Resources for NASA Managers

The Program and Project Management Collection

A special collection, The Program and Project Management (PPM) Collection, has been established at the NASA Headquarters Scientific and Technical (S&T) Library. The collection is part of the Program and Project Management Initiative, sponsored by the NASA Office of Human Resources and Organizational Development.

The S&T Library maintains and lends documents from this collection to interested personnel through each of the NASA Center libraries. The collection includes books, seminar proceedings, documents, and videos gathered from Headquarters and the NASA Centers. Some of the materials include:

Books

Project Management: A System Approach to Planning, Scheduling and Controlling by Harold Kerzner, 1984.

Management: Tasks, Responsibilities, Practices by Peter Drucker, 1974.

Computer Models for Operations Management by Owen P. Hill, Jr., 1989.

Beyond the Atmosphere by Homer Newell, 1981.

Issues in NASA Program and Project Management, (NASA SP-6101) 1988 and (NASA SP-6101(02)) 1989.

Documents

Getting on Contract, JPL D-1844, Rev. C October 1987.

Management Directives Relevant to Typical Phase A, Phase B, and Phase C/D Request for Proposals, Marshall Space Flight Center, Revision E, July 1987.

Technical Managers Handbook, Engineering Directorate, Goddard Space Flight Center, May 1989.

Videos

Introduction to Project Management, IEEE, Parts 1- 4, 1982.

Shared Experiences in NASA Projects, Angelo Guastaferro, April 21, 1989.

Project Management at Johnson Space Center, Aaron Cohen, December 7, 1989.

Explorer Satellites Program: Shared Experiences, Gerald Longanecker, September 1989.

Proceedings

NASA Colloquium on Project Management, 1980.

Project Management Institute Seminar/ Symposium, Several years running.

Materials from the PPM Collection are accessIble at each Center Library using the Aerospace Research Information Network (ARIN). ARIN is an online catalog to which all of the NASA libraries contribute on a daily basis. Any book added to a NASA library collection can be located through the use of ARIN. Much like a card catalog, ARIN may be searched by title, author, or subject. The advantage of an online system is its keyword searching capabilities. All of the materials in the PPM Collection have been "tagged" with a special code. Using that special code in a keyword search will display every title in the collection.

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Because there will be many titles in the entire collection you may want to limit your search by subject:

K=XPMX SYSTEMS ENGINEERING

or you may know when a document was published. Enter:

K=XPMX 198$

An author search may be entered like this:

K=XPMX CLELAND

There are many variations on keyword searching. Ask your librarian for assistance.

The request will be handled quickly if you have a title, author and call number, such as "T56, 8 N37 1989." The request will be forwarded to the NASA Headquarters S&T Library. After identifying the materials you want to borrow, please relate pertinent information to the reference desk at your NASA Center library, which will expedite the request and get the material to your library as soon as possible. You may keep the material for one month. Exceptions will be considered on an individual basis.

Additional questions concerning the collection may be addressed to Char Moss, at FTS-453-, or (202) 453-8545, who welcomes suggestions from users on how to improve the collection and what could be added. Donated materials — books, documents, videos, or proceedings — are always needed. If you have any useful materials that would be of value or interest to NASA management, forward them to the Headquarters S&T Library where they can be processed and made available to others. Out-of-print books on NASA management and historical reports on "lessons learned" from NASA projects are particularly in demand. Keep in mind that this collection is useful not only for current NASA managers but also the next generation of NASA managers as they learn from the past and prepare for the future.

A Crash Course in Defining 'Systems Engineering'

Back on September 27, 1968, a NASA engineer by the name of George S. Trimble wrote to the Chief of the Management Analysis and University Programs Office after the Chief issued a letter to find a universally suitable definition for "systems engineering." The engineer told the manager that the term had no particular meaning at all. "In fact," Trimble claimed, "I may know the guy who thought it up or resurrected it, as the case may be, for modern usage." His seemingly authoritative account follows:

"During the war, new management practices were introduced at a great rate, and one of the functions that came to the fore was the business of writing job descriptions and evaluating them. Certain industrial relations experts fell heir to this function, and there was a tendency for them to write very clear job descriptions for all jobs except their own. It soon became obvious that the value of a job, or, more importantly, the money it paid (or even more importantly, its draft-dodging power), was inversely proportional to the ease with which one could describe it. Industrial relations people were able to describe any engineering job in 25 words or less, whereas an industrial relations function might take two or three pages. Although miserable to begin with, engineering salaries were threatened and so was draft status.

"Of course, everyone knows that engineers are very creative. They could see that the industrial relations boys had a good thing going, so they borrowed the approach and improved on it (typical engineering method).

"Soon it took five pages to describe the most menial engineering task, and the engineers were saved. It was a simple matter to spend three hours explaining to a job analyst from industrial relations why a 'systems engineering' blueprint file was much more complicated to run than a simple old 'engineering' blueprint file, which was, of course, familiar. The guy from industrial relations never did understand it because the guy who explained it, didn't. It takes a lot of words to explain something you don't understand or that isn't there. Try explaining 'zero' sometime.

"A parallel effort with the objective of emphasizing *!!ENGINEERING!!* was carried out with great dispatch by the 'scientists,' all of whom became famous at the close of WWII because a couple of them single-handedly invented and built the A-bomb, all by themselves, with great secrecy. What they were really doing all that time, of course, wasn't science — it was engineering. When this was discovered, a mixed wave of nausea and terror ran through the brotherhood. It was worse than being caught reading a dirty book in church. Most learned scientists knew that engineers were people who ran around with special hats and oil cans and made steam locomotives go, and who, incidentally, made too much money. Being identified as part of the same crowd was too much for the intellect to bear. Scientists had to be working on something more important than 'engineering' which is supervised by a Ph.D. and is therefore high-class and also obvious to those schooled properly, but difficult if not impossible for anybody else to understand.

"Since, as we all know, very few, if any, Ph.Ds understand the meaning of plain, ordinary 'engineering,' it follows that 'systems engineering' has given engineering a bad name, and should be avoided for that reason alone.

"A third group who helped the cause for systems engineering were the pre-war 'handbook' engineers who discovered creative engineering when they joined up with a wartime industrial engineering group to avoid being drafted. They had always thought that 'engineering' was the *choosing* from a catalog of the proper washer for a quarter-inch bolt. It was difficult for them to use the same name for their new discovery, creative engineering (*designing* a washer for a quarter-inch bolt). The term 'systems engineering' suited well, and groups of people were noising it around by then. It sounded nice and, after all, a quarter-inch bolt is a fastening system of high complexity. It consists of a bolt with threads (helical inclined plane), a nut of the proper size, hand and thread configuration (bolt interface problem), external shape (wrench interface problem), one or more washers (structures interface problem), and sometimes even a cotter pin (reliability).

"Moreover, one could dream of performing systems engineering at increased hierarchical levels by considering at one and the same time not only the quarter-inch bolt, but also the half-inch bolt. Advanced systems engineering.

"So much for the history and meaning of systems engineering. You can demonstrate the validity of my story to yourself in several ways. Your letter can be clarified by eliminating the word 'systems.' I believe it appears 10 times. Check the universities for courses in systems engineering and find out what they're really teaching. Note also that the term 'systems engineering' does not yet appear in a an accredited dictionary. This is because Webster can't figure it out either. Good luck."

Well, that was the extent of definition history, according to engineer George Trimble in 1968. But what about today? Is "systems engineering" a set, definable term in the dictionary today? First stop, American Heritage Dictionary — no listing for "systems engineering."

Second stop, a Webster's. Indeed, the granddaddy of all dictionaries has it listed as an "Americanism," a term indigenous to this country. It reads:

> **systems engineering**, a branch of engineering using esp. information theory, computer science, and facts from systems analysis studies to design integrated operational systems for specific complexes.

All well and good, you suppose, but whatexactly is "information theory" following the "esp."? Turn back 722 pages and you find:

> **information theory**, the study of processes of communication and the transmission of messages; specif., the study dealing with the information content of messages and with the probability of signal recognition in the presence of interference, noise, distortion, etc.

The "etc." may be imprecise, but just when you think you are getting a handle on an up-to-date definition of "systems engineering" which has something to do with "information theory," you get thrown off by another term: "signal recognition." Not to worry, right? Because you can always look up that fuzzy term for a clear, concise definition. But guess what: "signal recognition" is not in Webster's (nor is it in American Heritage Dictionary). Mr. Trimble may have been right all along.

BOOK REVIEWS

Project Management Body of Knowledge (PMBOK)

by PMI Standards Committee
(Drexel Hill, PA: Project Management Institute, 1987)

The hundred or so pages of PMBOK covers nine areas of concentration: PM Framework (Philip Nunn), Scope (Richard Cockfield), Quality (William Dixon), Time (Joe R. Beck), Cost (Peter G. Georgas and George Vallance), Risks (David V. Pym), Human Resources (John R. Adams and Linn C. Stuckenbruck), Contract/Procurement (Shakir Zuberi), and Communications Management (Shirl Holingsworth), plus an essay by R. Max Wideman on PMBOK Standards and a glossary.

PMBOK was developed by a PMI Committee in 1983 as an effort to describe and define the knowledge necessary to function adequately as a Project Management Professional. As such, it became the official PMI basis for certification exams and review of graduate programs in September of 1988.

The effort itself was well thought out. Purposes were to organize and classify in PMBOK; to integrate, correlate, store, and retrieve, and "build on what we have." Characteristics of the effort had to be simple, logical, saleable, comprehensive, compatible, systematic, and understandable. As areas were carved out, they were published in the Project Management Quarterly (now Journal).

Stuckenbruck, in an overview section, illustrates the basic project management elements and functions in a matrix model which resembles this:

Project Management Functions ↓ / Project Elements	Scope	Quality	Scheduled	Cost	Environment
Planning and Control					
Project Integration					
Resources					
Risk					
Human Resources					
Contacts and Procurement					
Information and Communications					

Project Management Matrix Model

Wideman suggests that a simpler Work Breakdown Structure (WBS), defined as a task-oriented tree of activities, "is too restrictive for purposes of representing the PMBOK," so the matrix model serves as the framework for discussion of the PMI approach to a project management body of knowledge.

Wideman traces the effort to produce a body of knowledge on project management to 1976. The main concerns then were standards, certification, accreditation, and a code of ethics to establish project management as an independent profession. By 1986, the PMI project #121 had settled on a working definition: "A project is any undertaking with a defined starting point and objectives by which completion is identified. In practice, most projects depend on finite or limited resources by which the objectives are to be accomplished."

PMBOK is nicely printed with foldout charts and diagrams in a looseleaf binder. As the discipline or standards of project management change, modified pages can be inserted easily. And as the distinct profession of project management evolves, pages can be added. PMBOK thus represents a strenuous effort on the part of prominent management theorists in the U.S. and Canada to reduce the commonly accepted essentials of project management knowledge into one short, easy-to-read binder with useful glossaries and references at the end of each section.

The Management of Research Institutions: A Look at Government Research Laboratories

by Hans Michael Mark and Arnold Levine
(NASA SP-481. Washington, D.C.:
U.S. Government Printing Office, 1984)

Starting with the assumption that "the greatest strength of the technology development laboratory is in basic and applied research and not (with rare exception) in product development," physicist Hans Mark and social scientist Arnold Levine set out to analyze large research institutions constrained by normal financial limitations. For example, how does a manager do medium- and long-range planning on an annual funding cycle?

Following a brief historical overview from the Lyceum of Aristotle and Plato to the founding of the British Royal Society, the authors focus on the past two decades of NASA, DoD, and the Nuclear Energy Development Center.

The "ultimate reality" for the authors are projects themselves, leading to some "practical" applications of technology development. The use of project methods is nothing new — re-call the six-month construction of the Monitor in 1862, the Manhattan Project, and the Apollo Program. However, "the project approach sometimes entails heavy penalties when it is pushed to the exclusion of other approaches and becomes a brute force effort to achieve a goal, or freezes technology prematurely." No better example serves them than Apollo, with lunar landing as a "dead end." Had NASA selected "earth-orbit rendezvous initially, the lunar landing could still have been achieved and NASA would have had at least a ten-year start on deploying an orbiting space station, rather than waiting until 1982 to let study contracts for its design." The authors contrast the "single-minded" Apollo program with the "open-ended and continuing" Shuttle Program and suggest that the Project Approval Document (PAD) may no longer be possible for NASA in some projects, due to their complexity.

The authors make several assumptions about the management of professional staff in large research institutions. First, "there are no personnel policies which are guaranteed to work across organizational lines." Such policies as continuing education, indefinite or term employment, and rotating work assignments may or may not work, depending on the organizational culture. Rather, they see personnel issues as "synonymous with the organizations goals." They quote Arnold Deutsch to the effect that technical people are best motivated by the challenge of the work itself, as inspired by the institution's environment. The steady decline in large research institutions suggests to the authors that they will change little but also that an older work force will not mean obsolescence if the institution can transform scientists and engineers into managers.

Can they? In a case study, the authors point to NASA in the 1970s. Yes, scientists and engineers can and do make good managers when their loyalties are more to the organization- than to their technical discipline. Many are called to internships and supervisory training programs, but few are chosen because of "a narrowly, technical education," these authors conclude.

The Management of Research Institutions is amply illustrated with charts, illustrations, and case studies, ending with an assertion that the most precious of all qualities is the human imagination, which enabled even Andrei Sakharov to withstand stifling. Imagination is best freed in a decentralized system "where decision-making is not monolithic but yet is well enough organized to make the importance of science and technology felt."

Organizing for Project Management

by Dwayne P. Cable and John R. Adams
(Drexel Hill, PA: Project Management Institute, 1986)

This 34-page monograph is described as a "concise yet readable" introduction to or refresher in organizational alternatives. It is not a guidebook or manual, but rather a brief description of standard organizations on a scale of no or low to high project managerial authority: functional, expeditor, coordinator, weak matrix, strong matrix and fully projectized structures. Expeditor and coordinator are described as subsets of functional organization, and the "fully projectized" organization is defined as one in which the project manager has total responsibility, with all the personnel needs assigned to that one project.

The differences in structure and authority are spelled out in a series of organizational charts, including one repeated 10 pages later. Of course, as the authors point out, "few large organizations involved in multiple projects use any single form of organization" in pure form, but selection of the best chart may be "an enormous step from which there may be no return."

While most of the outline and description would be "old hat" to the seasoned or schooled project manager, the authors do list 22 advantages and disadvantages of a matrix organization form. Particularly interesting is a section on "Matrix Pathologies." They include Power Struggles, Anarchy, Groupitis (confusing matrix behavior with group decision making), Collapse During Economic Crunch, Excessive Overhead, Decision Strangulation (caused by too many administrators), Sinking (when matrix structure falls to lower management levels), Layering (matrices within matrices), and Navel Gazing (absorbed with internal operations to the detriment of the world outside the organization).

Team Building for Project Managers

by Linn C. Stuckenbruck and David Marshall (Drexel Hill, PA: Project Management Institute, 1988)

U.S.C. Professor Stuckenbruck and his research assistant suggest that "team building" is at the very core of project management, perhaps even more important than technical knowledge.

"Even the best projects using the best tools are not immune to failure," they say, claiming that most troubled projects require "team members to work together and provide outstanding group performance."

To accomplish such team building, the authors say "the cookbook approach" to management, a recipe of tools and techniques, won't work for projects, nor for a losing football team. A project is "losing" or sick when there are signs or symptoms of frustration, conflict, and unhealthy competition, unproductive meetings, or lack of confidence in the project manager. An alert manager will turn the situation around by presenting the problem as a challenge, giving regular review and feedback on performance, using a team reward system (such as visibility or recognition), encouraging professional development (papers, workshops, and special training opportunities), encouraging healthy competition, and providing a good environment for a wholesome place to work with all the tools and support necessary to excel. Clear and effective communication are basic in such remedies. That is not to say "team building" is a cure-all. The authors say no amount of teamwork will save a project if the project concept is faulty. Also, the lack of top management support can undermine any efforts towards team building. Finally, no amount of team building will save hopelessly unproductive people nor a hopelessly inept manager.

Nevertheless, the authors insist that "team building can very well be the most important aspect of the project manager's job," and this 50-page booklet is a good start in the process.

Roles and Responsibilities of the Project Manager

by John R. Adams and Bryon W. Campbell (Drexel Hill, PA: Project Management Institute, 1988)

In a mere 30 pages, the authors attempt to describe the functions of a typical project manager, as well as the education and experience needed for effectiveness. As such, these topics are merely touched upon, making the booklet a very broad overview of a few basic, commonly accepted generalizations.

However, the PMI booklet does contain a few fresh topics on conflict resolution, derived from a 1979 book co-authored by Adams. Conflict over planning, organizing, and controlling occur frequently over the span of a project, and the authors suggest five resolution-strategies. Most common is "confrontation," whereby the two parties face the problem directly and work together toward a workable solution. "Compromise" is a second method, involving give and take. Another important method, they suggest, is "smoothing" where differences are played down and areas of agreement are given the most attention.

Fourth is "forcing" a win-lose agreement, where the project manager exerts power to impose a solution. The least used is "withdrawal" or when one or both parties backs down and gives up the conflict for the sake of the project. The point is: the project manager is expected to manage even conflict situations in one of the five ways as part of the demanding job.

"Experience is irreplacable as a learning tool for managing people in a project, " the authors assert, but formal education in management is also desirable to complement a manager's technical expertise. Typically, such a complement would be an MBA degree, although they also suggest formal education in such areas as psychology, labor relations, and law, plus informal workshops in communication, group dynamics, leadership, and, of course, conflict resolution.

Skill in Communication: A Vital Element in Effective Management

by David D. Acker (Defense Systems Management College, Fort Belvoir, VA: U.S. Government Printing Office, 1985)

David Acker spent two decades with Rockwell in the Autonetics Division before becoming a professor of management at the Defense System Management College. He asserts that good communications are the source of good management, and skill in communications is essential to every other management skill."

Interactive communication is needed in any organization, he says, for task coordination, problem solving, information sharing, and conflict resolution. The manager, before communicating, must have a purpose, know the audiences' needs, select the right channel or medium, and expect a specific kind of feedback. It sounds elementary, but these are useful reminders.

Skills in presentations (public speaking), listening, reading, writing, and conducting meetings are outlined from a managerial point of view. Short chapters on non-verbal communication, communication barriers, and communication theory round out this handy, pocket-size booklet of 86 pages.

While there is no attempt to provide depth, the author does throw up some bewildering terms like "kinesics" (related to something called "movement analysis"), "paralanguage" (not defined), and "noise barrier" (defined mysteriously as "any communication problem that can't be fully explained"). Nevertheless, its brevity is the booklet's strength. This booklet is a storehouse of useful tips to refer to before a manager is called upon to speak, present, read, write, or listen.

One insightful term which keeps popping up in Skill in Communication is "empathy." Acker suggests that the speaker or author "can put yourself in the receiver's place and analyze the message from his viewpoint." A disclaimer in a footnote explains, but does not justify, that the author is using the male adjective as a literary term, in a generic sense. Rhetoricians are saying now that the use of sexist language is inexcusable. A sentence that calls for a personal (male) pronoun is, more often than not, a poorly constructed sentence anyway.

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