JPL's Approach for Helping Flight Project Managers Meet Today's Management Challenges

Charles J. Leising

Meeting the Project Manager Challenge
UM University College Conference Center
College Park, MD

March 30-31, 2004

Background and Environment

- Mid 90s
  - JPL faced decreasing NASA budgets, increasing cost pressures and competition
  - Explosion in number of small projects
  - Retirement of experienced personnel
- Adopted “soft projectization” and FBC
  - Project Mgrs empowered to pursue creative approaches for cutting costs
  - Threw out old tried and true procedures
- Mars failures
  - External review committees questioned “how we do business”
- Environment after the failures
  - Increased oversight
  - Continued pressure to reduce costs

Problem Statement

- How can we put rigor back into the process and still get more efficient as an institution?
- How can we help project managers succeed in this difficult environment?

Approach

- Standardize the “routine” processes
  - New Flight Project Practices and Design Principles
  - New “standard” JPL lifecycle, gate products and WBS
  - Better coordinated review process
  - New project management training classes
  - Group procedures
- Increase the institutional support:
  - New position of Associate Director
  - New Project Support Office
  - Better partnering between line and projects
  - Mission design tools, cost databases, planning templates, examples and “project support” websites
  - Burden funded support teams

Organization

Project Support Office

Project Planning Office

- Planning Support
- Costing Office
- Team Support
- Launch Support
- Proposal Center
- FHLP
- Training

Project Engineering Office

- Design Principles
- Flt. Proj. Practices
- Technical I/S
- Project Facilities

Control Systems Office

- Project Data Mgt System
- Config. Mgmt.

Institutional Guidelines

Design Principles:

- Covers mission,systems, hardware, software and operations
- Includes subsystem designs, margins, interface requirements, grounding, EMI and verification

Flight Project Practices:

- Top level implementation practices
- 23 management, 18 engineering and 8 mission assurance

Compliance:

- Compliance matrices document compliance
- Attached to Implementation Plan
- Deviations must be justified and approved

Design Principles

Mission Design	Flight System Design	Software	Managed Margins	Flight Sequence Design	Flight System V&V Design	Flight System Flight Ops Design

Flight System Design

General
Mechanical Configuration/Systems
Power/Pyrotechnics
Information System
Telecommunications System
Guidance, Navigation & Control
Propulsion System
System Thermal
System Fault Protection
System EMC/EMI
Flight Software System
Flight Hardware System

Managed Margins

<u>Project Programmatic Resource Margins</u>
•Budget Reserve
•Schedule Margin
<u>Mission Design Resource Margins</u>
•Propellant
<u>Flight System Development Resource Margins</u>
•General
•System Mass
•System Power
•System Energy
•Flight Software Margins
•Power/Pyro System Margins
•Telecom System Margins
•Flight Hardware Margins

Flight System V&V Design

<u>General</u>
•Min Op Times for Electronics
•Handling & Test Constraints
<u>Pre-delivery Verification</u>
•Subsystem and Assembly Level
•Early Interface Testing
•System Level
<u>System Assembly, Integration & Test</u>
•System Assembly
•System Integration
•System Functional Verification
•Flight Sequence Verification
<u>System Fault Protection Verification</u>
•System Stress Testing
•System Envir Verification
•Inter-system Verification
<u>Launch Operations</u>
•Pre-mate Verification
•Post-mate Verification

Flight Project Practices

Management Practices

Life Cycle
WBS and Planning
Science
Organization
NEPA & Launch Approval
Spares, Testbeds, and Models
Make-or-Buy Decisions
Scheduling, Cost Estimating, Etc
Information Mgt
Level 1 Descope Planning
Project Staffing & Destaffing
Priorities/Competing Char
Acquisition
Reporting
Reviews
Risk Management
Waivers
Crisis Response
Science Data Management
Ext Comm & Public Engagement
Lessons Learned
Margins & Margin Mgt
ITAR

Engineering Practices

Mission Design
Telecommunications Design
Mission Operations
S.E.
L/V and Launch Operations
Inheritance
Planetary Protection
Fault Tolerance/Redundancy
Flight H/W Logistics
Materials, Processes, and Contamination Control
S/W Devel
Protection and Security of Flt H/W
Design & Verification for Environmental Compatibility
System Level Functional V&V
C. M.
Orbital Debris
H/W Development
Mission Ops System Devel

Mission Assurance Practices

M.A. Mgmt
Reliability Engineering
Q. A.
S/W IV&V
Electronic Parts Reliability, Acquisition
Problem Reporting
Mission Operations Assurance
Systems Safety

JPL Project Lifecycle

NASA Phases		FORMULATION	APPROVAL	IMPLEMENTATION			
JPL Life Cycle Phases	**Pre-Phase A:** Advanced Studies	**Phase A:** Mission & Systems Definition	**Phase B:** Preliminary Design	**Phase C:** Design & Build		**Phase D:** ATLO	**Phase E:** Operations
Major JPL Reviews *(Review Cluster Includes a Director's GPMC)*	Concept Review [1] STEP 1 TMC [2,3]	Preliminary Mission & Systems Review PMSR [1,4] STEP 2 TMC [2] PMSR [2]	Project PDR	Project CDR	Assembly, Test & Launch Operation Readiness Review ARR	Operations & Mission Readiness Reviews ORR & MRR	Post Launch Assmnt Review PLAR Critical Events Readiness Review CERR [6]
Major NASA Enterprise Reviews	Concept/ Proposal Review	Initial Confirmation Review ICR	Confirmation Review CR			Mission Briefing	
Major Events	Down Select for STEP 1	Commitment, Select for STEP 2	Contract			Launch	

(1) Program driven projects
(2) AO driven projects
(3) Not a GPMC review
(4) A PMSR is equivalent to what Code S refers to as a combined Mission Definition Review and SRR
(5) For Earth Science Missions, a PDR may be combined with a Mission Design Review
(6) CERRs are established at the discretion of Program Offices

Gate Products

- Documented over 100 products required at each Gate in the LifeCycle
  - planning
  - costing
  - technical
- Maturity at each Gate
  - draft, preliminary or final
- Used by projects and upper management:
  - planning
  - costing
  - scheduling
  - assessment
- Invoked by Flight Project Practices

Examples of Gate Products

- Project plans
- Mission scenarios
- System requirements
- Cost estimates
- Flight designs
- Verification results
- Interface documentation
- Command dictionaries
- Flight rules
- Etc

Templates and Examples

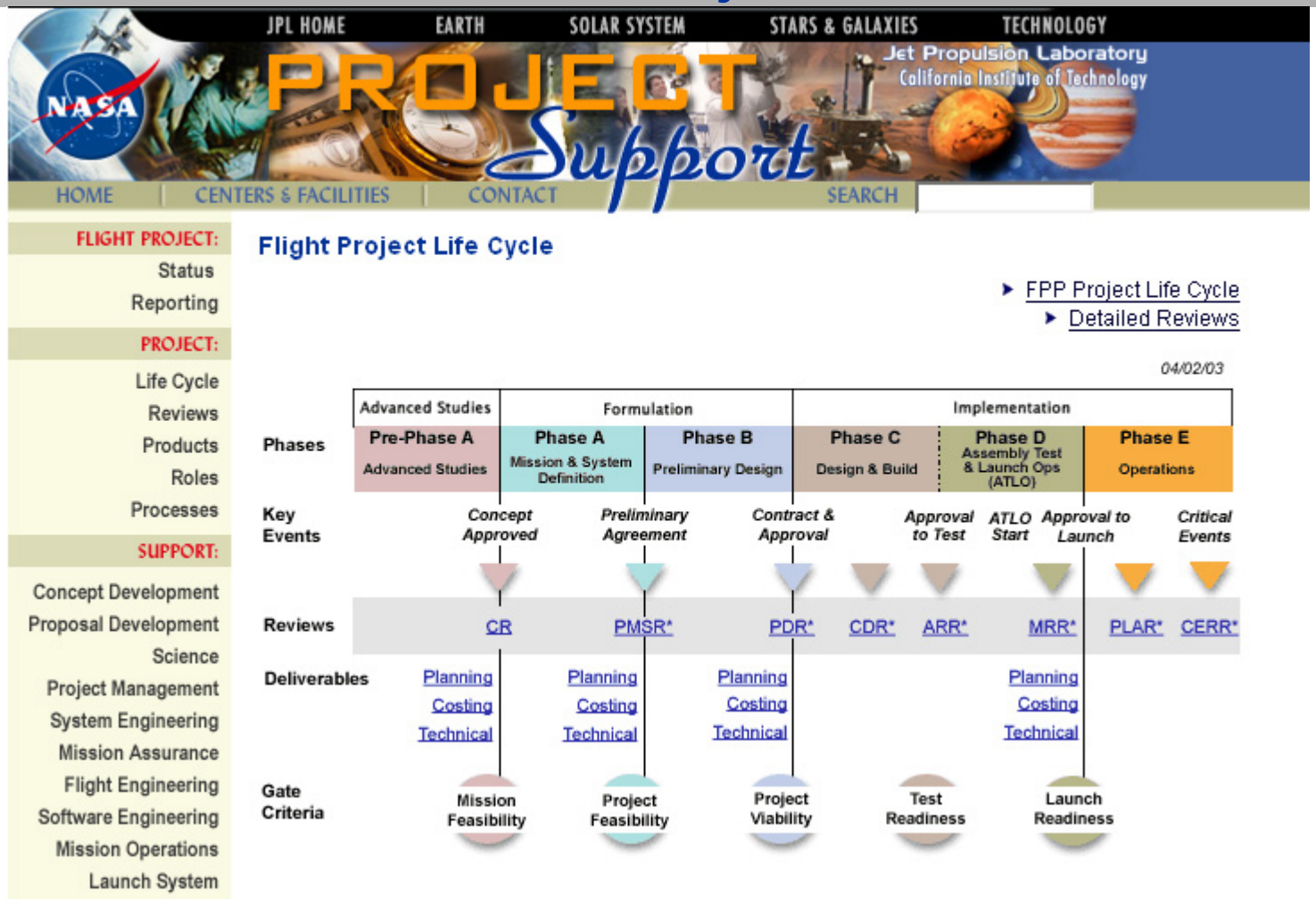
- Work breakdown structure and dictionary
- Plans
  - Task Plans (funding authority)
  - Project Plans responsive to FPP and NPG 7120.5
  - Detailed Project Implementation Plans, compliance matrices and work agreements
- Grass roots costing guidelines
- Documentation trees
- Requirements documentation
- Maintained in library accessible from website

Formulation Team

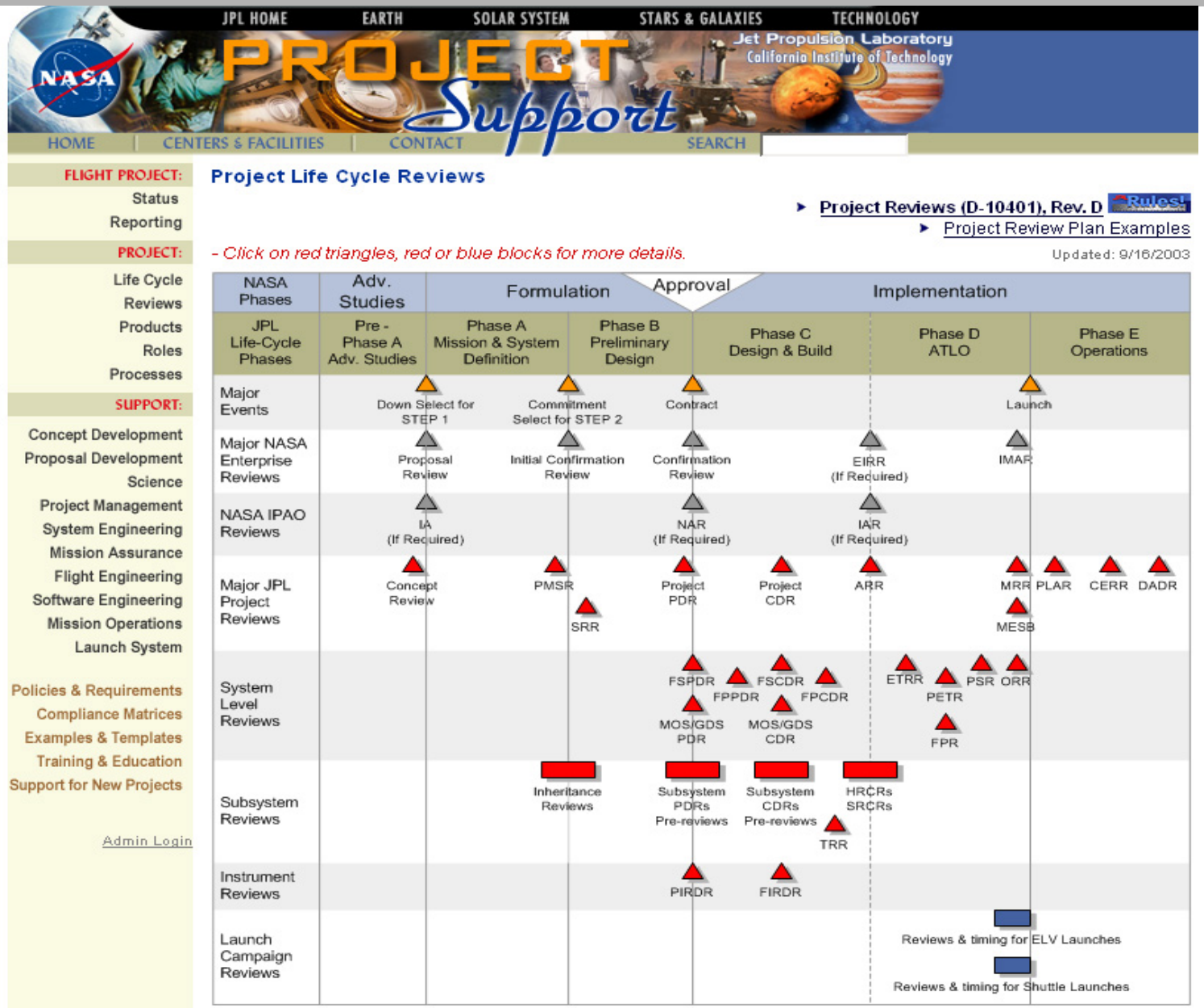
- Multi-disciplinary team
  - 7 burden- funded, full time equivalents
  - Planning, work breakdown structures, cost estimation, earned value support, requirements definition, information system, software, acquisition
- Support projects
  - Institutional requirements
  - Templates, examples and process support during Formulation Phase
  - Time-critical problems
- Assures that projects get started on right path for successful implementation

Project Support Website

Project Support Website - Life Cycle



Project Support Website - Reviews



Project Support Website - Review Descriptions

Preliminary Design Review- Project/Mission/Flight System

The PDR period is the time frame of transition, in the nomenclature of NASA 7120.5, from the Formulation process to the Implementation process. As such, it is a primary source of insight for assessment teams to allow the agency to confirm transition.) A hierarchy of PDRs is conducted, at the Project/ Mission, System and Subsystem level.

Note: *Typically, the Project and Flight System level reviews are combined, while the Mission operations System review is held sometime later, as its design lags the Flight system, and hence it matures later, to the PDR level.*

Objective:

The preliminary design review evaluates the project's readiness to proceed with implementation. This review evaluates the completeness and consistency of the planning, technical, and cost baselines--to the systems level, developed during formulation. It assesses the compliance of the design with applicable requirements.

Scope:

a. Project level 1 requirements and mission success criteria
b. Project description, plans and schedules, participants and roles and responsibilities
c. Science objectives and payload description
d. Project, mission, and science requirements completeness wrt mission objectives
e Requirements flow-down to level three (systems level), and draft flow-down to level four.
e. Mission, system and subsystem designs including key trade-offs
f. Technology developments
g. Verification and validation approach
h. Project risk management approach including the significant risks, mitigation options, and descopes
i. Project lifecycle cost estimate including costing methodology and validation, budget reserves, and cost risk
j. Open items and plans

Timing:

This review is held prior to the phase B-to-C/D transition, when the maturity of the planning, design, and costing allows the project to give credible presentations on the PDR topics

Success Criteria:

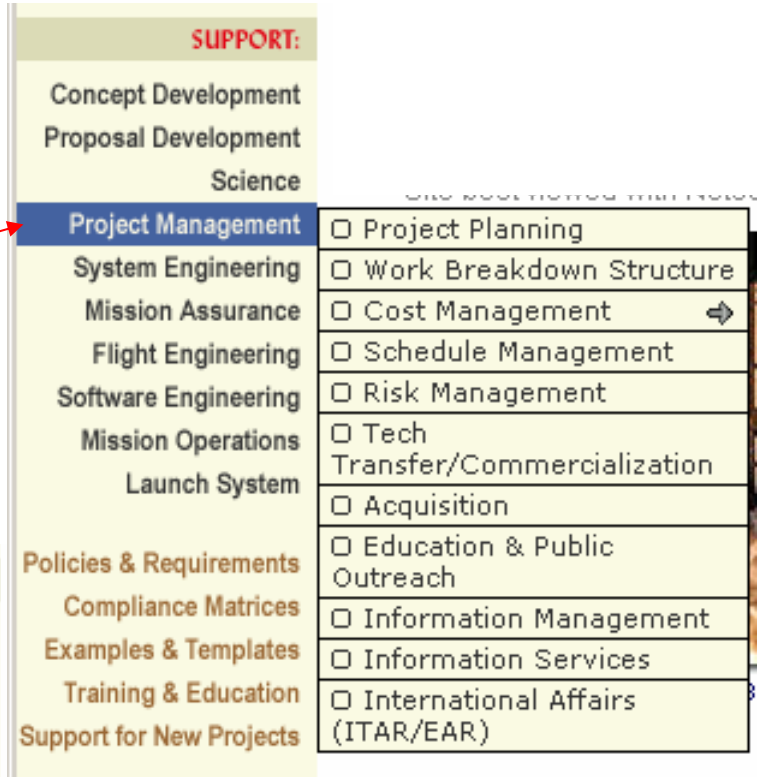
The review board is able to conclude that:

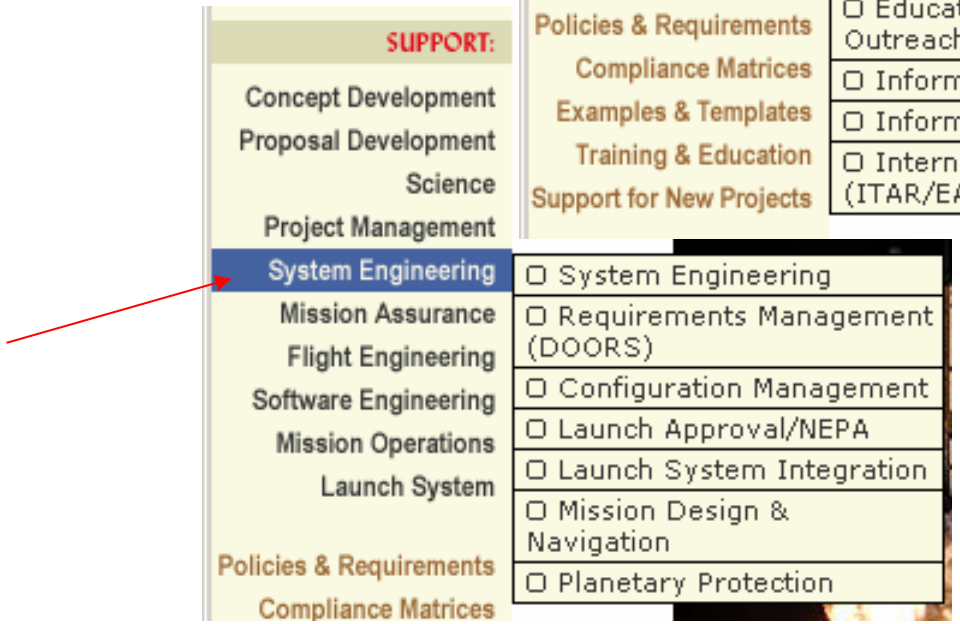
a. The level 1 requirements and mission success criteria are reasonable, finalized, and stated clearly.
b. The requirements flowdown is complete, and adequate understanding exists for the mission and system requirements.
c. The mission and system designs comply with the requirements, contain adequate margins, and represent acceptable mission risk.
d. The proposed management approach, including the plans and schedules, is sufficiently well defined
e. The technical and programmatic resources, including the staffing plan, schedule margin, and budget reserve, are adequate to complete the development with acceptable risk.
f. The Project risks are understood, and adequate plans and a process exists for managing these risks.
g. The Project state of readiness of the technical baseline and implementation approach is sufficiently mature, and adequate plans exist for the handling of the open items, such that a formal commitment can be made to the sponsor, and the Project proceed with the implementation.

Agenda Topics:

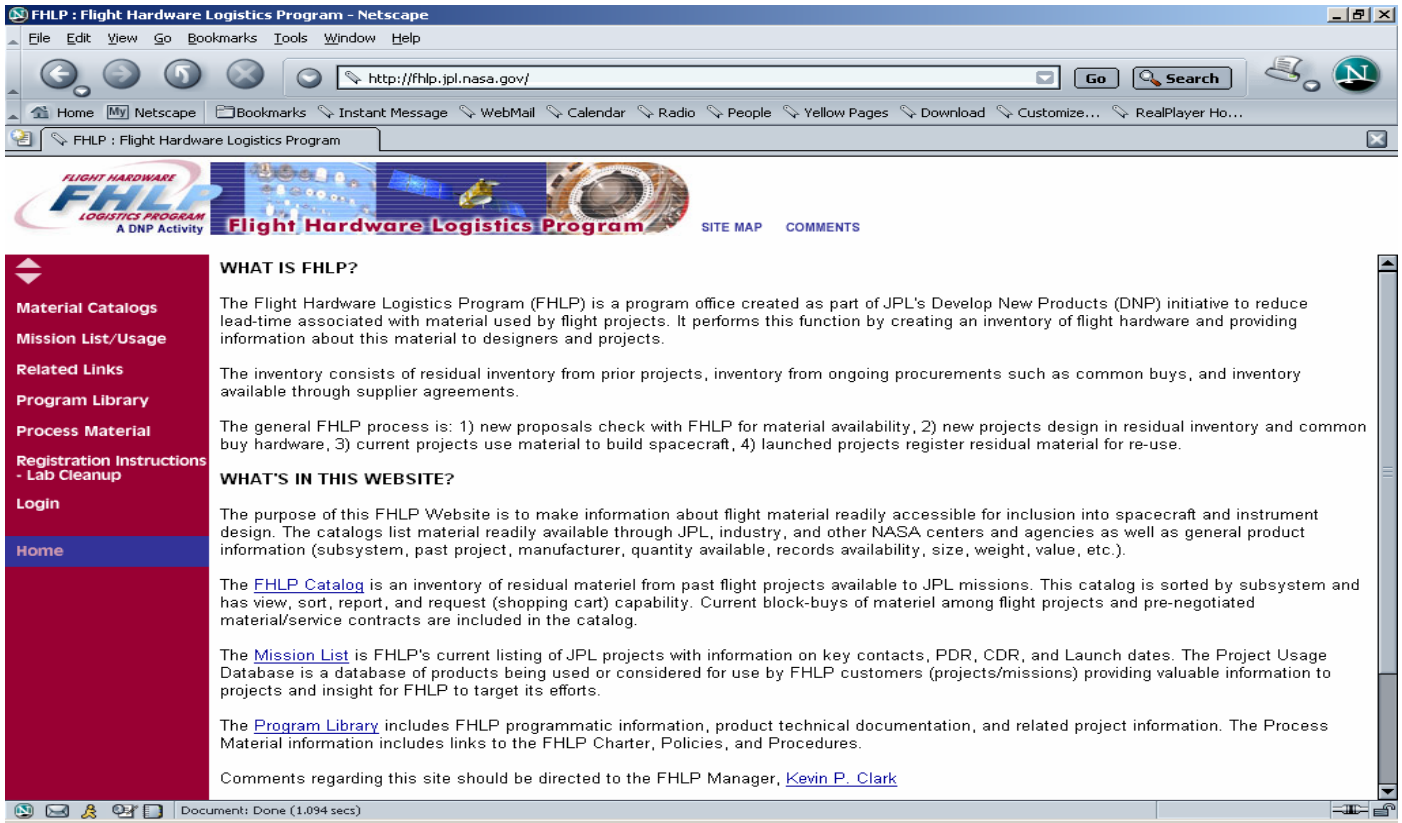
a. Project
   1. Project description
   2. Level 1 requirements and assessment
   3. Key challenges and Project constraints
   4. Key Project policies (including single point failure policy)
   5. Mission success criteria
   6. Project organization chart and key staff status
   7. Project implementation mode
   8. Project schedule (including critical path) and margin
   9. Project deliverables and spares philosophy
   10. Significant changes/accomplishments since PMSR
   11. Status of PMSR action items
   12. Open issues/items and resolution plans and assessment
   13. Project summary status
   14. Program interfaces

Project Support Website - Project Management and System Engineering





Project Support Website - Flight Hardware Logistics Program



On-Line Configuration Mgt Plan

JPL - Configuration Management Plan Generator

The CM Generator will generate a draft CM plan (CM Plan definition) in Word 97 within your browser. You can then save the draft to your machine and use it to complete a CM Plan for your project.

Follow these steps to generate your draft:

1. Enter the appropriate information in the form on this page. A draft outline will be generated.
2. Enter the appropriate information in the draft outline form. A draft Word file will be generated.
3. Save the Word file to your local disk; change the name of the file extension from *.exe to *.doc.

Enter the *Project Name* as you would like it to appear in the document:

Project1

(1) What type of project is it?
(please check all that apply)

- ☐ Spacecraft
- ☐ Instrument
- ☐ Ground System
- ☐ Software Development
- ☐ Prototype
- ☐ Science
- ☐ Technology Demonstration

(2) What is the nature of the project?
(please check all that apply)

- ☐ In-house development
- ☐ Commercial Team Partners
- ☐ Government Team Partners
- ☐ Subcontractors
- ☐ Universities

(3) What is the nature of development?
(please check all that apply)

	Software			Hardware		
	Flight	Test	Ground Support	Flight	Test	Ground Support
New	☐	☐	☐	☐	☐	☐
Heritage	☐	☐	☐	☐	☐	☐
Commercial off the shelf (COTS)	☐	☐	☐	☐	☐	☐
Modified off the shelf (MOTS)	☐	☐	☐	☐	☐	☐
Government Furnished Equipment / Software (GFE/GFS)	☐	☐	☐	☐	☐	☐
Integration with externally developed / provided system elements	☐	☐	☐	☐	☐	☐

Configuration Mgt Plan Example

New Project
Configuration Management Plan

PD xxxx-xx

Prepared By:

_____ _____
Name Date
Configuration Management Engineer

Concurrence By:

_____ _____
Name Date
TBD Project Manager

_____ _____
Name Date
TBD Flight System Manager

_____ _____
Name Date
TBD Mission System Manager

_____ _____
Henry F. Tauchen Date
JPL DNP Configuration Management Process Owner

NATIONAL AERONAUTICS and
SPACE ADMINISTRATION

JET PROPULSION LABORATORY
California Institute of Technology
Pasadena, California

JPL D-yyyyyy

Table of Contents

1.0 Introduction
1.1 Purpose and Scope
1.2 Configuration Management Process
1.3 References and Applicable Documents
2.0 Configuration Management Organization- Roles and Responsibilities
2.1 Project Manager (PM)
2.2 Project System Engineer (PSE)
2.3 Configuration Management Engineer
2.4 Product Data Management System (PDMS)
2.5 Other Project Personnel
3.0 Configuration Identification
3.1 Equipment List (Configuration Items) Selection
3.2 Product Structure
3.3 Identification Practices
3.3.1 Project Specification Identification
3.3.2 Project Drawing/Model Identification
3.3.3 Reference Designations
3.3.4 Software Identification/Version
3.3.5 Interface Identification
3.3.5.1 Interface Control Documents
3.3.5.2 Interface Control Working Group (ICWG)
3.4 Serialization and Traceability Identification
3.4.1 Hardware Product Serialization
3.4.2 Hardware Product Lot/Date Coding
3.5 Document Identification
3.6 Baseline Identification
3.6.1 Requirements Baseline
3.6.2 Design Baseline
3.6.3 Product Baseline
3.6.4 Operational Baseline
3.7 Release Procedures
4.0 Configuration Control
4.1 Configuration Control Process
4.1.1 Pre-Release Change Control
4.1.2 Baseline Change Control
4.2 Configuration Control Boards
4.2.1 Level 1 CCB
4.2.2 Level 2 CCB
4.2.3 Level 3 CCB
4.3 Change Classifications
4.3.1 Class 1 Changes
4.3.2 Class 2 Changes
4.4 Change Processing
4.4.1 Engineering Change Request Process
4.4.2 Engineering Change Instruction Process
4.4.3 Use of Redlined Drawings and/or Procedures
4.4.4 Use of Unreleased Drawings for Fabrication
4.5 Waivers
5.0 Configuration Status Accounting
5.1 Status Accounting Tools
5.2 Status Lists
5.3 Unified Problem Reporting System (UPRS)

Cost Risk Factors

- Mission Complexity
- Significant Technical Development
- New or Unvalidated Software Inheritance
- Technical Margins
- System Architecture
- Contractor Capabilities Match
- Programmatic/ Cost and Schedule Margin
- Management and Organization

Application of Risk Factors

- Subfactors identified to explain and quantify each factor
- Factors and subfactors identified as:
  - Primary
  - Secondary
- Allocation added for unknown- unknowns
- Correlation based on 13 most recent projects
- Validated through review and application to other projects
- Used as a tool for evaluating reserve posture on new proposals and projects

Project Manager Course

- Week-long offsite offered twice a year
- End-to-end overview of JPL Project Life Cycle
- Rules, lessons learned, where to get help
- Presentations, panel sessions, top management, NASA and contractor involvement
- Planning, costing, project control, system engineering, design, development, test and operations
- Assumes management skills and focuses on how to manage a project at JPL
- Required for all candidate project managers
- Highly rated and much in demand

Other Possible Applications

- NASA HQ
- NASA Centers
- Other FFRDCs
- Industry??

Summary

- Reliability and efficiency have been increased
- Changes in culture have taken 3 years
  - Everyone now knows what is expected
  - Couldn't have happened without active top management support
- Definition of rules in combination with more institutional help to project personnel has proven to be an excellent model
- Could be applied to HQ, other Centers and FFRDCs