STATE OF THE ART
OF PROJECT MANAGEMENT: 2003

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PART 2

PM APPLICATIONS, PRACTICES, and TOOLS

Three topics are discussed in this section*:*

> **Part 2-1** Areas of Project Management Application: which industries, organizations, and institutions apply PM practices ?
>
> **Part 2-2** Project Life Cycle Models: what are the characteristics of the project life cycle models and systems that are in use today for various areas of application and project categories ?
>
> **Part 2-3** PM planning and control methods, tools and information systems: what is the nature of these management tools?

PART 2-1

AREAS OF PROJECT MANAGEMENT APPLICATION

which industries, organizations, and institutions apply PM practices ?

The benefits of recognizing

1) that projects exist in all types of human enterprise, and
2) that the systematic approach to project conception, selection, definition, authorization and execution embodied in modern project management principles produces superior results compared to previously used methods, are now very widely understood.

Modern project management had its genesis during and following World War II simultaneously in two industries: the facilities engineering and construction industry, and the defense/aerospace industries. We now know that this is true in the U. S., Western and Eastern Europe, including Russia and other republics in the former Soviet Union. The discipline spread slowly to other areas of application until the 1990s when it rather quickly penetrated essentially all types of industry, institutions and governmental agencies.

One indicator of this rapid spread is the growth pattern in PM professional associations. PMI, as one example, started in 1969 with about 30 members, grew in 21 years to 8,500 members in 1990 (mostly in the U. S. and Canada), and in the past 13 years has grown to over 112,00 members today in 120 countries (69% of members are in the U.S., 11% in Canada, and 20% in the rest of the world.) The national member associations of IPMA have also experienced remarkable growth in their memberships in recent years. For a complete directory of PM associations around the world go to http://www.pmforum.org.

The great diversity in the areas of application is illustrated by the many specific interest groups (SIGs) within the Project Management Institute that relate to specific application areas, as shown in Table 4. Each of these SIGs brings together executives and project management practitioners that have specific interests in that area of application or business sector. It will be noted that these specific interest groups are not mutually exclusive. Additionally there are thirteen PMI® specific interest groups that deal with particular aspects of project management across all of these areas of application. Also, the PMI® College of Performance Measurement is devoted primarily to the military/aerospace area of application, and the PMI College of Scheduling focuses on that part of the project management discipline across all areas of application.

Aerospace & Defense	**Automation Systems**
Automotive	Design-procurement-construction (across all economic sectors)
Dispute Management	E-Business
Environmental Management (pollution remediation and prevention)	Financial Services (banking, investment)
Government	Healthcare Project Management
Hospitality Management (major events, such as the Olympic Games)	Information Systems (software)
Information Technology and Telecommunications	International Development (infrastructure, agriculture, education, health, etc., in developing countries)
Manufacturing	Marketing and Sales
New Product Development	Oil/Gas/Petrochemical
Pharmaceutical	Retail
Service and Outsourcing (buying rather than making)	Urban Development (potential SIG)
Utility industry (generation and distribution of electric power, water and gas)	

Table 4 The specific interest groups (SIGs) within PMI® that relate to specific areas of application of project management. For a directory of project management Specific Interest Groups to www.pmforum.org/prof/sigdir.htm.

The top five industries represented by the PMI membership are "computers/software/data processing, information technology, telecommunications, business management, and financial services" (*PMI Corporate Council Update* March 2003, p 3), in spite of the fact that construction and defense/aerospace are the most mature PM areas of application.

Project Management Driven and Dependent Organizations

Two broad classes of organizations can be identified:

First, those ***project-driven*** organizations whose primary business is in fact made up of projects. Examples of this class include architect/engineer/constructor, general contractor, and specialty contractor firms; software development firms who sell their products or services on a contract basis; telecommunications systems suppliers; consultants and other professional services firms; and other organizations that bid for work on a project-by-project basis. Growth strategies in such organizations are reflected in the type, size, location and nature of the projects selected for bidding, as well as the choices made in how the required resources will be provided (in-house or out-sourced) to carry out the projects, if and when a contract is awarded or the project is otherwise approved for execution. NASA is a project-driven organization, for example, and its executives have stated that their entire annual budget is based on projects.

The second class of organizations—those that are **project-dependent** for growth—includes all others that provide goods and services, and not primarily projects, as their mainstream business. Projects within these organizations are primarily internally sponsored and funded. Examples include manufacturing (consumer products, pharmaceuticals and engineered products), banking and financial services, transportation, communications, governmental agencies, computer hardware and software developers and suppliers, universities, hospitals, and other institutions, among others. These organizations depend on projects to support their primary lines of business, but projects are not their principle offering to the marketplace. Many of these sponsors of internally funded projects are important buyers of projects from project-driven organizations.

Examination of the project categories listed in Table 1(Part 1-2) and the PMI SIGs listed in Table 4 gives a fairly complete picture of the breadth of the current areas of application of modern PM. Specific new application areas will continue to emerge, including, for example, military operations, recovery from natural (earthquakes, floods, fires, famines, medical epidemics) and man-made (wars, terrorist acts) disasters, and the trillion dollar per year world-wide industry to restore the natural and built environment (Foti, *PMNetwork* October 2003, pp 28-34). These and other areas of PM application will no doubt require defining additional project categories and sub-categories to those previously listed in Table 1 (Part 1-2).

Part 2-2

PROJECT LIFE CYCLE MODELS

what are the characteristics of the project life cycle models and systems that are in use today for various areas of application and project categories ?

A number of commonly used models, consisting of a number of phases or stages and related decision points, have been developed and are currently in use to portray project life cycles within each project category and sub-category shown previously in Table 1 (Part 1-2). Such models provide a major starting point for applying systems thinking to managing projects. The models within each category and/or sub-category will show considerable similarities, but in most cases there will be significant differences in the life cycle models from one category/sub-category to the next.

Purposes of Project Life Cycle Process Models: The purposes of designing and documenting the overall project life cycle process for each project category are to:

- Enable all persons concerned with creating, planning and executing projects to understand the process to be followed during the life of the project.
- Capture the best experience within the organization so that the life cycle process can be improved continually and duplicated on future projects.
- Enable all the project roles and responsibilities, and the project planning, estimating, scheduling, monitoring and control methods and tools, to be appropriately related to the overall project life cycle management process.

Unless a well-documented, understandable picture of the life cycle process – the model -- for each project category/sub-category exists it is difficult (if not impossible) to achieve the full benefits of modern, systematic project management.

Life Cycle Phases and Decision Points: There is general agreement that the four broad, generic project phases are (common alternative terms are shown in parentheses):

- Concept (initiation, identification, selection.)

- Definition (feasibility, development, demonstration, design prototype, quantification.)

- Execution (implementation, realization, production and deployment, design/construct/ commission, installation and test.)

- Closeout (termination, including post-completion evaluation.)

However, these phases are so broad and the titles so generic that they are of little value in documenting the life cycle process so that it can be widely understood, reproduced, and continually improved. What is needed is the specific definition of perhaps five to ten basic phases for each project category and sub-category, usually with several sub-phases defined within each of the basic phases.

In designing and documenting a life cycle process (or model) for a given project category there are three parameters to work with:

- The number of basic phases and the number of sub-phases within each, together with the short title and full definition of each of these.

- Which of the basic phases and sub-phases will be strictly sequential, which will overlap, and for those that overlap how much overlap can be tolerated; whether any phases are repeated; and how they are inter-related in a process flow chart (continuous flow, spiral, or other graphic shape.)

- The number and placement of decision points (approval to proceed, revise project objectives or scope, kill/terminate, put on hold , repeat a previous phase or sub-phase, and others) in the process.

Identification of Products or Results (Deliverables) To Be Produced in Each Phase: It is desirable (some would say mandatory) to identify the products or results to be produced (documents and physical products) during each of the phases and sub-phases:

- Documents related to the *project* include all those required for the subsequent phases: revised, updated, and/or elaborated statements of project objectives and scope, plans, schedules, resource and cost estimates, evaluation of risks, earned value and other cost reports, work orders, contracts, project release authorizations, and other project management documentation.

- Documents related to the *product or results* include specifications, drawings, descriptions, test procedures, process and other designs, flow charts, product cost estimates, test and other reports, product change orders, and other documentation closely related to the products or results of the project.

- Physical products or results include intermediate or final mock-ups, scale or full size models, prototypes, test articles, tools and tooling, items of equipment, facilities, consumable materials and supplies, and other physical objects. In many projects the final end results will be one or more documents (including CDs, which are electronic documents) that embody a system or describe a service to be implemented, provided, or sold, but do not include physical objects. The results of an information system project may be embodied on a CD-ROM, but the system itself is usable only of course when invisibly stored in the memory of a set of computer hardware.

The product development process for the end result to be produced by the project will of course have a direct impact on the project life cycle model to be used, and must be integrated into that life cycle model.

Defining the Decision Points: Key decision points (events or milestones) occur at the start and end of each phase or sub-phase. They may also occur within any of the life cycle phases. The decisions typically authorize the project manager and team to:

- Proceed with the remaining work in the current phase.
- Start work on the ensuing phase.
- Re-plan and re-start a phase or sub-phase already completed if satisfactory results have not been achieved.
- Revise the project objectives, plans and schedules when major changes in scope are required.
- Terminate the project if the conclusion has been reached that its objectives cannot be achieved successfully or if the risks have been determined to be too great.
- Place the project on hold pending availability of funds, new technology, or some other external event.

Documenting a Project Life Cycle Management Process: For each project category or sub-category we must document and describe the project life cycle process to:

- Select the life cycle model to use, name the phases and sub-phases, determine their inter-relationships, and identify the key decision points.
- Describe the methods, procedures, forms, documents, tools, systems, and other practices for authorizing, planning, analyzing and mitigating risks, budgeting, scheduling, monitoring, and controlling all projects within the category.
- Specify the documents and related levels of approval authority for initiating and authorizing new projects and major changes to authorized projects.
- Identify the key project roles and define their responsibilities and authority.
- Identify and describe the major deliverables to be produced in each phase and sub-phase.
- Specify the procedures for escalating the inevitable conflicts (competition for key

resources, priorities between projects, and others) and unresolved issues to the appropriate level for their prompt resolution.

The detailed project management project process for a given project category must also include provisions for handling projects of different sizes, complexities, risks, durations, sources of funding, and serving different customers.

Specific Life Cycle Model Examples: Table 3 lists a number of various life cycle models, with references, for some of the categories and subcategories listed in Table 1 (Part 1-2), reflecting the results of an incomplete literature search. In several of the models identified in Table 3 the decision points are referred to as "gates."

Two Basic Types of High-Technology Life Cycle Models

There are two basic types of life cycle models as shown in Table 3 for what can be termed 'high-technology' project categories: Predictive and Adaptive. Examples for information system development projects are given here, but may also apply to some other high-technology projects.

Predictive life cycle models "favor optimization over adaptability" (Desaulniers and Anderson 2002) and include:

- Waterfall: (also known as traditional and top-down): linear ordering of the phases, which can be strictly sequential or overlapping to some extent; no phase is normally repeated.
- Prototyping: functional requirements and physical design specifications are generated simultaneously.
- Rapid Application Development (RAD):based on an evolving prototype that is not thrown away.
- Incremental Build: decomposition of a large development effort into a succession of smaller components.
- Spiral: repetition of the same set of life-cycle phases such as plan, develop, build, and evaluate until development is complete.

Adaptive life cycle models "accept and embrace change during the development process and resist detailed planning" (Desaulniers and Anderson 2002) and include:

- Adaptive Software Development/ASD: Mission driven, component based, iterative cycles, time boxed cycles, risk-driven, and change-tolerant.
- Extreme Programming/XP: Teams of developers, managers, and users; programming done in pairs; iterative process, collective code ownership.
- SCRUM: Similar to above adaptive life cycle models with iterations called "sprints" that typically last 30 days with defined functionality to be achieved in each sprint; active management role throughout.

Agile Software Development Models: These adaptive models are also referred to as "agile" life cycle models (Bullock 2003). In 2001 the "Agile Software Development Manifesto" was issued by a group of seventeen representatives of these adaptive life cycle model users, and this movement has gained considerable momentum in the IT industry. See http://www.agilemanifesto.org .

Project Environment Impact on the Life Cycle Model: Design and adaptation of the life cycle model for each project category or subcategory must reflect the important characteristics of the project environment. "The organizational characteristics, the degree of familiarity with the technology to be used, and the competitive demands for initiating the project are just some of the environmental factors that can vary from project to project" (Desaulniers and Anderson 2002.)

Project Categories	**Life Cycle Models and References**
Generic Project Models: All (or many) project categories below.	Belanger 1998, pp 62-72: Generic, Waterfall, Parallel-Work, Evolutionary Models. Morris 1994, pp 245-248: Standard, Waterfall, Cyclical, Spiral Models.
1. Aerospace/Defense Projects 1.1 Defense systems 1.2 Space 1.3 Military operations	DOD 2000: Defense Acquisition Model. NASA 2002: Process Based Mission Assurance (PMBA) Program Life Cycle, 8 phases: 1. Program Mgt, 2. Concept Development, 3. Acquisition, 4. Hardware Design, 5. Software Design, 6. Manufacturing, 7. Pre-Operations Integration and Test, 8. Operations.
2. Business & Organization Change Projects 2.1 Acquisition/Merger 2.2 Management process improvement 2.3 New business venture 2.4 Organization re-structuring 2.5 Legal proceeding	See above generic models.
3. Communication Systems Projects 3.1 Network communications systems 3.2 Switching communications systems	See above generic models.
4. Event Projects 4.1 International events 4.2 National events	See above generic models.
5. Facilities Projects 5.1 Facility decommissioning 5.2 Facility demolition 5.3 Facility maintenance and modification 5.4 Facility design/procurement/construction	See above generic models.
6. Information Systems (Software) Projects	Desaulniers and Anderson 2002: Predictive (Waterfall, Prototyping, RAD, Incremental Build, Spiral) and Adaptive (ASD, XP, SCRUM) Models. Whitten 1995, pp 19-22: Code and Fix, Waterfall, Incremental, Iterative Model. Muench 1994: Spiral Software Development Model. Lewin 2002, p 47: "V" Software Development Model; p 50: Formula-IT Development Model. Kezsbom & Edward 2001, p 122: Refined Process Spiral Model.

7. International Development Projects 7.1 Agriculture/rural development 7.2 Education 7.3 Health 7.4 Nutrition 7.5 Population 7.6 Small-scale enterprise 7.7 Infrastructure: energy (oil, gas, coal, power generation and distribution), industrial, telecommunications, transportation, urbanization, water supply and sewage, irrigation)	World Bank Institute 2002, Module 1. People and process intensive projects in developing countries funded by The World Bank, regional development banks, US AID, UNIDO, other UN, and government agencies; and Capital/civil works intensive projects—often somewhat different from 5. Facility Projects as they may include, as part of the project, creating an organizational entity to operate and maintain the facility, and lending agencies impose their project life cycle and reporting requirements.
8. Media & Entertainment Projects 8.1 Motion picture 8.2 TV segment 8.2 Live event	
9. Product and Service Development Projects 9.1 Information technology hardware 9.2 Industrial product/process 9.3 Consumer product/process 9.4 Pharmaceutical product/process 9.5 Service (financial, other)	Cooper and Kleinschmidt 1993: Stage-Gate ® Process Model Kezsbom & Edward 2001, pp 108: Stage/Gate Product Development Model. Thamhain 2000: Phase-Gate Process Model. Murphy 1989: Pharmaceutical Model.
10. Research and Development Projects 10.1 Environmental 10.2 Industrial 10.3 Economic development 10.4 Medical 10.5 Scientific	Eskelin 2002, p 46: Technical Acquisition: Basic Model, Phased Model, Multi-Solution Model.

Table 3. Project life cycle models and references: generic and for various project categories [Source: Archibald 2003, pp 45-46].

Managing Software Development Projects With the Rational Unified Process/RUP®

RUP is a widely used process model developed by IBM that consists of six best practices:

- Develop software iteratively
- Manage requirements
- Use component-based architectures
- Visually model software
- Continuously verify software quality, and
- Control changes to the software.

Wideman (2002) presents a comprehensive treatise on RUP that can be seen at http://www.maxwideman.com/papers/acquisition/intro.htm . RUP® is a process product developed, maintained and integrated with a suite of software tools available from IBM on CD-ROM or via the Internet at http://www.us.ibm.com .

Improving the Project Life Cycle Management Process

Once the life cycles have been designed and documented for each category or subcategory of projects, it is then possible to define and document the project life cycle management system for each. Only when such documentation exists can the system be improved in a systematic, integrated manner. To establish a total quality management (TQM) approach to an organization's project management capabilities and to avoid sub-optimal improvements being introduced on a disjointed, piece-meal basis, the following approach is recommended:

Document the integrated life cycle process model: As discussed earlier.

Document and describe the resulting *Project Life Cycle Management System* (PLCMS) for each project category within the organization: also discussed earlier.

Re-engineer the integrated process to apply appropriate re-engineering methods to each category's PLCMS to:

- Identify system constraints, gaps and weaknesses.
- Identify 'speed bumps' that inadvertently slow the process down and potential 'accelerators' that can speed it up (Githens 2002).
- Relate the undesirable project results and possible causes to the PLCMS wherever possible.
- Redesign the PLCMS beginning with the most obvious constraints, gaps and weaknesses and document the results.

4. Implement the Improvements.

- Obtain needed agreements and conduct appropriate tests or analyses to prove out the validity and feasibility of the proposed system revisions.
- Plan, approve and execute the improvement project to implement the revised PLCMS.

5. Repeat the steps as required until an optimum achievable PLCMS has been implemented.

The PLCMS improvement team must include experienced practitioners from within the organization who are familiar with the existing PM practices.

Part 2-3

PM PLANNING AND CONTROL PRACTICES, SYSTEMS, AND TOOL*S*

what is the nature and current status of these management tools ?

Practices, systems, tools, and methods for integrative and predictive project planning and control are at the heart of the PM discipline. *Integrative* means that all phases of the project and all the elements of information mentioned later are logically linked together. *Predictive* means that the system forecasts what will happen in the future based on the current plans and estimates, with the actual physical progress and reported expenditures constantly updating the schedule and cost forecasts and comparing these with the authorized baseline budgets and schedules. The goal is to predict undesirable results in sufficient time to allow corrective actions to be taken to assure that the undesirable results do not become the reality.

The state of the art today in this important aspect of PM has advanced rapidly in the past few years, capitalizing on the rapid advances in the information technology/IT industries and the

Internet/World Wide Web, together with our advancing understanding of projects and of the fact that project management must be closely linked, through project portfolio management, to the strategic management of organizations.

Today's methods, systems and tools enable organizations to plan and control every project on an integrated life cycle basis:

- Including all contributing functional areas or organizations;
- Through all of each project's life cycle phases: conception, definition, design, development/manufacture/construction, installation/initial use/operation, and close-out;
- Including all the elements of information (schedule, resources, cost, technical, risk) pertinent to the situation, together with (1) resource allocation and management reports; and/or (2) earned value techniques (Fleming and Koppelman 2000) with cost and schedule variance reports where appropriate;
- Using Web-enabled project management software systems and procedures; and
- Linking all projects within programs and project portfolios and producing the pertinent information summarized for senior executives to enable appropriate strategic direction on all projects.

Project Management Software Systems and Tools: PM software applications are today a major market with hundreds of available, competing systems of widely varying power and capabilities. Table 5 provides a summary indication of the systems that are listed in the 1999 PMI Project Management Software Survey.

PM Software Category	PMBOK® Guide Knowledge Areas
PM Suites (36)	All
Process/Scope Management (19)	Integration Management
Schedule Management (43)	Time Management
Cost Management (27)	Cost Management
Resource Management (27)	Human Resources Management
Risk Management and Assessment (15)	Risk Management
Communications Management (17) Subcategories: Graphics Add-ons (21) Timesheets (25) Web Publishers/Organizers (15)	Communications Management

Table 5. Software categories and related knowledge areas [summarized from PMI 1999, p 3]. The number of software application products surveyed in each category is shown in parentheses, as listed in Appendix B of the PMI Survey. The categories are not all mutually exclusive.

One Integrated System: The powerful computer-supported project planning and control systems available today enable using one integrated system (usually consisting of project-oriented subsystems that are properly linked together) for each and every project within the organization, on an integrated life cycle basis, to:

- Systematically define and control the project's objectives and scope.

- Evaluate and proactively manage individual project risks together with the aggregate project portfolio risks.

- Define and control the specification, quality, configuration and quantity—in a word, scope—of intermediate and final products (or deliverables) of the project.

- Systematically define and control the project scope and the work to be carried out within each of its life cycle phases using the project/work breakdown structure (P/WBS) approach.

- Estimate the labor, material and others costs associated with (1) each project's deliverable products and related work elements, and (2) each summary element in the P/WBS.

- Plan and control the sequence and timing of the project deliverables and related work elements using a top level project master schedule plus an appropriate hierarchy of more detailed, integrated schedules.

- Authorize and control the expenditure of funds, work hours, and other resources required to execute the project.

- Provide the information—regarding both a) actual progress and expenditures and b) forecasts in the future—required by project managers, department managers, functional task leaders and work package leaders on a timely and reasonably accurate basis.

- Continually evaluate progress and predict and mitigate problems with scope, quality, cost, schedule and risk, using earned value project management methods where appropriate.

- Report to management and customers on the current status and future outlook for project scope, quality, cost and schedule completion, including post-completion reports.

When customer demands or other factors such as joint venture needs require that a specific project planning and control system be used for a particular project that is different from the corporate system, that different system can be linked with and provide summary information to the corporate system so that all project information, and particularly the time-related resource data, can be viewed on an integrated basis for the total organization.

Web-Enabled Project Management:This is one of the most significant advances in PM in recent years. Among the many advantages and efficiencies of Web-enabled PM are (Archibald 2003 pp 113-114, Timmons 2000):

- 24 hour availability of current project information and the project document repository,

- Ease of updating and exchanging current project information from any geographic location,

- Improved reporting capabilities and timeliness of information,

- Improved project baseline control,

- Ability to build virtual teams of people located anywhere in the world,

- Simplified storage and retrieval of vendor information and documents,
- Ability to create a virtual project turnover/completion (punch) list.
- Accelerated reaction to changes in risk, schedules, cost, or other factors
- Enhanced ability to capitalize on opportunities for schedule, cost, or other improvements.

Distributed Project Management (DPM) Software:

Web-enabled PM software is becoming known as distributed PM software and is a very large and rapidly growing market. "In addition to IT-related organizations, users of collaboration tools [DPM software] come from a variety of non-IT companies such as those in architecture, engineering, aerospace, defense, energy, healthcare, pharmaceutical, manufacturing, telecommunications and construction industries" (Patterson 2002, p 2)

The market for these specialized tools is projected to surpass US$3 billion by 2004 (Collaborative Strategies 2001).

"Definite trends are now emerging in the DPM marketplace. There is a strong movement away from complex, desktop-based applications to easy-to-use, browser-based systems even though there is an increasing shift from simple, local projects to distributed, more complex projects" (Patterson 2002, p 2).

Critical Chain Method/CCM of Project Planning and Control

The critical chain method has emerged in the past few years and is embraced by some practitioners as a significant advance in the state of the art of project planning, scheduling and control. Others take the position that it is not significantly different from the critical path method/CPM, when that method is effectively used.

CCM builds on the familiar CPM network planning technique in the following ways:

- Resources and "Resource Buffers": CCM focuses more intensively on resource constraints in creating the network plan logic. It identifies quantified resource buffers to assure that critical resources will be available when required to avoid project delays. Quantified resource buffers are certainly a new addition to project planning and control practices, although some would argue that they are basically the same as the 'management reserves' that have long been used in the application of CPM.

- Duration Estimates: CCM uses range estimates for activity durations, but its use of a 'mean value' is disputed by Piney (2000) as inferior to the original PERT approach to range estimates of duration. Many practitioners use range estimates with CPM as well, although this is not a formal requirement with CPM.

- Critical Chain Buffers: These are sized in CCM based on the uncertainty in the protected group of activities, and CCM proponents claim that these are different from CPM float or slack. Arguments by practitioners continue about these and related points concerning the differences between CCM and CPM. (See Archibald 2003, pp 274-275, Piney 2000, and Leach 2000 for more detail on these points.)

Reported Benefits of CCM: As an example, the U. S. Navy recently reported significant improvements when they switched from using CPM to CCM in 2002 at the Pearl Harbor Naval Shipyard for its Fleet Maintenance Availability Project for Submarines. These include:

- Better schedule performance, with the last 13 submarines finishing on time.
- 11% more jobs done for each submarine turnaround while using 5% fewer people hours.
- 13% increase in job completions.
- Average length of repair time reduced by 5.6 days (*PMI PMNetwork* 2003 p 10).

The Navy says that main reason the switch to CCM produced these improvements is because with CCM if a job finishes early the next job will start immediately, whereas with CPM the next job would not start until its original scheduled date, since the needed resource would not be available to start earlier. CCM encourages a 'relay race' behavior, they say, with workers finishing a job as quickly as possible and passing the baton without delay to the next in line. Others would argue that this type of behavior is not dependent on the planning method used.

The More Integrated Approach to Project Planning and Scheduling Developed in Russia

Methods and supporting software developed and widely used in Russia on many types and sizes of projects since about 1991 have some advantages and are more integrated compared to those commonly used in other countries. The methodology is based on the *resource critical path* approach (Liberzon 2001). This approach has common features with the Critical Chain Method and includes:

- Calculating the critical path taking into consideration all schedule constraints including resource and financing constraints,
- Calculating *resource constrained activity floats* (analogue of the CCM feeding buffers),
- Calculating *resource constrained assignment floats* and determining *critical resources*,
- Project risk simulation and calculation of the *success probabilities using range duration estimates*,
- Calculation and management of the *contingency reserves* (analogue of CCM project buffer).

"By controlling current values and trends of the project success probabilities the project managers obtain powerful tools that make project performance analysis very informative and even easier than the traditional Earned Value methods" (Liberzon and Archibald 2003, and Archibald 2003, Appendix pp 362-377). The Russian approach often calculates activity durations based on work quantities or volumes and data bases with extensive resource utilization rates that can be used for range estimates and success probability estimates.

Managing Risk in Programs and Projects

Formal risk management in PM has become a topic of great interest within the past 10 or 15 years. The outcome, schedule, cost, and environmental factors affecting projects are never completely certain, so the challenges are how best to identify and mitigate the areas of greatest risk during the life of any given project. "The goals of risk management, therefore, are to identify project risks and develop strategies which either significantly reduce them or take steps to avoid them altogether. At the same time, steps should be taken to maximize associated opportunities. In essence, it involves planning which minimizes the probability and net effects of things going wrong, and carefully matches responsibility to residual risks which are unavoidably retained. It is a very constructive and creative process" (Wideman, 1992, p I-2).

"Instead of considering uncertainty as a necessary evil, it should be considered as an extremely important, inspiring and useful factor given its inherent opportunities for making improvements and taking measures against risk. In the author's opinion, uncertainty is likely to hold some of the greatest potential for improving management skills and efficiency today" (Lichtenberg 1990, p 21).

Enterprise Resource Planning/ERP Applications and Project Management

ERP applications (offered by SAP, Oracle, PeopleSoft, and others) provide enterprise-wide information about people and other resources that must be well integrated with PM software applications. Linking ERP with the corporate PM planning and control system is probably the most effective way to integrate all projects with other non-project operations (manufacturing/production, sales/marketing/ distribution, field service, corporate staffs, and so on) in project dependent organizations.

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