying and specifying the mission-imposed spacecraft/observatory requirements, in developing subsystems and systems capable of fully meeting those requirements, and in demonstrating that the spacecraft/observatory and its components meet its functional performance goals in the launch and space environments. He/she ensures that the infrastructure, facilities, tools, fixtures, test equipment, and Automated Data Processing (ADP) hardware and software required in the fabrication, assembly, integration, and test of the subsystems and of the spacecraft/observatory are procured or developed and are available at the appropriate times and places. The Spacecraft/Observatory Manager is responsible for planning and managing these tasks so that they are completed on schedule and within the available resources. In an out-of-house project, he/she is the Contracting Officer's Technical Representative (COTR) for the observatory contract.

3.2.3.2.8 Payload Manager (Instrument Systems Manager (ISM)) ¾ The Payload Manager, or Instrument Systems Manager, is responsible for close liaison and monitoring of the instrument development or other types of payload hardware development being performed by other GSFC directorates or outside GSFC, by universities and contractors. He/she must ensure through coordination and technical review of the payload designs that the instruments or payload hardware meet the technical performance, cost and schedule parameters for the basic mission requirements. He/she is responsible for coordinating the spacecraft bus/payload interfaces and for providing the related Ground Support Equipment (GSE), and for assuring that scientific algorithm development, in conjunction with the Project Scientist, is completed in a timely manner.

3.2.3.2.9 Procurement Manager ¾ The Procurement Manager works closely with and supports the Deputy Project Manager/Resources, and is responsible for all major procurement functions of the project, including planning, directing, coordinating, and evaluating all project procurement activities in accordance with the Project Plan, NASA policies and Goddard QMS requirements.

3.2.3.2.10 Financial Manager ¾ The Financial Manager is a member of the business support team and reports to the Deputy Project Manager/Resources. He/she is responsible for the application of sound financial management principles in the areas of cost control, financial analysis, EVM evaluation and assessment, budget preparation and execution, pricing, and support of Project QMS management.

3.2.3.2.11 Project Support Manager ¾ The Project Support Manager is a member of the business support team and reports to the Deputy Project Manager/Resources. He/she is responsible for scheduling, configuration management, manpower analysis, property management and control, life cycle logistics coordination, Management Information Systems (MIS), personnel safety, and other general administrative and overall project planning activities including Goddard QMS management.

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GODDARD HANDBOOK FOR MANAGEMENT OF PROGRAMS – PROJECTS – PRODUCTS

This Volume is currently under revision.

Volume 4

Product Management

FEBRUARY 1999
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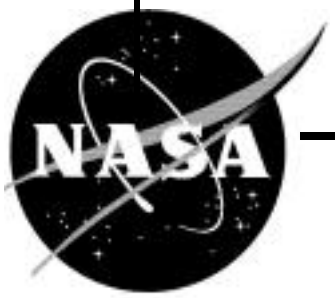
Mission Integration Office
Flight Programs and Projects Directorate



GODDARD SPACE FLIGHT CENTER

GREENBELT, MARYLAND

Responsible Office: 401 Mission Integration Office
Title: GODDARD HANDBOOK FOR MANAGEMENT
OF
PROGRAMS – PROJECTS – PRODUCTS

Volume 4: Product Management

Purpose

This Handbook is designed to aid all Goddard personnel assigned to a program – project – product. The Handbook encompasses the Program – Project – Product Management environment, and how to successfully meet its demands and take advantage of its flexibilities, such as tailoring requirements to produce products which:

a. Meet intended and specified customer requirements.
b. Conform to NASA requirements for technical performance, schedule, budget, and management processes, including ISO 9001.
c. Support the NASA initiatives for Faster – Better – Cheaper products.

Applicability

The Program – Project – Product Handbook applies to the hardware, software, material, and services delivered to customers as a result of the following NASA/GSFC core processes at both the Greenbelt and Wallops facilities:

a. Science Enabling –The grants process; providing data to the science community; science support tools; the proposal support process; and the science research management process;
b. Systems Development –Space flight systems; balloons; sounding rockets; aircraft experiments; ground systems; and data systems;
c. Program/Project Management –Cost, schedule and technical control; review and reporting; budgets; procurement; contracts; and safety and mission assurance;
d. Technology Enabling –New concepts studies; investment strategies; crosscutting developments; mission specific products; transfer; and commercialization;
e. Mission Operations –Customer service commitments, including Project Service level Agreements and Project Commitment Documents.

Authority

GPD 7120.4 – Goddard Policy for the Conduct of Programs, Projects and Products

References

NPD 7120.4 – Program/Project Management
NPG 7120.5 – NASA Program and Project Management Processes and Requirements
GPG 7120.1 – Program Management
GPG 7120.2 – Project Management

VOLUME 4. Product Management

4.0 Introduction to Product Management

"Products" include all deliverables subject to GSFC Quality Management System (QMS), including all hardware, software, services, mission data, science, and technology output, to GSFC customers. All GSFC Product Management Teams and/or Product Design Lead's (PDL's) are to conduct business in accordance with the principles of GSFC QMS and NPG 7120.5.

This volume summarizes QMS (GPG) requirements as they apply to Product/Program/Project Managers and PDLs. A project is a very special, well-defined and disciplined product management system, which may have unique requirements not covered by the more generic discipline of product management. This volume does not, however, deal with requirements and responsibilities for a non-product manager. For non-product applications, or more detailed information, the reader should consult the QMS directives. This volume applies to every Product Manager and his product team, whether the product is as small as an aerospace item brought in for application of a special plating, a suborbital payload or experiment, or a major NASA spacecraft.

These requirements are a compilation of the ISO 9001 requirements derived from GSFC GPG's, and add explanatory information where useful. ISO requirements define sound business practices, and enable an organization to understand and improve its services as related to a product. To the extent allowable by the GSFC Quality Manual (GPG 8730.3), these requirements may be tailored by the individual directorates Programs, Projects, and PDLs to meet their organizational needs and customer product requirements.

4.1 Management Responsibility (ISO 9001 Element 4.1)

GPG 1060.1 Management Responsibility
The Product/Project Manager must ensure that quality policies and procedures are in place that define the responsibilities, authorities, and interrelationships of personnel responsible for:

a. Initiating preventive and corrective action
b. Identifying and recording product, process/subprocess, and system problems
c. Initiating, recommending, or providing solutions and verifying implementation
d. Controlling further processing of non-conforming product prior to correction or formal disposition.

Uniform requirements for these policies and procedures may be developed by divisions and directorates.

4.2 Quality System (ISO 9001 Element 4.2)

GPG 8730.3 Quality Manual
This is the GSFC Quality Manual that implements ISO 9001 at GSFC. It summarizes the GSFC Quality System described in the GPG's, but it does not impose any unique requirements for Product Managers. All requirements addressed in the Quality Manual are detailed in the GPG's.

GPG 8730.4 Quality System
This GPG requires the performing directorate to assign a Product (or Project) Manager, responsible to establish or ensure availability of specific types of plans tailored to meet Center, directorate, and customer requirements for each product or project. The Product Manager is responsible for:

a. Preparation or ensuring availability of applicable documented plans that address product/project requirements derived from customer requirements and Center or directorate requirements related to budget, schedule, risk management, acquisition, commercialization, and performance objectives (per NPG 7120.5)
b. Development of controlled Quality System documentation per GPG 1410.1.
c. Submission of plans for management review, approval, and implementation, such as:
    1) Project Plan
    2) Project Systems Plan
    3) Project Technology Requirements Plan, including development of unique quality requirements or processes
    4) Project Technology and Commercialization Plan
    5) Project Operations and Business Opportunities Plan
    6) Assessment of infrastructure and development of upgrade and new requirements for Infrastructure Plan (reflected in the Project Plan)
    7) Knowledge Capture Process Plan
    8) Quality Plan, tailored to meet customer requirements, defining the quality requirements, means of implementation, processes, Nonconformance Reports (NCR) and Material Review Board (MRB) requirements, etc.

All product and project managers (of products such as satellites, instruments, ground systems, software, etc.) within the scope of GSFC QMS must tailor these requirements to a level acceptable to the directorate, commensurate with customer requirements. Tailoring of requirements includes defining appropriate supporting documentation and is compatible with the requirements of ISO 9001 and NPG 7120.5. Performing directorates are required to review and evaluate Product/Project Formulation, Approval, and Implementation at scheduled intervals. A detailed definition of these requirements is found in Volume 3 of this Handbook.

Guidelines for product/project agreements and formulation may be issued by individual directorates for use by the PDL.

4.3 Contract Review (ISO 9001 Element 4.3)

GPG 1310.1 Establishing Customer Requirements

Product/Project Managers shall act as or obtain a sponsor/advocate at the directorate level supporting the customer's request for a product. Work shall proceed after an appropriate customer agreement has been established.

a. Customer agreements with a full cost LCC of $5 million or more, shall follow the procedures described in this GPG, including the sponsoring directorate's priority proposal for submission to the STAAC Director.
b. For customer agreements of less than $5 million, the directorate advocating the arrangement establishes the Center's commitment, including defining necessary documentation requirements.

4.4 Design Control (ISO 9001 Element 4.4)

GPG 8700.1 Design Planning and Interface Management
The following elements, taken collectively, constitute the Design Plan. It is important that these elements be tailored to a level acceptable to the directorate, commensurate with customer requirements. It is also important to note that some or all of this entire requirement may not apply, particularly with smaller products, because these requirements are fulfilled before delivery of the product to the performing organization. The following requirements apply to projects or products where the design is required of the performing organization.

The PDL is the product or project manager (or his/her designee), and has overall responsibility for managing the design activity, managing the technical and organizational interfaces identified during design planning, and leading the design team. He/she can be a Flight Project Manager, Mission Manager, Instrument Manager, Subsystem Manager, Lead Engineer, etc. The PDL defines the goals and objectives for the design requirements and the means for achieving them. These design requirements shall be traceable to the customer requirements/agreement in accordance with the directorate's commitment. The PDL will:

a. Define a structure/organization chart and distribution of responsibilities for the product or project, and create a Work Breakdown Structure (WBS) if required.
b. Determine needed logistics support interfaces as described in GPG 6400.1.
c. Identify appropriate support organizations including personnel qualifications, training, and certifications.
d. Generate a schedule of design activities, considering factors such as funding, parts and equipment lead times, and other items identified in GPG 8700.1.
e. Establish a resource plan by developing a phased budget for manpower and dollars.
f. Establish required and anticipated paths of communication between organizations/personnel, including the customer.

g. Establish a method for defining, documenting, and controlling each technical design interface [e.g., Interface Control Document (ICD)].
h. Document and maintain design plan information as quality record(s).

GPG 8700.2 Design Development

To the extent necessary, and due to tailoring of requirements described for GPG 8700.1, the following requirements may apply. For instance, a flight project with full design responsibility would address all of the following. However, for smaller products, the performing directorate is responsible to ensure that these elements are addressed to an extent appropriate to meet the customer requirements, and remain compliant with the QMS.

The PDL convenes a Product Design Team (PDT) to:
a. Review customer requirements (GPG 1310.1)
b. Review the Design Plan (GPG 8700.1)
c. Review scope of the product design
d. Document derived requirements as design input
e. Develop detailed product design schedules
f. Perform design activities necessary to meet customer requirements and the Design Plan
g. Produce design output documentation in terms that can be verified against design requirements, including:
   - Drawings, specifications, and/or procedures to develop and/or operate the product
   - Acceptance criteria for validation
   - Identification of characteristics essential to safe and proper functioning of the product

Design verification ensures the design output meets design input requirements, whereas design validation ensures that the product conforms to user needs and/or requirements. Design validation normally should directly involve the customer.

As part of PDL responsibility for the PDT, the PDL will also maintain product descriptions, configuration management records, analyses, reports, instructions, and test results as quality records.

GPG 8700.3 Design Validation

The PDL must ensure validation requirements are met, including customer involvement by reviewing and updating the Validation Plan to reflect the customer's full requirements, prior to product validation at each level of product development. The PDL and PDT shall be responsible for all phases of product validation. These requirements include:

a. Evaluate the performance, durability, safety, reliability, and maintainability of the product under all customer-defined operational and storage conditions.
b. Identify and document intermediate validation(s) on discrete portions (e.g., subassemblies, assemblies, and component(s) of the final product).
c. Identify and document final validation required on the complete, integrated product.

After final validation, the PDL shall:
a. Document successful completion of validation, and release the product for future processing in accordance with product plans (GPG 8730.4 and GPG 5330.3)
b. Document validation nonconformance in accordance with GPG 5340.2.

GPG 8700.4 Technical Review Program

A flight project will frequently require a full review program, as described below. However, for smaller products, the product/project manager shall ensure that appropriate review programs are tailored commensurate with the product cost, design complexity, and customer requirements.

In support of the technical review program, the product/project manager shall:

a. Work within the guidelines of the Systems Review Office (SRO) (Design Review Program Guidelines), to develop a System Review Plan (SRP) (see GPG 8730.4) that considers product complexity, criticality, new technology, flight history, mission objectives, mandated constraints, and maintenance of records.
b. Ensure the PDL identifies the schedule and subject of peer reviews in a Peer Review Plan (PRP) that considers the same subjects as above. The PRP development process shall include the maintenance of peer review records.
c. Approve the PRP (see GPG 8730.4).

The conduct of Peer Reviews and System Reviews are described below:

a. Peer Reviews. The product/project manager shall appoint a chairperson for the Peer Review team, who is independent of the PDL. The chairperson shall:
   - Select appropriate technical experts who are independent of the PDL as review team members. Personnel outside the Center may serve as review team members or as a co-chairperson.
   - Lead the review. The PDL and the PDT shall present the review materials.
   - Document and transmit Requests for Actions (RFA's) to the PDL at the completion of the review.
   - Develop a schedule for RFA responses in coordination with the PDL.
   - Determine the acceptability of each RFA response and return unacceptable responses with appropriate annotations regarding remaining issues.
   - Document the results in a Peer Review Summary for the PDL and the Product Manager within 30 calendar days.

b. System Reviews. The Chief, SRO, shall appoint the chairperson for the System Review team. The chairperson shall:
   - Select technical experts who are independent of the project or product team as review team members. Personnel outside the Center may serve as review team members or as a co-chairperson.
   - Lead the review. The PDL and the product design team shall present the review materials.
   - Document and transmit RFA's to the product/project manager PDL at the completion of the review.
   - Develop a schedule for RFA responses in coordination with the product/project manager.
   - Determine the acceptability of each RFA response and return unacceptable responses with appropriate annotations regarding remaining issues.
   - After the conclusion of the System Review, prepare a summary of the results for the Chief, SRO, and the Product Manager within 30 calendar days. The chairperson shall also prepare an assessment of Product status for approval by the Chief, SRO, and the Director, OSSMA and subsequent submission to Office of the Director (Code 100) (System Review Summaries).
   - After the conclusion of the final System Review, and after all RFA responses are approved by the chairperson, prepare a summary of the Product Group/Projects/System Review Program for approval by the Chief, SRO, and the Director, OSSMA and subsequent submission to Office of the Director (Code 100) (System Review Program Summary).

4.5 Document and Data Control (ISO 9001 Element 4.5)

GPG 1410.1 Directives Management

The Product/Project Manager supports the generation, approval, distribution, and change of necessary directives as follows:

a. Determines the need for directives
b. Assigns the action to create, revise, or rescind the directive
c. Coordinates and secures appropriate approval
d. Cancels directives that are no longer applicable

Additionally, he/she shall:

a. Designate a Directives Manager for the project/organization to manage document availability
b. Support the generation of Procedures and Guidelines to implement GPG's
c. Support the generation of WI for activities that require structured implementation
d. Provide necessary controls to support NASA Online Directory Information System (NODIS) or an equivalent system and the Master Document List
e. Ensure that all directives meet the format requirements of the GPG

The revision process includes review and approval by those who performed the initial review, or by designated individuals who have access to pertinent data to ensure a sound decision. New changes from prior documents will be outlined, whenever possible. Documents that are no longer current or applicable shall be removed and destroyed. Limited quantities may be retained, but shall be prominently marked as obsolete.

4.6 Purchasing (ISO 9001 Element 4.6)

GPG 5100.1 Procurement

a. The Product/Project Manager provides management oversight of delegated functions, including support for quality and safety audits, in order to conduct purchasing in a manner which leads to procurement of materials which meet specified requirements. He/she ensures: Procurements are properly prepared and include performance requirements, the applicable quality standard, receiving and inspection requirements, and other requirements of GPG 5100.1.
b. Proper Letters of Delegation are provided, as applicable.

GPG 5100.2 Supplier Performance Records

The Product/Project Manager ensures that supplier performance data is used in evaluating current and potential suppliers or subcontractors. To accomplish this responsibility, he/she ensures that:

a. Supplier performance data is recorded, documented, retained, and maintained during and at completion of contract performance per GPG 1440.7 and GPG 5100.2.
b. Supplier performance documentation is processed according to GPG 5100.2.
c. Records of the supplier's evaluation shall be maintained as Quality Records.

The supplier evaluation process is useful in determining subcontractor performance acceptability based on the type of product being secured, past experience with the supplier, and the supplier's capabilities.

These requirements are tailored to meet product needs. The Directorate will ensure these requirements are met in cases where it is inappropriate to place this burden on the manager of a small product.

GPG 5100.3 Quality Assurance Letter of Delegation

The Program Manager ensures that Letters of Delegation are processed as required in GPG 5100.3. The Directorate will ensure these requirements are met, in cases where it is inappropriate to place this burden on the manager of a small product.

4.7 Control of Customer Supplied Product (ISO 9001 Element 4.7)

GPG 5900.1 Control of Customer-Supplied Product (CSP)

The Product/Project Manager is responsible to ensure that:

a. The PDL identifies CSP expected for delivery at GSFC, and prepares receiving inspection. requirements per this GPG, GPG 4520.2, and customer requirements.
b. Upon receipt at GSFC, CSP is identified on the Work Order Authorization (WOA) and inspected as required. See GPG 5330.3.
c. Ensure the rework/repair of CSP is only performed when authorized and as instructed by the customer.
d. The CSP, which is damaged or malfunctions during GSFC processing is documented and handled as nonconforming material per GPG 5340.2.
e. The PDL refers CSP damage to the customer for disposition instructions.
f. The CSP is handled and stored per GPG 6400.1.

In general, these requirements ensure controls for CSP during inspection, storage, handling, and maintenance activities. It should be noted that GPG 5340.2 requires that, should this material become unusable for any reason, it must be segregated, identified, controlled, and reported to the customer.

4.8 Product Identification and Traceability (ISO 9001 Element 4.8)

GPG 5310.4 Identification and Traceability of Products

The Product/Project Manager is responsible to ensure that:

a. WOA's (or acceptable equivalents) shall provide positive identification of a product (see GPG 5330.3 and GPG 5310.4).
b. Identification and traceability of software product shall be as described in the applicable Directorate-Level Configuration Control Document (see GPG 8700.2) or Software Inspection and Test Status Identification Document (see GPG 5330.3).
c. Product traceability, including location, application, disposition, or history of the product, is accomplished by the accumulated WOA's (or equivalent).
d. The PDL maintains all WOA's (or equivalent) as quality records.

The GPG 5330.3 require that events, including in-process and final inspection and test, shall reflect the detailed design and design validation plans resulting from GPG 8700.2 and GPG 8700.3.

These procedures will ensure clear and proper identification and traceability of materials as they move through the production, installation, delivery, and servicing (if required) processes to ensure that the customer's requirements are satisfied.

4.9 Process Control (ISO 9001 Element 4.9)

GPG 8072.1 Process Control

This section is aimed at ensuring that manufacturing processes, particularly special processes, are carried out safely and under well-planned, controlled conditions, so that these processes provide maximum assurance of process success. Examples of such processes are thermal-vacuum plating, dry bearing lubrication, lens grinding, contamination sampling, and the many other processes necessary to provide a quality aerospace product.

To ensure successful process control, the product/project manager is responsible to ensure that:

a. The PDL identifies required processes during design to meet customer requirements (see GPG 1310.1) and project design plan (see GPG 8700.1). This includes the definition of overall quality management plans that are to be met.
b. Process owners assess existing process capabilities in terms of specific process requirements needed to satisfy customer needs. Then, process owners use or develop, for each production, installation, and servicing process under their cognizance, Process Management Plans which address the following:
   - Documented procedures defining the manner of production, installation, and servicing, where the absence of such procedures could adversely affect quality.
   - Use of suitable equipment and a suitable working environment.
   - Compliance with reference standards/codes, quality plans, and/or documented procedures.
   - Identification, monitoring, and control of suitable process parameters and product characteristics.
   - Approval of processes and equipment, as appropriate.
   - Criteria for workmanship, documented and expressed in the clearest practical manner.
   - Suitable maintenance of equipment to ensure continuing process capability.
c. Process Management plans for special processes address pre-qualification (pre-production) of the process operations, and:
   - Process operator training/qualification, and/or
   - Continuous monitoring and control of identified process parameters

d. The PDL identifies product characteristics to be inspected and/or tested to verify results of the process applied. Such inspection/test events, criteria for workmanship and acceptance, and process events, as applicable to GSFC product, shall be documented in accordance with GPG 5330.3.

e. Continuing process capability shall be evaluated by results of both product evaluation and the monitoring of process parameters identified in the Process Management Plan.
   - Processes, which yield unacceptable products are subject to corrective action, root cause analysis, and investigation in accordance with GPG 1710.1.
   - Process parameters are monitored and evaluated over time for evidence of negative trends or 'out of control' situations.
   - Specific statistical techniques to be employed are defined and documented in accordance with GPG 8070.2.
   - The process owner maintains records of process evaluation and process correction.

These requirements provide a controlled process environment that ensures that the quality of the product is adequate and in conformance with documentation and record requirements. This requires adequate and controlled written instructions (procedures) or representative samples that ensure proper assembly and workmanship standards. These standards should define the criteria for acceptable workmanship.

4.10 Inspection and Testing (ISO 9001 Element 4.10)

GPG 4520.2 Incoming Inspection and Test

The Product/Project Manager is responsible to ensure that:

a. The procurement initiator prepares, as part of the procurement package, Receiving Inspection Instructions, documented on a WOA or equivalent (see GPG 5330.3), which include the following:
   - Who is to perform the inspection
   - Where it shall be performed
   - Verification of kind (correct part number), count (quantity as required), and condition (visual inspection to determine that items are undamaged)
   - Other conditions specified in the procurement package
b. Received items shall be identified in accordance with GPG 5310.1. Customer-Supplied Product shall be identified in accordance with GPG 5900.1.
c. Results of the Receiving Inspection are documented on the WOA. Receiving Inspection records are Quality Records and shall be controlled in accordance with GPG 1440.7.
d. Items released prior to completion of Receiving Inspection are identified and controlled as Nonconforming Product in accordance with GPG 5340.2.

Note: Should an item(s) be received without proper Receiving Instructions, the item(s) will be delivered to the GSFC Receiving Officer, who will notify the PDL or his/her designee before further processing. The Receiving Officer will identify, segregate, and retain the item(s) as nonconforming product as specified in GPG 5340.2.

GPG 5330.1 In-Process and Final Inspection and Test

The Product/Project Manager is responsible to ensure that:

a. The PDL documents the work, including inspections and tests, to be conducted on the product on a WOA. Special items or equipment needed for inspections or tests are identified on the WOA.
b. No work event is performed prior to its planning and approval on the WOA.
c. No work event is performed until all required prior work has been completed and documented as quality records.
d. No item is released for further processing until the required inspections/tests and documentation (including quality records) are completed.
e. The responsible work performer or inspector shall document the work events, inspections, and tests completed, results, and any nonconformance in accordance with GPG 5330.3 and GPG 5340.2.
f. All nonconforming products are processed in accordance with GPG 5340.2.
g. For final release to the customer or launch site, the PDL verifies and documents, on the applicable WOA, the following:
   - Product has satisfactorily completed all planned activities
   - Nonconforming product has been dispositioned in accordance with GPG 5340.2
   - Documentation/quality records are complete, authorized, and available

4.11 Control of Inspection, Measuring, and Test Equipment (ISO 9001 Element 4.11)

GPG 8730.1 Calibration and Metrology

The GSFC has a support contractor that provides calibration and metrology services that meet the requirements of this GPG. The organization using the equipment in the processing of aerospace products is responsible to ensure that the equipment is made available to the contractor, as required, to meet these requirements.

The Product/Project Manager is responsible to ensure that his organization uses pre-established, documented procedures for the calibration, maintenance, storage, and use of Inspection, Measuring, and Test Equipment (IMTE). He/she ensures that users or Property Custodians:

a. Verify that the IMTE is appropriate for the measurements to be made (see GPG 8730.4).
b. Properly store and maintain IMTE.
c. Verify that IMTE is properly calibrated before use.
d. Ensure that IMTE is labeled regarding its calibration status. If unlabelled, notify the calibration and metrology lab per established procedures and get it labeled before use.
e. Develop and implement appropriate control procedures for IMTE whose calibration status may change during a period of use.
f. Respond to Calibration Due Notices in a timely manner.
g. Assess validity of work done with IMTE found to be out of calibration, and develop, document, and implement additional testing if required.
h. A product, which was inspected or tested by IMTE subsequently, found to be out of calibration shall be controlled as a nonconforming product in accordance with GPG 5340.2.
i. Ensure that only authorized personnel make adjustments to IMTE that may affect its calibration.
j. Ensure that newly purchashed IMTE is labeled and is calibrated (if required) before using.

4.12 Inspection and Test Status (ISO 9001 Element 4.12)

GPG 5330.3 Inspection and Test Status

The Product/Project Manager is responsible to ensure that:

a. Software meets inspection and test requirements of GPG 5330.3, or documents an alternate process per GPG 1410.1.
b. Processing of product is documented as follows:
   - Inspection and test status is documented and traceable by WOA.
   - Applicable WOA's, and other required associated information generated throughout the development of a product, shall remain with the product and be continuously traceable to the product's current configuration and location.
   - Applicable WOA's shall ensure that events, including in-process and final inspection and test, shall reflect the detailed design and design validation plans resulting from GPG 8700.2 and GPG 8700.3.
   - The PDL generates a WOA, after the initial Receiving Inspection WOA, prior to further product handling or processing.
   - The PDL generates all subsequent WOA's.
   - Receiving personnel shall complete a WOA upon receipt of product from a vendor. Note: see note under 4.10 above, GPG 4520.2, for clarification in the event product is received without a WOA.
   - Completion of planned events is annotated on applicable WOA's prior to proceeding with subsequent events.
   - The PDL maintains WOA's as quality records
   - A nonconforming product is documented on a Nonconformance Report, annotated on the WOA, and a copy attached to the WOA, in accordance with GPG 5340.2.
   - The product/project manager is responsible for a continual product test status related to conformance or nonconformance of the materials.

4.13 Control of Nonconforming Product (ISO 9001 Element 4.13)

GPG 5340.2 Control of Nonconforming Product

The Product/Project Manager is responsible to ensure applicable, documented procedures are in place to control nonconforming products as described below:

a. The project or product organization has Quality Planning documentation as required in GPG 8730.4 addressing:
   - Procedures for evaluation and disposition of nonconforming product.
   - Project MRB membership, including chairperson.
   - MRB operation.
   - Restrictions on who can document an NCR.
   - Responsibility for tagging and segregating nonconforming product.
   - Identification and operation of segregation areas(s)/facilities(s).
   - Project interface with the on-line Nonconformance Reports/Corrective Action (NCR/CA) database, including NCR disposition/corrective action roles and authorities and identification of nonconformance scenarios requiring customer approval.
b. Quality Planning documentation meets the requirements of GPG 5340.2. This shall include establishment of product/project procedures for nonconforming product evaluation and disposition.
c. Nonconforming product is tagged with a Nonconformance Tag (or equivalent) in accordance with GPG 5340.3, and physically segregated from conforming product.
d. Nonconformances are entered into the NCR/CA database, documented on applicable WOA's, and the NCR and WOA's cross-referenced to each other.
e. Product-oriented NCR's are dispositioned prior to processing that would make the nonconformance inaccessible without disassembly.
f. Nonconforming product disposition shall be one of the following:
   - Rework
   - Repair
   - Use-as-is
   - Reclassify
   - Return to vendor
   - Scrap
g. Requirements for customer notification are met.
h. All NCR's are properly closed and appropriate corrective action is taken.
i. All customer complaints are documented and entered into the NCR/CA database.
j. Corrective action is completed, documented, and verified effective by follow-up action in accordance with GPG 1710.1.

GPG 5340.3 Preparation and Handling of Alerts and Safe Alerts

As part of project management (GPG 8730.4), the Product/Project Manager plans an appropriate level of participation in the Alert process, considering:

a. Development and update of Parts Identification Lists (PIL's) in the Alert system
b. Technical support for preparing an Alert for disposition of nonconformances
c. Disposition of Safe Alerts
d. Other matches between the PIL's and the Alert database

The Systems Assurance Manager usually performs these functions. The Product or Project Manager is responsible for ensuring that the procedures are in place, individuals are designated to perform the necessary steps in the process, and the process is working as expected.

4.14 Corrective and Preventive Action (ISO 9001 Element 4.14)

GPG 1710.1 Corrective and Preventive Action

The Product/Project Manager must ensure that documented procedures are in place for dealing with identification, segregation, evaluation, and disposition of non-conformances as defined in GPG 5340.2. The Product/Project Manager is responsible to ensure that, when nonconformances have been identified, appropriate corrective and/or preventive action is taken as follows:

a. PDL or other appropriate designees determine and implement corrective action for nonconformances identified in the NCR/CA database in accordance with GPG 5340.2.
b. For NCR's documenting product nonconformances, corrective action shall be determined, documented, and approved in accordance with the organization or project's Quality Plan. Determination of corrective action shall include consideration of ALERT/SAFE ALERT requirements.
c. For NCR's generated as a result of an audit, corrective action shall be determined, documented, and approved in accordance with the project Quality Plan.
d. Verification of corrective and/or preventative action implementation and effectiveness shall be scheduled and approved as required in GPG 1710.1.
e. Support proper and timely follow-up to NCR's and MRB actions.
f. Verify that nonconformances traceable to suppliers are reported and corrected as appropriate.

The Product/Project Manager is required to take corrective and/or preventative actions based on unsatisfied customer requirements, in-service failures, audits of operations, management direction, and NCR's as described above. This action must look for the root cause of the problem and put corrective procedures and practices in place that will prevent future occurrences. The responsible organization should put controls in place to ensure that all corrective actions are carried out, that they are effective, and that the associated effort is commensurate with the potential risk to the customer.

4.15 Handling, Storage, Packaging, Preservation, and Delivery (ISO 9001 Element 4.15)

GPG 6400.1 Handling, Storage, Packaging, Marking, Preservation, and Transportation

The product/project manager shall:
a. Identify and document requirements for handling, storage, packaging, marking, preservation, and transportation of product, addressing:
   - Environmental Control
   - Special Storage
   - Packaging
   - Safety
b. Update the above requirements, as necessary, to address design changes, schedule changes, or other factors that affect handling, storage, packaging, marking, preservation, and transportation of product.
c. Coordinate these requirements with the Center Transportation Officer (CTO) or his/her designee.
d. Establish appropriate, documented processes and procedures for project storage areas.
e. Submit storage and transportation requirements to the CTO, sufficiently in advance to provide adequate planning and coordination.
f. Ensure that:
   - Product is monitored for condition and deterioration during storage and transportation.
   - Appropriate records (GPG 5330.3 and GPG 5340.2) are kept and maintained.
   - Product handlers are properly trained, qualified, and certified.
   - Product and material is handled and stored as required by the product/project manager and GPG 6400.1.
   - Handling devices are certified and maintained before use.

4.16 Control of Quality Records (ISO 9001 Element 4.16)

GPG 1440.7 Control of Quality Records

The Product/Project Manager ensures that organization-specific quality record controls are adequate and addressed in appropriate directorate-level procedures or WI. In the absence of such organization-specific requirements, the following shall apply:

a. When a quality record is identified in a QMS document, that document shall also identify the record custodian and the location(s) where the quality records are maintained. If a specific recording media or special environmental controls for record storage required, these shall also be identified.
b. Quality records shall be filed by a method that enhances accessibility and retrieval by the record user.
c. Records maintained on site shall be retrievable within 1 hour from the request.
d. Quality records shall be preserved, maintained, and disposed of in accordance with NPG 1441.1.

The above requirements place extremely stringent controls over quality records, unless directorate-level procedures are produced. If such procedures are produced, the requirements identified above do not apply, but the elements of these requirements must be addressed to ensure compliance with the requirements of Element 4.16 of ISO 9001, while at the same time providing adequate indexing, control, storage, and retrievability of these records. The directorate should also identify the types of documents that are to be designated as quality records.

Records, including WOA's or equivalents, demonstrate requirements and their satisfaction, and the effectiveness of operations through internal audits, corrective actions, senior management reviews, assessment of suppliers, calibration, training, customer contracts, design reviews, product nonconformances, inspection and testing, and product identification.

4.17 Internal Quality Audits (ISO 9001 Element 4.17)

GPG 9980.1 Internal Audit System

The Product/Project Manager is responsible to ensure that:
a. Personnel and documentation are available to support audit activities as necessary.
b. A schedule of corrective actions resulting from NCR's is established.
c. Corrective actions are completed and documented according to the schedule and to GPG 9980.1.
d. Follow-up audit activities verify and record the implementation and effectiveness of the corrective action taken.

4.18 Training (ISO 9001 Element 4.18)

GPG 3410.2 Employee Training and Qualification

The Product/Project Manager ensures that work is performed only by qualified personnel through:
a. Defining training and requirements for each position
b. Identifying knowledge, skills, and abilities required for specific tasks
c. Identifying special processes requiring qualification
d. Communicating applicable training requirements to Office of Human Resources (OHR)

The Product/Project Manager integrates these requirements to provide qualified personnel to perform the required tasks. The Product/Project Manager requires training and associated documentation for all personnel whose activities affect product quality. Personnel must be trained in the specific tasks assigned, qualified to perform these tasks, and supported with documentation and records of training and certifications. These records must be maintained as quality records.

4.19 Servicing (ISO 9001 Element 4.19)

Servicing is not within the scope of the GSFC Quality System, so this element is not applicable.

4.20 Statistical Techniques (ISO 9001 Element 4.20)

GPG 8070.2 Identification and Application of Statistical Techniques

The Product/Project Manager is responsible to ensure that:

a. The PDL's determines when statistical techniques may be used to verify product characteristics in lieu of 100 percent inspection or test.
b. The PDL's identifies product-unique process-control statistical techniques, when different from those determined by the process owners, and document/reference on WOA's.
c. Process Owners determine (and document in process control documents) statistical techniques to be applied to measurement and maintenance of process controls.
d. The PDL and Process Owner documents and maintains as quality records:
   - How the statistical techniques are applied
   - What outputs (quality records) are expected
   - How the outputs will be used to effect decisions on acceptability of processes and products
   - The appropriate inspection/test instructions