Effective Space Project Management

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Introduction

The application of project management concepts and techniques in space-related projects involves the basic requirements and overall principles of project management from mission objectives definition to final disposal. It requires the project manager of space projects to address a variety of issues that are quite unique from those faced on other types of projects. These issues normally fall into two basic categories: a high degree of uncertainty regarding the scope of the overall project during the proposed system and payload development strategy stage supporting project's mission requirements as well as a lack of previous experience in implementing a disciplined, standardized project management approach for these types of projects.

Project management of the development and execution of space projects involves the integrated approach to product definition, development, production, verification, operation, and disposal in response to client's project objectives through various phases of the space project life cycle such as Mission Requirement and Conceptual Studies, Concept Definition and Preliminary Design, Detailed Design/Functional Testing, Production/Manufacturing and Operations. This approach consists of three interrelated processes, Engineering, Production and Operations, each of which influences, and is influenced by the other two. The objective of space project management is, first to devise and define, and then to implement a plan in which the relationship between these three processes is optimized; that is, the desired mission requirement is attained at the lowest practicable cost and in the shortest practicable time, with the required quality for space operations and within accepted risk boundaries.

Implementing an effective space project management approach will provide project managers in the space industry with a needed management technique that will increase the probability of success for their projects by addressing the above-mentioned issues, optimizing the required processes, resulting in clear benefit to them, their project team and the customers.

The purpose of this paper is to present an effective project management approach used in the planning, monitoring, and controlling of space-related projects. It describes the various roles, responsibilities, practices and procedures applicable in managing space technology development projects to ensure the efficient transition of new technologies into space systems for planned missions. It is to examine and discuss the following key areas of effective space project management:

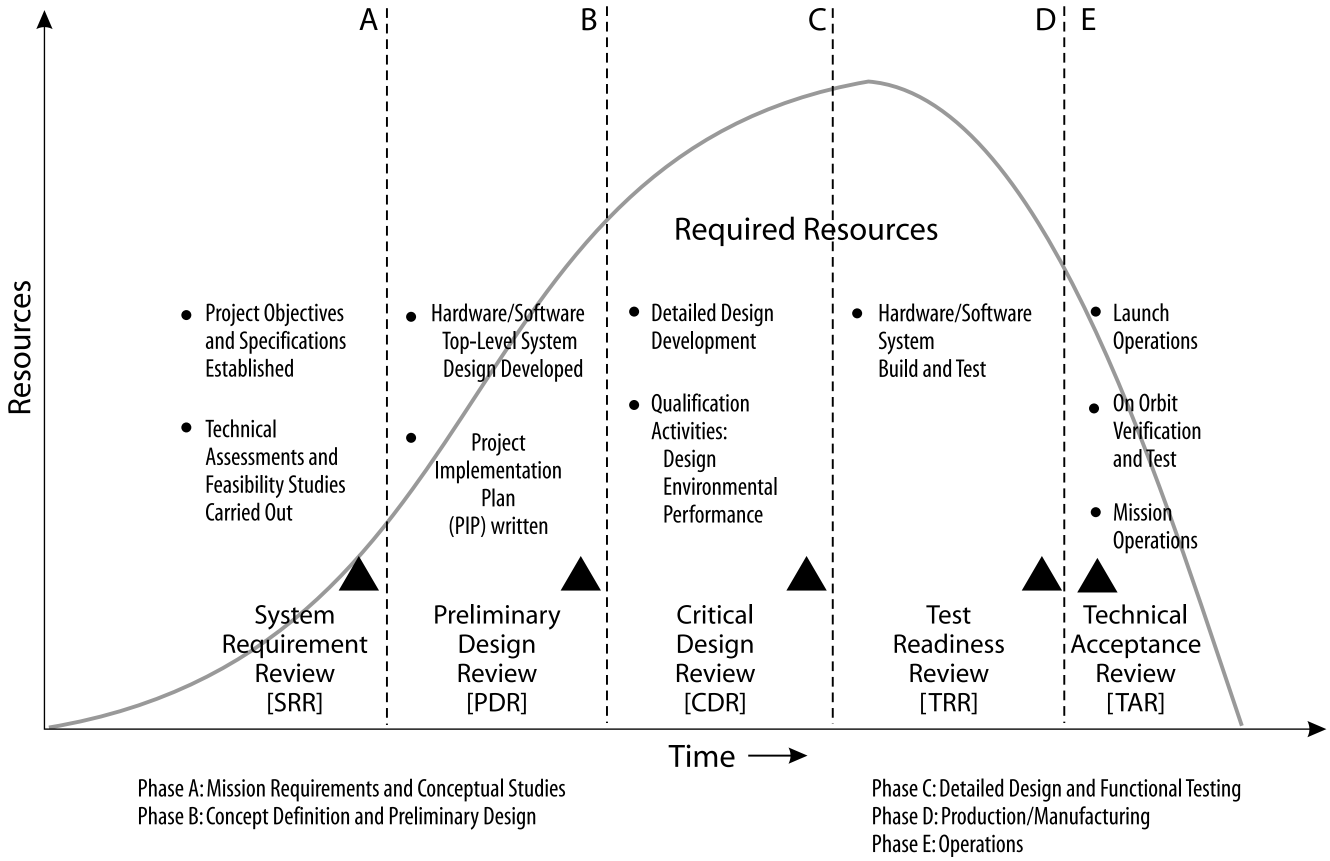
- The project manager in space-related projects
- Space project life cycle
- The Project Implementation Plan (PIP)
- Implementation management of space technology development project
- Application and acceptance of standard space project management approach for the 21st century.

The Project Manager in Space-Related Projects

As in other project environments, the space project manager is a generalist, a team builder and a leader, a decision-maker with the role to plan and control the interface between various management functional activities. She must be responsible to effectively manage the project's system of flow of work items through its life cycle from one functional activity to the next by implementing an integrated space approach to the specific requirements of each project to meet or exceed customer expectations. This includes, first and foremost, understanding the customer needs and expectations in terms of the specific space environment and the related conditions in which the end space product will be utilized by the end users, and to which it shall be designed to accommodate. Second, defining the end product's functional and performance requirements, productivity, reliability, availability, maintainability, safety, quality assurance, and environmental aspects as well as the life cycle process for manufacturing, testing, delivery, support, training, and disposal of the end product (system).

Project managers of space-related projects can effectively accomplish their project's objectives by implementing a systematic planning and control cycle of the traditional Quality/Scope, Cost, and Time parameters to optimize the Engineering, Production, and Operation processes and having the functional specialists committed to the planned actions that the project manager will control as well as coordinating the interface between the functional activities. The optimization of the above product-oriented processes will result in the desired space end products attained to satisfy the customers' needs within the cost and schedule constraints, with the required quality for space operations and within accepted risk boundaries for the customers.

Exhibit 1. Typical Space Project Phases and Its Life Cycle



The Space Project Life Cycle

Space system development project, with its inherent high costs and risks due to space environment operations, involves the execution of system-oriented production. Focussing on system engineering practices and integration of space-related engineering specialties, it describes the process for translating mission requirements into engineering functional requirements to be allocated to individual subsystems components, evaluating alternative design solutions, selecting design solutions to be implemented into subsystems, and verifying system performance. Consequently, a space project composes integrated time-phase tasks required to accomplish a particular system serving a specific purpose. The system, in its complete production form, must include related facilities, equipment, materials, and services required for its operations to be considered as a self-sufficient unit in its intended operational or support environment. It typically consists of five phases:

Phase A: Mission Requirements and Conceptual Studies

Identify needs, establish feasibility; that is, Go or "No-Go" decision is made concerning whether the mission is technically and economically feasible. This phase ends with the System Requirements Review (SRR). The objectives of the SRR are to ensure that system requirements are completely and properly identified, mutual understanding of all project stakeholders of the system requirements as well as consideration of software, operations, integration, testing/manufacturing constraints and logistics support. The top-level system and individual system components requirements will be developed and validated for completeness and consistency for review and approval at the SRR.

Phase B: Concept Definition and Preliminary Design

Refinement of concept, confirmation of product requirements. This phase ends with the Preliminary Design Review (PDR), whose objectives are to evaluate top-level design before proceeding to the detailed design, evaluate the development specifications and technical risks for the top level design.

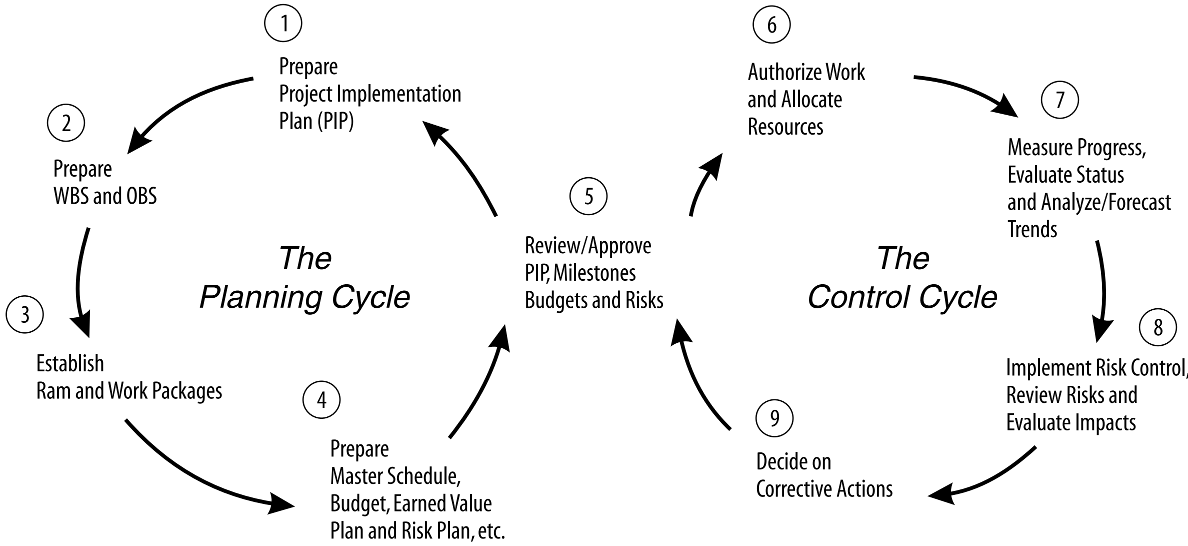
Phase C: Detailed Design and Functional Testing

Design and development of system, subsystems, and associated testing. This phase ends with the Critical Design Review (CDR), whose objectives are to determine design adequacy as well as ensure interface definition adequacy before approval for proceeding to production/manufacture of flight hardware.

Phase D: Production/Manufacturing

The functional designs are turned into actual space-related hardware and software to form system elements to be qualified for flight. This phase ends with the Test Readiness Review (TRR)

Exhibit 2. Planning/Control Cycle in Space Project Management



marking the system's readiness for operation in the specified space environment.

Phase E: Operations

Transfer of operating responsibility from the implementing authority. This phase accommodates launch operations, on-orbit verification and test, and system/payload operations.

Exhibit 1 illustrates different phases of a space-related project and its life cycle.

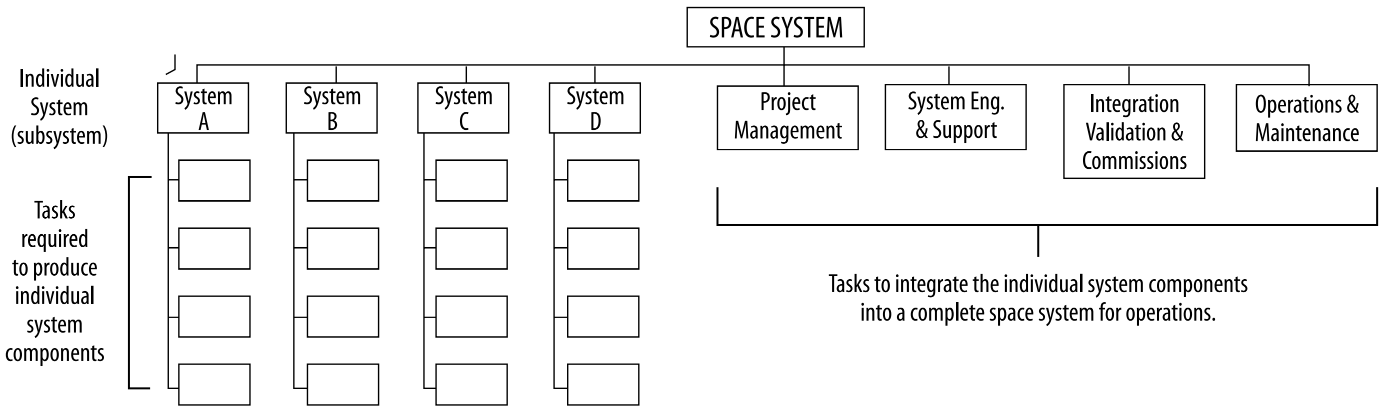
The Project Implementation Plan (PIP)

Implementation of space project management involves the planning, controlling, and reporting of the project's milestones' activities. It monitors, tracks progress, and flags items that could potentially impact milestones achievement. Exhibit 2 illustrates the basic planning and control concept in space project management. The project's planning cycle starts with the development of the PIP, which describes the company's approach, processes, organizations, and controls utilized to ensure successful execution of the project activities. A specific PIP content is dependent on the project size, its complexity, and contract requirements. It should outline a summary of the project's background, the various components of the project, the integrated approach, and methodology aiming at meeting the overall objectives of the project, project team members' responsibility, authority, and accountability. Thus, the PIP defines the project's overall scopes and objectives and provides the basic plan to achieve these objectives within the project's constraints. A basic PIP should include, at a minimum, the project's scope, its objectives, the system description and its operations concept, the project management approach, the development/production/acquisition strategy, prototype test and evaluation, maintenance and support plan, safety and product assurance, operational training, configuration and data management, risk management, and administrative procedures. The PIP will be the basis against which the project's progress will be measured and potential problem areas detected and assessed so that timely corrective actions can be taken if necessary. It will be a living document, updated periodically to reflect significant changes to one or more elements of the project. The project manager in conjunction with configuration management will be responsible for the upkeep and maintenance of this document as this reflects his philosophy and direction relating to the management of his space project.

Implementation Management of Space Technology Development Project

The planning cycle starts with a meeting with the customer to thoroughly understand her requirements so as to plan project activities reflecting customer-dedicated operations; that is, working in close partnership with the customer, targeting all project efforts on understanding, and anticipating customer's operations needs so as to develop fast, cost effective, value-added solutions to these needs. A clear understanding of the project requirements and a well-defined scope are the essential elements in developing subsequent detailed and effective programmatic objectives taking into account cost, schedule, and quality constraints. The objectives should provide an explanation of why the project was undertaken, thereby providing a basis for future tradeoff analyses. The development of the project Work Breakdown Structure (WBS) is followed with the identification of manageable elements of work to be done in the project. The WBS identifies the hardware, software, facilities, deliverable items, and associated services as well as other elements which constitute all the work

Exhibit 3. Typical Space Work Breakdown Structure (WBS)



to be performed during the development and manufacturing of a space product to attain the product objectives. The WBS should be product-based, with the top level as the specified product and the subsystems at successive lower levels. The major objectives of the WBS are to ensure project coherence in terms of technical, administrative, financial, and documentary activities of the whole project and to provide a framework for planning, organizing, scheduling, costing, and their respective control means. A well-developed WBS is used immediately for estimating required resources and scheduling the work during the planning phase. Exhibit 3 shows a typical space project WBS. The project Organization Breakdown Structure (OBS) is then established drawing resources from the company organization's functional structures. In order to meet the project objectives, it must cover all the roles and responsibilities of each project team member and his or her interaction in terms of authority and related reporting. The OBS must address the requirement to review the existing structure at defined intervals to ensure its continuing stability and effectiveness, which could impact quality requirements of the project. The OBS, thus, identifies the functional groups of the project team and provide the organizational framework for planning, performance, controlling and reporting. In addition, identification of project resources impacted provisions such as project facilities, information technology (hardware and software), information systems, and project documentation must be done as these may impact the project performance. Immediately after the development of the WBS and the OBS, the Responsibility Assignment Matrix (RAM) is produced by creating a matrix with the WBS on one axis and the OBS on the another. The RAM is updated and maintained throughout the project implementation effort to incorporate any changes in the WBS and its associated responsibility assignment. As the WBS is a logical representation of all the work required on the project, the RAM shows all the work packages (WP) necessary for the completion of the project and their associated performing organizations. Each WP should focus on specific activities of the WBS, will serve as management controlled point where all aspects of technical, cost, schedule and performance measurement are operationally integrated. WPs are key points for the day-to-day management of project activities relating to the planning, analysis, and control of the project work. As a result, the definition of the project's major WPs, which will be included in the PIP, is pivotal to the success of the project execution and should include a description of the planned works, schedules, and associated budgets as well as the responsible performing organizations.

The planning continues with the definition and identification of the project phases highlighting the successive stages through which the space system (or product) evolve. The planning of the project scope/quality, cost/schedule, and risk parameters will be based on the key project milestones resulting from these identified phases; that is, the start of a phase is generally subject to the completion of an important milestone, normally occurring after a specific review.

Consequently, the planning for and conduct of technical exchange meetings and design reviews forms an integral and essential part of the space project management process. Agenda approval and completion criteria agreement for each review must be determined with the customer. Reviews (SRR, PDR, CDR, TRR) are organized to allow critical and independent assessment of potential problems and proposed solutions.

A Master Schedule (MS) showing the work to be performed at the highest level of the project must be subsequently developed based on the WBS. It shall be prepared by the Project Management Office (PMO), an organization created for the purpose of running the day-to-day operations of the project and responsible for the successful delivery of the space system on schedule, within budget, and with customer's satisfaction, in consultation with the key project team members. The PMO normally consists of the project manager, the technical director, the project administrator whose roles, responsibilities, and accountabilities are well described and defined in the PIP, and depending on the size and complexity of the project's workscope, it could include the risk manager and the Quality Assurance manager. The activities at the individual system components level of the WBS are identified. The MS establishes the fundamental logic of carrying out the project work and the major interdependencies of the activities of one system with another. The milestones (key dates) which are normally identified on the MS shall include the project start date, major contract awards, key dates for start and completion of system technical reviews, procurement of major equipment (ordering/delivery dates), dates of individual system trial operation, project space system tests and start-up dates, project in-service (end-to-end) dates, etc. The MS shall be formally reviewed and presented to the customer for approval. Once approved, it remains as the graphical presentation of the overall strategy for the execution of the project. The MS must be baselined and shall be used as the comparative baseline for the monthly status report as schedule management reflects a project control milestone approach that maintains the schedule details at the logic network level but identifies a clear set of critical milestones against which commitments are made and performance measured.

The establishment of the project budget will be done by estimating specific planned costs associated with each work package. The costs shall be broken down into labor, materials, subcontract work, and others based on the WBS. Cost estimating of space project is one of the most important project management tools used to assist in planning and achieving the optimum balance between Engineering, Production, and Operations processes. It may be defined using different methodologies associated with the maturity level of the design and similarity to other space projects. Space estimating methodology should normally be a proven method prior to being used on the project. Parametric estimates are recommended to be used for the development of the cost parameters, which will be presented for feedback and approval at each major project review. The estimate shall be based on dedicated methodologies for hardware and software, the basis of cost databanks for work packages of past space projects taking into consideration key factors such as engineering, development, and production status. The accuracy range of the types of cost estimates is expected to be more accurate as the details of the design and development activities progress, parametric estimating will then be refined and substituted by detailed cost estimates for all work packages. Lessons learned from other space projects shall constantly be considered.

In space project environment, Earned Value (performance measurement) technique is used to provide the measurement and analysis of the cost, schedule, and technical progress data of the project. It clearly and objectively indicates the amount of physical progress of the work and properly relates cost, schedule, and technical achievement to that work; that is, Earned Value compares actual accomplishment of scheduled work and associated cost against an integrated schedule and budget plan. It is a project control technique that provides a quantitative measurement of work performed as well as evaluates work progress in order to identify potential schedule slippage and areas of budget overruns. Value earned for a given task is computed as a function of time, work completed and the budget; i.e., the measurement of the budgeted value of the work actually carried out, and its comparison with the budgeted value of the work that should have been carried out and what it actually costs. The WBS, detailed schedules, and WP budgets form the foundation for earned value assessment. As a result, five important basic data elements must be determined and planned for objectives evaluation of project's progress and performance

- Budgeted Cost for Work Schedule (BCWS): The time-phase budget plan, applicable to the work scheduled to be accomplished within a given time frame, against which performance is measured. It is time phased by the assignment of budgets to scheduled increments of work. Time-phasing budgets must be directly related to scheduled activities milestones so that expenditure trending profiles can be developed for cost management purposes.
- Budgeted Cost for Work Performed (BCWP): The budgeted cost for all work actually accomplished during a given time period (Earned Value). The determination of BCWP will indicate effective evidence of deviations from the planned baselines in terms of cost/schedule variations and cost/schedule performance indexes.
- Actual Cost for Work Performed (ACWP): The costs actually incurred and recorded in accomplishing the work performed within a particular time period.
- Budget at Completion (BAC): The sum of all budgets allocated to all contract's authorized WBS elements.
- Estimate at Completion (EAC): The cost allocated to the work to date plus the estimated cost for authorized work remaining.

Included, as part of the planning process, is the project's Configuration Management (CM) as being the technical and management process that defines formal hardware and software baselines, controls successive evolutions/changes to the baselines. A configuration baseline is represented by a set of documents describing the characteristics of a product and, is formally designated as the reference of the product characteristics whose changes, if any, must be subject to a formal change procedures through a Configuration Control Board (CCB) involving all disciplines concerned before these changes can be taken into account. During the space product life cycle, configuration baselines are generally defined and classified into three types:

- Functional Configuration Baseline: The functional status described in the Functional Specification at the system level. This document specifies the system's characteristics in terms of its mission capabilities as well as the criteria and corresponding levels of acceptance.
- Development Configuration Baseline: The status specified in the Technical Specifications. This document specifies the product's characteristics in terms of technical requirements and constraints as well as their verification conditions.
- Production Configuration Baseline: The status initially described in the Production Master File. This document contains all the detailed characteristics necessary for its production, acceptance, operation, and support. This baseline contains the

final versions of the Interfaces Control Documents (ICD), which specify and control the system's technical interface requirements.

Comparable configuration baselines for software life cycle must also be defined. The space system comprises identifiable entities whose configurations are separately controlled through Configuration Items (CI). Hardware CIs and computer software CIs (CSCIs) are selected and specifications, drawings, version descriptions, and so forth, are prepared so that each identifiable entity is clearly shown and specified resulting in the overall configurations of the system and subsystems are clearly and unequivocally defined. These CIs shall ensure that from the bottom up, the complete space system is controlled; for example, prior to conducting the TRR, a Physical Configuration Audit (PCA) shall be conducted to compare the As-Built configuration to the As-Designed configuration. Interface control and management plans must also be developed to define, document and maintain functional and physical interfaces between connecting equipment (e.g., on-Orbit and Support Segment). These plans shall ensure that interfacing configuration items are physically and functionally compatible. The interfaces will be maintained through the use of Interface Control Documents (ICDs). Each ICD will consist of the definition of the system/segment interface requirements to the interface as well as document the agreed upon design implementation of the interface. ICDs will be developed at different levels of review and final ICDs should be submitted for approval at the CDR. Maintenance of the approved ICDs to project completion will be provided by configuration management change control process.

The projected schedule and cost estimate will help to identify potential risks associated with the defined work scope in terms of technical performances of the project's system components, development and commercial risks. A proactive risk management approach, then, should be established and implemented to evaluate potential, manageable project risks (technical, schedule, cost) during the project's life cycle, isolate the critical ones and formulate cost effective methods for minimizing the impacts of these risks on the project, and, therefore, increase the probability of the project's success. The project's risk management approach composes of the planning and control processes. The former includes activities expected to be completed during the planning stage whereas the latter includes activities existing throughout the contract performance period. Risk planning should consist of risks identification, assessment, selection, avoidance approach, contingency plan, tracking and reporting approach, organization and responsibility, and database preparation. Risk planning is to be followed by risk control, which will be implemented during the project execution.

In addition to the above-mentioned, key plans for space projects, the followings should also be part of the planning process for an effective space project management operations:

- Integrated Logistics Support (ILS) plan: Deployment of material resources and services, in time and in proper quantity, to support the system's operation and maintenance and control of associated risks that meets availability requirements with minimum resources supportability and training programs such that the customer can operate and maintain a system in its operational conditions, for the expected lifetime.
- Safety and Product Assurance (S&PA) plan: Processes to ensure project activities are well performed in terms of Safety, Quality, Reliability/Availability/Maintainability (RAM), and Software Quality Assurance (SQA). The interface between CM and S&PA is provided through participation on the CCB (Configuration Control Board) activities. Change review is also performed by S&PA organization for assessing the impact of proposed changes on all elements of quality, including test requirements and procedures, manufacturing processes, etc.
- Subcontractor Management plan: An effective approach used in the planning, monitoring, and controlling of the subcontractor's contract performance. The plan must address subcontractors' milestones completion during the design, procurement, assembly, integration, testing, and associated production of operational and simulation software of subsystems and ensure that subcontracts efforts are adequately identified and performances accurately measured and reported on a regular basis for quick integration into the prime space contract.

The control cycle starts with a clear understanding of the Scope of Work (SOW) as defined and reflected by all WPs written and included in the PIP. This SOW forms the basis of understanding between the project team and the project customer by defining the project deliverables, and formally documenting the space project objectives, ensuring and culminating in authorization to start the project activities and the allocation of resources to accomplish the project WBS tasks. Weekly project team meetings are held to discuss the previous week' activities progress status, current and potential issues with plans or actions for resolutions, planned activities for the week, and any recommendation for actions by PMO members. A weekly meeting minutes report is issued and distributed by PMO through e-mails to all team members so that they can follow up on what had been discussed and agreed-upon actions items. An action items list is set up to trace progress on the resolution of these action items. During the life cycle of the project and depending on the maturity of the system design, major technical interchange meetings and design reviews (e.g., PDR). CDRs were held with the customer for the purpose of assessing the technical progress of the project and the readiness to proceed with the next step in the development process. The completion criteria applied for each of these review must be concurred by the customer and applied against each subsystem during its development to ensure potential rework/review is minimal. RIDs (Review Item Discrepancy/Dispositions) are raised by participants of the design review against problems in the review technical data packages. RIDs are classified based on the degree of severity whether from simple editorial problems to critical design flaws. The number of RIDs and their severity will be considered as indicator of the project's technical performance. Inability to close a RID's issue for extended periods reflects contractor technical management problems. A design review is normally considered

Exhibit 4. Risk Tracking Status

RISK TITLE:			RISK #
Project:	**Risk Item Mgr:**	**Last Updated**	**Rev.**

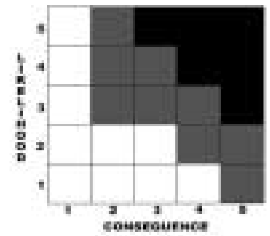
DESCRIPTION:

RATING	INTERPRETATION
1	Not Likely
2	Low Likelihood
3	Likely
4	Highly Likely
5	Near certain

Likelihood Ratings

RATING	INTERPRETATION
1	Low
2	Minor
3	Moderate
4	Significant
5	High

Consequence Ratings



POTENTIAL IMPACTS	
COST	
SCHEDULE	
TECHNICAL	

ABATEMENT / MITIGATION PLANS			CLOSURE CRITERIA
ACTION	ACTIONEE	DATE	
			Closure Authorized by:
			Risk Item Manager ____ Date ____
			Project Manager ____ Date ____

to be completed should all identified RIDs be closed. In general, all outstanding RIDs from a review should be disposed of before the next review is held. Project status will be determined by project management reviews where programmatic and technical status as well as cost/schedule status will be assessed. These reviews shall be held from contract award through system delivery, with more frequency and major emphasis during the design and development period. All key project team members are requested to attend the reviews to present the technical, cost and schedule status of their WBS areas' work packages and their planned work for the next period. Areas of major concerns will be identified and corrective action plans generated and followed up with action items implementation. The project manager will chair these reviews and customer participation requested. Review agendas must be prepared and distributed to all concerned before the review and formal minutes recorded to document action items, agreements, directives and status.

The project progress status, as measured and reported in all review meetings, is reflected by the application of the Earned Value concept. The measurement of cost/schedule performance of the project starts with the data accumulation of BCWS, BCWP, and ACWP, as these will occur and generated by the selected project management software system used during different phases of the space project. The BCWS data will be given by the system resulting from the baselines established during the planning phase. The BCWP (Earned Value) data are generated in the form of activities progress statusing from technical team members responsible for all WBS WP areas of the project. Guidelines and instructions for deriving BCWP, under each approved earned value method, are issued to the project team members as part of the performance measurement plan. BCWP reflects values of milestones accomplishments for all in-process work and the value of completed work. The ACWP data are recorded by and generated from the finance/accounting department where actual costs incurred are processed and recorded during the corresponding period, conforming to acceptable accounting practice as agreed by the client. These project data elements, including those of BAC and EAC, will provide a mechanism for calculating the current project status (cost and schedule variances) and its future trend which is best reflected through the calculation of the cost and schedule performance indices CPI and SPI whose purpose is to indicate the efficiency with which work has been accomplished. The following formulas were used to assess project performance:

SV = BCWP – BCWS CV = BCWP – ACWP (Negative variance indicates an unfavorable situation)

SPI = BCWP/BCWS CPI = BCWP/ACWP (Performance indices indicate work efficiency)

Exhibit 5. Monthly Project Assessment

Project Assessment

CONTRACT: **MOD:**
CUSTOMER: **PERFORMANCE PERIOD:**
CONTRACT VALUE:
PIP PUBLISHED DATE:
CUSTOMER REVIEW
LAST: **TYPE:**
NEXT: **TYPE:**

Project Manager Assessment Element	Oct-99	Nov-99	Dec-99	Jan-00	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00
	PAST HISTORY					(SIX-MONTH WINDOW FORECAST)					
1. Meets technical requirements	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
2. On schedule	!	X	X	X	X	X	!	OK	OK	OK	OK
3. Within planned budget	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
4. Risk Avoidance status	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
5. Quality/Productivity status	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
6. Adequate manpower	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
7. Adequate financial funding	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
8. Customer satisfaction	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK

NOTES:
OK 1= means the project is under control
! 2= means the project is experiencing some difficulties
X 3= means the project is in jeopardy

PROJECT MANAGER COMMENTS:
*
*

HIGHLIGHTS:
*
*

Where SV is Schedule Variance, CV is Cost Variance, and SPI and CPI are Schedule/Cost Performance Indices.

With risk planning completed in the early part of the project, risk control can now be exercised with risk avoidance approach implementation, reports and reviews of risk issues, implementation of risk contingency plan and the evaluation of the risk contingency plan to assess weather the contingency plan activities are still effective, and if not, potential redefinition of contingency plans for these risks. This will result in an effective management of risks where threats (risks) to the project are clearly identified and actions to control these threats should they materialize, are properly implemented to minimize negative impacts on the project in terms of cost, schedule and technical parameters. The project manager and her team will then decide on corrective actions to bring back the project on the right course to meet its objectives and consider whether or not the project baselines are still realistic for project performance. The project implementation continues with the reporting process where a monthly progress report is prepared to communicate the project's status to all stakeholders. The content of this report includes an executive summary in which the project manager highlights the major accomplishments of the past month, provides an overview assessment of the project to senior management and the customer, presents the status of the technical/cost/schedule parameters in terms of what has been accomplished for the reporting period and planned to accomplish for the next period, as well as areas of concern and proposed solutions. A management section is reserved for the project PMO to discuss programmatic issues with the customers including proposed resolutions of these issues. Appendices are attached to back-up reporting information and will serve as references purposes for those concerned. Typical appendices may include status of total implementation budget, cash flows and commitments, WBS tasks progress, summary tasks progress, RIDs resolution, key risk issues, and a risk database. Exhibits 4 and 5 show a risk tracking status appendix and a project assessment table in a typical project monthly report.

Application and Acceptance of Standard Space Project Management Approach for the 21st Century

As the need for effective management of space projects increases in the space industry resulting mostly from fierce competition for space-related projects as well as ongoing activities of the International Space Station (ISS) program, the largest cooperative venture in science and technology ever undertaken in the history of mankind and a symbol of cooperation amongst the world's most industrialized nations to build the permanently orbiting laboratory in space, the pressure is on space project managers to improve the management of their projects, which will help to complete this most ambitious engineering project by the middle of this decade. Unfortunately, the application of effective project management techniques for space-related projects was rarely presented and standardized. In many cases, it has been associated with the management of projects in the defense and high-technology industries where implementation usually involves the execution of systems-oriented production. Thus, an attempt has been made in this paper to present an efficient, effective, and value-added process to manage space projects although the degree of application is dependent on other factors such as the size of the project, the complexity of the space technology involved, as well as the environment in which the system is expected to be operational. While this is a worthwhile long-term objective for the project management community, short-term results have indicated continued cost overruns and schedule slippages in managing space projects. It is, however, hoped that this approach will contribute to the development of a standardized space project management approach that will be accepted and recommended for implementation by project managers in the space industry in the years to come.

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