

# STATE OF THE ART OF PROJECT MANAGEMENT: 2005-2010

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## ABSTRACT

The practice of project management (PM) has evolved over half a century and permeates nearly all industries, institutions and governments throughout the world. This paper conveys a picture of the state of the art in this management discipline in 2005, and provides some predictions of the direction of its continued evolution over the next five years.

Four major subjects are covered:

1. PM Within Organizations
2. PM Applications, Practices, and Tools
3. PM and People
4. PM in the Next Five Years

A global perspective is presented and briefly discussed for several topics under each of these subjects.

## 1. PROJECT MANAGEMENT WITHIN ORGANIZATIONS

Three topics are discussed in this part:

- **Characteristics of PM:** How does PM differ from managing functional organizations?
- **Projects, Programs, and Project Portfolios:** Their classification and management needs.
- **Organizational Capabilities and Maturity in PM:** Assessing and improving PM capabilities.

### *CHARACTERISTICS OF PROJECT MANAGEMENT*

Projects exist in every type of human enterprise. They are unique, complex undertakings that create new products, facilities, services, and events, among other things, bring about major organizational and other desired changes, or recovery from natural or man-made disasters. Projects have starting and ending points in time and progress through a number of life-cycle phases.

The discipline of project management has evolved because the more traditional, well-established industrial age principles and methods for managing our classical functional organizations (involving on-going, repetitive operations of various kinds) do not work well for planning, authorizing, controlling, and managing projects, programs, or project portfolios. Projects are comprised of diverse tasks that require diverse specialist skills, and hence cut across the traditional functional organizational lines. They are temporary endeavors with a finite lifetime and so do not provide stable organizational homes for the people involved. The challenge is to accomplish the right projects at the right time while providing stable homes that develop the diverse skills needed for all the specialists who contribute to the projects.

Key differentiating characteristics of PM when compared to functional organization management are:

- Assignment of **integrative responsibilities** related to each project, program and project portfolio (as defined in the following section):
  - General manager/managing director
  - Portfolio steering groups (or portfolio governance committees)
  - Project and program sponsors (or directors)
  - Manager of project management (or Chief Projects Officer/CPO) (the Project Management Office/PMO)
  - Project and program managers

- Affected functional (specialist) managers and functional project leaders. These responsibilities are fully described in current PM literature (for example see Archibald 2003, pp 82-106 and 201-225.)
- Application of **integrative and predictive practices, methods, systems and tools** for producing and effectively using the information required to plan, schedule, monitor, and control the scope, risks, schedules, resources and costs of projects, programs and project portfolios, integrating their entire life-cycles. Iterative processes are sometimes required, (for software or R&D projects) but these still have a predictive objective for the entire project.
- Building and directing each **project and program team**, comprised of the multi-disciplined functional managers and specialists needed to create, plan, execute, and manage each project and program.

In almost every case the evolution of the PM discipline within a complex organization results in a project/functional matrix of responsibilities that can range from a weak to a strong matrix, referring to the authority of the project and program managers to give project direction to the project team members.

**Managing the Total Project Life Cycle:** The primary (some say the *only*) difference between projects and an ongoing enterprise as something to be managed is that the project has a life-cycle: it starts, is executed, and it ends. More elaborately, a project has a number of life-cycle phases, the simplest definition of which includes *concept, definition, execution, and closeout* phases. (Life-cycle models are discussed in more detail in a later section.) The practice of PM has moved from focusing in the early years on planning and controlling the *execution* of projects to include now the *conceptual* phases, and project portfolio management (discussed later) provides the needed linkage between strategic growth management of the organization and PM. Extension of the project life-cycle beyond the traditional definition of *project completion* to include achieving the desired results from completion of a project is now a reality for some practitioners.

**Achieving the Project Benefits:** In 2005 we see movement toward including within the PM discipline the important post-completion objective of achieving the benefits from completion of the project. Projects frequently require changes in the organization itself in order to gain the benefits from the results of the project. Thus project management often encompasses organizational change brought on by the successful ‘completion’ of a project. This can be considered as a post-completion project phase, perhaps named “project results integration” or “project benefits realization.” If the project has been executed under contract for an external customer, then the primary benefit will be whatever financial profit has been realized under the contract, plus of course the experience gained and the possibility of future business with that customer, or with other customers using the experience gained. For the customer or purchaser of the project it is necessary to integrate the project results (new information system, new office building, new process plant, new product, for example) into the ongoing business operations.

An example of this movement is provided by Fern (1999) in his book *Time-to Profit Project Management*, which emphasizes that the goal of new commercial product development PM is not simply to launch a new product, but to achieve a profit with that product in the marketplace. “Most Chief Executive Officers now want to know when they will get the benefits and the forecast level of benefit, rather than when the project will be complete and at what cost. Processes and systems to answer these questions are still being developed and are far from maturity” (Harpham 2000, p 4). A “business change manager” is sometimes appointed with responsibility for realizing the project benefits.

### **PROJECTS, PROGRAMS, AND PROJECT PORTFOLIOS**

Projects—with different sizes, shapes, degrees of risk and complexity, and widely varying products or results—are the common denominator for project management. Having a practical scheme for categorizing projects would be useful to all organizations for a number of reasons, but a widely accepted project categorization system does not exist at present. Two efforts were conducted in 2003 to develop and test such a scheme (see Archibald and Voropaev 2003, Crawford et al 2002. Table 1 shows the categories and sub-categories that were tested in a 2003 survey (see Archibald and Voropaev 2004 for the results of that survey.)

<b>Project Categories:</b> Each having similar life-cycle phases and a unique project management process	<b>Examples</b>
<b>1. Aerospace/Defense Projects</b> 1.1 Defense systems 1.2 Space 1.3 Military operations	New weapon system; major system upgrade. Satellite development/launch; space station mod. Task force invasion
<b>2. Business &amp; Organization Change Projects</b> 2.1 Acquisition/Merger 2.2 Management process improvement 2.3 New business venture 2.4 Organization re-structuring 2.5 Legal proceeding	Acquire and integrate competing company. Major improvement in project management. Form and launch new company. Consolidate divisions and downsize company. Major litigation case.
<b>3. Communication Systems Projects</b> 3.1 Network communications systems 3.2 Switching communications systems	Microwave communications network. 3 <sup>rd</sup> generation wireless communication system.
<b>4. Event Projects</b> 4.1 International events 4.2 National events	2004 Summer Olympics; 2006 World Cup Match. 2005 U. S. Super Bowl; 2004 Political Conventions.
<b>5. Facilities Projects</b> 5.1 Facility decommissioning 5.2 Facility demolition 5.3 Facility maintenance and modification 5.4 Facility design/procurement/construction Civil Energy Environmental High rise Industrial Commercial Residential Ships	Closure of nuclear power station. Demolition of high rise building. Process plant maintenance turnaround. Conversion of plant for new products/markets. Flood control dam; highway interchange. New gas-fired power generation plant; pipeline. Chemical waste cleanup. 40 story office building. New manufacturing plant. New shopping center; office building. New housing sub-division. New tanker, container, or passenger ship
<b>6. Information Systems (Software) Projects</b>	New project management information system. (Information system hardware is considered to be in the product development category.)
<b>7. International Development Projects</b> 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)	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. <i>Facility Projects</i> 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.
<b>8. Media &amp; Entertainment Projects</b> 8.1 Motion picture 8.2 TV segment 8.2 Live play or music event	New motion picture (film or digital). New TV episode. New opera premiere.
<b>9. Product and Service Development Projects</b> 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)	New desk-top computer. New earth-moving machine. New automobile, new food product. New cholesterol-lowering drug. New life insurance/annuity offering.
<b>10. Research and Development Projects</b> 10.1 Environmental 10.2 Industrial 10.3 Economic development 10.4 Medical 10.5 Scientific	Measure changes in the ozone layer. How to reduce pollutant emission. Determine best crop for sub-Sahara Africa. Test new treatment for breast cancer. Determine the possibility of life on Mars.
<b>11. Other Categories?</b>	

Table 1. Proposed project categories/sub-categories, with each category or subcategory having similar project life cycle phases and one unique process management process [Adapted from Archibald 2003, Fig. 2.3, p. 35].

Projects within these different categories, and often within the sub-categories:

- Typically exhibit or require very different life-cycle models
- Require different planning and control methods, systems, and tools
- Use different terminologies
- Demand different knowledge, skills and experience of the project managers and project team members
- Place differing emphases on the detailed aspects of planning, scheduling, cost estimating, reporting, controlling, executing and closing.

This is becoming recognized more widely today, as indicated by PMI's *Government Extension to a Guide to the Project Management Body of Knowledge/PMBOK® Guide* (October 2002), for projects under government contracts within the U. S., and PMI's *Construction Extension to the PMBOK® Guide* (2003). Current standards projects are in progress by PMI to update these two standards and to create an *Automotive Extension to the PMBOK® Guide*. In addition, new standards for Program/Portfolio Management, Configuration Management, Scheduling, and Work Breakdown Structures are under development by PMI (*PMI Today*, October 2003 Supplement). All PMI standards can be downloaded by members at no cost.

**Software/Information Systems/IS Projects:** To illustrate the wide differences in the results of one project category compared with another, compare a facilities design/procure/construct project with an information system/IS project. The products of IS projects are inherently invisible until they produce displays of the information they handle on computer screens. A skilled, successful IS project manager would likely fail if placed in charge of a power plant design/construction project, and vice versa. Bullock (2003) presents a useful description of "The Top 10 Ways Software Projects are Different."

### **Defining Project Categories and Sub-Categories**

Ten recommended basic project categories are listed in Table 1, plus an eleventh category for all others, oriented primarily to products (results) of the projects. It is recognized that this list is preliminary and incomplete: a 'work in progress.' Projects within each of these ten specific categories are believed to use similar life cycle phases and utilize similar authorizing, planning, budgeting, scheduling, monitoring and controlling procedures and tools throughout their life-cycles.

Subcategories are identified in Table 1 within nine of the basic categories. In most cases there will be differences—in some cases significant—between the project life-cycle management process for the basic category and at least some of its subcategories. Others may wish to add subcategories to those shown in Table 1, or to add additional subcategories to those that are listed. Additional major categories may also be required to assure that all conceivable projects of significance to the international PM community are included. The names and terms used in Table 1 will no doubt undergo extensive changes before a broadly accepted list of categories has been established.

It should be noted that these categories are not mutually exclusive: many projects will include aspects of two or more categories. For example, most communications systems projects include at least the adaptation of information system software. Many facilities projects also include communication systems, and vice versa. In such cases the project probably should be classified in the more dominant category, or—if justified by their size, complexity, or risk—defined as two or more projects (of different categories) within a program, with each project having a different life-cycle definition.

### **Classifying Projects Within Categories and Sub-Categories**

There is a wide range of projects within each project category or sub-category in large organizations. The project management process for each project category must provide the flexibility to choose the proper level of detail for planning and control of large, complex, high-risk, 'new territory' projects compared to smaller or 'old hat' projects. It may be necessary or useful to further classify projects within categories or sub-categories using the following (or other) characteristics:

- Project Size
- Project Complexity
- External or Internal Customer

- Degree of Customer Involvement in the Project
- Levels of Risk in the Projects
- Major and Minor Projects Within a Category
- “Mega” Projects or Programs
- “Stand-Alone” Versus “Create Supporting Infrastructure” Projects:
- “Standard” Versus “Transitional”, or “Development” versus “Deployment” Projects

(See Crawford *et al* 2002, 2004, 2005 for a more detailed discussion of these factors.)

### Multi-Project Programs

Programs are defined as long-term undertakings that include two or more projects that require close coordination (Archibald 2003, p 25). Projects within a program are usually closely related in some way, such as using common resources, having dependency relationships (in which tasks within one project cannot proceed until the results of tasks within a second project have been completed,) or supporting common strategic objectives. Programs may be related to a particular product line, operating division, or geographic area, for example. Projects having a common customer may also be grouped within a program, as another example. A UK definition of the term programme (in the PM arena) is “a set of related projects with a common strategic goal or aim” (Harpham 2002, p 7).

The responsibilities of a program manager are similar to but broader than those of a project manager, since the program manager gives direction to and integrates the efforts of two or more project managers. The program manager role is of longer duration than that of any of his project managers, since the overlapping projects within a program rarely, if ever, start and end at the same time. “Unlike projects, programmes had no distinctive start or end, rather the strategy could be accelerated or slowed down, by introducing new projects, speeding up old existing ones, or slowing up projects, or stopping existing or planned projects respectively (Harpham 2002, p 3).

**Project and Programme Management Within the UK:** The UK’s Office of Government Commerce/OGC has for some years developed and promoted PM concepts for governmental and non-governmental applications. Its publications (available free from [www.ogc.gov.uk](http://www.ogc.gov.uk) ) include:

- *PRINCE2 (Projects IN Controlled Environments):* “a structured method for effective project management (OGC PRINCE2 2002, p iii).
- *Management of Risk/M\_o\_R: Guidance for Practitioners* that “sets out a framework for taking informed decisions about risk at a project, programme and strategic level to assure that key risks are identified, assessed and that action is taken to address them (OGC M\_o\_R 2002, p ix).
- *Managing Successful Programmes/MSP:* “a pragmatic approach that will help organizations deliver and realize the required benefits, innovation, and new ways of working that will take them through the next decade” (OGC MSP 1999, p xi).

Programme management as practiced in the UK and its sphere of influence in Europe and elsewhere is essentially the same as project portfolio management in North America and elsewhere. “Programme management exists to bridge the gap between Corporate Strategy and Projects. It enables that fundamental question to be asked before starting the project – ‘where does it fit into the corporate strategy?’” (Harpham 2002, p 5).

**Role of Program Management:** A fairly recent example of the role of program management within General Motors’ new car model development and launch operations is given by Spina (2003, p 23) as:

- Align organizational resources
- Create single integrated program management organization
- Provide single voice for Program Management with Product Development
- Coordinate major work processes
- Balance process and organizational stability with improved competitiveness.

**Program Management in Governmental Agencies:** Many public agencies use a “planning, programming and budgeting system” that involves a number of high level programs that are really a

hybrid form of program management since they are made up of projects plus on-going “level-of-effort” operating activities.

### Project Portfolios

A major development in the state of the art of project management has been the recognition that projects, like other investments, must be managed on a portfolio basis in most large organizations. Program management is a step in the right direction, but more formalized project portfolio management goes beyond what is usually termed program management. As indicated above, a common understanding and use of the terms program, programme and project portfolio management has not as yet been established on a global basis.

The key differences between portfolio and multiple project management are shown in Table 2.

	<b>Project Portfolio Management</b>	<b>Multiple Project Management</b>
<b>Purpose</b>	Project Selection and Prioritization	Resource Allocation
<b>Focus</b>	Strategic	Tactical
<b>Planning Emphasis</b>	Long & Medium-Term (annual/quarterly)	Short-Term (day-to-day)
<b>Responsibility</b>	Executive/Senior Management	Project/Resource Managers

Table 2. High-Level Comparison of Project Portfolio Management and Multiple Project [or Program] Management (Source: Dye and Pennypacker, 2000).

**Three General Types of Portfolios:** As indicated in Figure 2, a project portfolio consists of the programs and projects supporting a given higher-level strategy. There could be only one overall corporate project portfolio, but it generally makes more sense to define more than one portfolio on a strategic basis in large organizations to reflect product line, geographic or technological divisions of the organization, industry or market. Combe and Githens (1999) identify three general types of project portfolios:

- Value-Creating: Strategic or enterprise projects.
- Operational: Projects that make the organization more efficient and satisfy some fundamental functional work.
- Compliance: “Must-do” projects required to maintain regulatory compliance.

Others have defined other types of project portfolios that reflect the specific organizational and industrial environments that are involved (OGC MSP 2002, Pellegrinelli 1997, Dye and Pennypacker 1999).

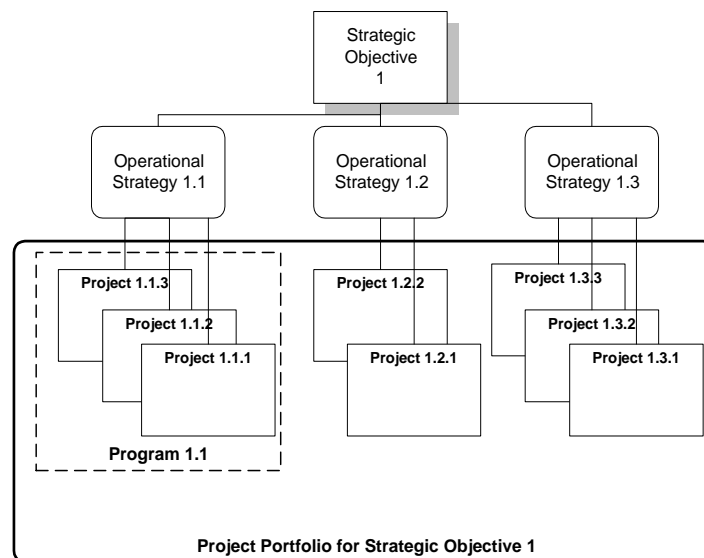


Figure 2. Schematic of Strategies, Projects, a Program and a Project Portfolio (Archibald 2003, p 13).

**Project Portfolio Management Process:** A typical project portfolio management process consists of these 12 steps (not always in this identical sequence):

1. Define the project portfolios required.
2. Define the project categories within each portfolio based on uniform criteria.
3. Identify and group all current and proposed projects within appropriate categories and programs.
4. Validate all projects with the organization's strategic objectives.
5. Prioritize projects within programs and portfolios.
6. Develop the project portfolio master schedule.
7. Establish and maintain a key resources data bank.
8. Allocate available resources to programs and projects within portfolios.
9. Compare financial needs (primarily cash flow) with availability.
10. Decide how to respond to shortfalls in money or other key resources and approve list of funded projects and their priorities.
11. Plan, authorize, and manage each program and project using the organization's PM process and supporting systems and tools for each project category. *This step comprises the entire practice of what has traditionally been thought of as "project management."*
12. Periodically reprioritize, reallocate resources to, and reschedule all programs and projects as required within each portfolio (Archibald 2003, pp 12-14 and 175-177).

In organizations that are mature in their PM capabilities a *Project Portfolio Steering Group* (or *Portfolio Governance Committee*) is responsible for this process and for making the decisions that are involved in its effective use (Archibald 2003 pp 87, 177-179).

### **ORGANIZATIONAL CAPABILITIES AND MATURITY IN PM**

**PM Maturity Models:** "In recent years the use of maturity models has grown in popularity for evaluating where a given organization stands in comparison to its potential and to other organizations in particular areas of management. Improving an organization's project management capabilities generally involves moving up the ladder of whatever maturity model best suits the needs of that organization. Such improvement, however, involves looking at the specific areas of project management and introducing improvements where the greatest payoffs exist, while keeping in mind the total picture of integrated project management principles and practices" (Archibald 2003 p 62). Greater PM maturity is presumed to indicate greater capability for successfully selecting, authorizing, planning, executing, controlling and closing out projects and programs that achieve the strategic goals of the organization.

"Unfortunately, there is no consensus as to the contents of an organizational project management maturity model, or even the principles on which such a standard is constructed. Some 30 existing models serve the market, with more appearing all the time. Books on the subject are now beginning to appear (e. g., Kerzner 2001, Knutson 2001)" (Cooke-Davies et al 2001). Some of these models are listed at <http://www.pmforum.org/prof/matmatrix.htm>.

The basic purposes of all of these maturity models are 1) to assess an organization's current PM capabilities, 2) to educate and train people involved in PM, and 3) to enable continued improvement in organizational and individual PM capabilities.

**PMI's OPM3:** The Project Management Institute/PMI released its Organizational Project Management Maturity Model/OPM3 in December 2003. This elaborate model, developed by a team of 200 some volunteers over a five year period and building on the widely used PMI PMBOK Guide®, consists of four levels (standardizing, measuring, controlling, continuously improving), and relates the five PM process groups identified in the PMI PMBOK Guide® (initiating, planning, controlling, executing, and closing) to each of three levels of application: projects, programs, and project portfolios. OPM3 will include a database with descriptions of best practices, capabilities, outcomes, and key performance indicators of success, and will interrelate these factors and allow user interrogation. It will be available in CD format with a paperback version of the knowledge element of the model (Fahrenkrog et al 2003, *PMI Today Supplement* October 2003). PMI expects that OPM3 will be used to assess and improve the PM capabilities and maturity of many types of organizations, as well as to educate practitioners in currently accepted best practices.

**Maturity Models in the U. K.:** In the United Kingdom the APM Group ([www.apmgroup.co.uk](http://www.apmgroup.co.uk)) accredits and assesses the capabilities of training organizations, trainers, consultants and practitioners and their organizations in various areas of project management, on behalf of the UK government's Office of Government Commerce (OGC) and its PRINCE2 and other project management initiatives. The *OGC Successful Delivery Toolkit* can be downloaded at [www.ogc.gov.uk/sdtoolkit](http://www.ogc.gov.uk/sdtoolkit). This Toolkit includes OGC's Project Management Maturity Model, for which the APM Group has recently developed a Maturity Level Assessment Tool for PM organizations to use in determining their current maturity level. The OGC Maturity Model will soon be augmented to include Programme and Portfolio Management, and the assessment tool will likewise be augmented. Only PM consulting organizations who have been accredited by the APM Group are licensed to use the OGC assessment tools.

**Japanese P2M:** In Japan a major, important initiative is under way: Project and Program Management/P2M (Tanaka 2003, Taketomi 2003), developed by the Engineering Advancement Association of Japan (ENAA) with funds provided by a research grant from the Japanese Government Ministry of Economy, Trade and Industry (METI.) Australian Professor Lynn Crawford has stated "the P2M is potentially the most significant advance towards integration and acceptance of the role of project and program management at the enterprise level. Factors contributing to this significance include development with the support of government, industry and professional associations; expected support and application within enterprises; and being the first guide that develops an approach to enterprise project and program management that starts afresh from the viewpoint of the enterprise rather than drawing on project paradigms developed in the context of large, single, physical projects as the day to day business of project based organizations:

- Directly addresses program management (rather than focusing only on single projects)
- Recognizes and responds to the complexities of fast moving, multi-stakeholder environments
- Recognizes and addresses the systematic nature of projects and programs" (as quoted in Tanaka 2003, p 2.)

P2M is briefly described as "integrated program management.... comprised of six management areas: 1) Profiling management, 2) architecture management, 3) program strategy management, 4) platform management, 5) program life-cycle management, and 6) value assessment management" (Taketomi 2003). To date a maturity model based on P2M has not been developed.

**Brazilian PM Maturity Model:** Darci Prado has developed a practical PM maturity model that has been widely used in Brazil (MMGP© - Modelo de Maturidade em Gerenciamento de Projetos –see <http://www.indg.com.br/projetos/maturidade.asp>, where complete information can be downloaded, in Portuguese, without cost.) Brazil, a country with 180 million people and very advanced high-technology industries, now has 17 PMI chapters located throughout this vast country. Prado is now testing the MMGP© model for a number of specific project categories similar to those shown in Table 1.

**Chief Projects Officer/CPO:** "The next organizational change necessary to enable project management to be fully effective will be to have a CPO managing cross-functional activities and providing the strategic perspectives that every organization needs" (Bigelow 2003). The most appropriate location for the CPO is probably for him or her to be in charge of the Project Management Office/PMO at corporate or operating division levels.

## 2. PROJECT MANAGEMENT APPLICATIONS, PRACTICES AND TOOLS

Three topics are discussed in this section:

- **Areas of Project Management Application:** which industries, organizations, and institutions apply PM practices?
- **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?
- **PM planning and control methods, tools and information systems:** what is the nature and current status of these management tools?



## ***AREAS OF PROJECT MANAGEMENT APPLICATION***

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 165,00 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://pmforum.org/diroforg/index.htm> .)

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 go to <http://www.pmforum.org/practices/sig.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-Driven and Project-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, engineered products, etc.), 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 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.

### **PROJECT LIFE-CYCLE MODELS**

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. 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, 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 [www.agilemanifesto.org](http://www.agilemanifesto.org).

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. <i>Facility Projects</i> 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].

**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.)

### **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:

1. Develop software iteratively
2. Manage requirements
3. Use component-based architectures
4. Visually model software
5. Continuously verify software quality, and
6. Control changes to the software.

Wideman (2002) presents a comprehensive treatise on RUP that can be seen at <http://www.maxwideman.com/papers/acquisition/workflow.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 [www.us.ibm.com](http://www.us.ibm.com) (search the site for RUP.)

### **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:

1. **Document the integrated life-cycle process model:** As discussed earlier.
2. **Document and describe the resulting *Project Life-cycle Management System (PLCMS)*** for each project category within the organization: also discussed earlier.
3. **Re-engineer the integrated process** to apply appropriate re-engineering methods to each category’s PLCMS to:
  - a. Identify system constraints, gaps and weaknesses.
  - b. Identify ‘speed bumps’ that inadvertently slow the process down and potential ‘accelerators’ that can speed it up (Githens 2002).
  - c. Relate the undesirable project results and possible causes to the PLCMS wherever possible.
  - d. Redesign the PLCMS beginning with the most obvious constraints, gaps and weaknesses and document the results.
4. **Implement the Improvements.**
  - a. Obtain needed agreements and conduct appropriate tests or analyses to prove out the validity and feasibility of the proposed system revisions.
  - b. 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.

### ***PM PLANNING AND CONTROL PRACTICES, SYSTEMS, AND 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 was 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 the 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.

### **3. PROJECT MANAGEMENT AND PEOPLE**

This part of this state of the art survey of PM consists of three topics:

- **Individual Capabilities in Project Management:** what is the state of PM education, training, and certification of individual people who specialize in PM?
- **Project Teams:** what is the importance of team work in project management and how is it best achieved?
- **The ‘Profession’ of Project Management:** is this a management discipline or a true profession?

#### ***INDIVIDUAL CAPABILITIES IN PROJECT MANAGEMENT***

**Education and Training in PM:** Today, formalized education and training for individuals in all aspects of project management is widely available in most of the developed countries of the world at doctoral, master’s, bachelor, and even high school levels. “More than 900 organizations (universities, government and non-government agencies, training and consulting companies, and independent consultants—on-line and on-site) in 46 countries participate in the R. E. P. [PMI Registered Education Providers] Program [initiated in 1999], currently offering 4,000 learning activities and training for more than 60,000 students per year” (*PMI Today* August 2003, Supplement). Many additional education and training providers are recognized by the 30 national member organizations of the International Project Management Association/IPMA. Eighteen graduate and undergraduate level PM certification and degree programs that exist today across the U. S. have been identified by one (Curtis 2003, pp 37-39) of the many printed and electronic periodicals devoted to PM.

#### **PMI® Certification Program**

([http://www.pmi.org/info/PDC\\_CertificationsOverview.asp?nav=0401](http://www.pmi.org/info/PDC_CertificationsOverview.asp?nav=0401)): Individual certification in project management is provided by PMI and IPMA and its member associations, as well as by various educational and training institutions. PMI’s certification is presently at two levels: Project Management Professional/PMP®, and Certified Associate in Project Management/CAPM®. The CAPM is designed for project team members and entry-level project managers, as well as qualified undergraduate and graduate students. By June 30 2005 PMI had certified 114,842 PMPs around the world, including 18,522 during the first 6 months of 2005 (*PMI Today* July 2005, p 5). The PMP certification examination is heavily based on the content of PMI’s PMBOK® Guide, which has been translated from English into eight languages (Brazilian Portuguese, French, German, Italian, Japanese, Korean, Mandarin Chinese, and Spanish) and focuses almost entirely on managing a single project, with little reference to multi-project, program, or project portfolio management. (The PMBOK® Guide has also been unofficially translated into Russian and probably other languages.) Although fairly extensive experience is required in order to qualify to take the PMP exam, some critics believe that PMI’s PMP certification is too heavily based on knowledge rather than capability or competence, is not sufficiently application specific, and does not specifically certify project managers per se.

**IPMA Certification Program** (<http://www.pmcert.org/resources/IPMACertYB2004.pdf>): IPMA's approach provides for the four levels of certification shown in Figure 1. These levels are being adapted and administered by the 36 national member associations of IPMA (<http://www.ipma.ch/>) for their countries and in their languages. The 32 page IPMA Certification Yearbook 2004, dated March 2005, can be downloaded from the above address. The main requirements for each level are:

- **Level A: Certificated programme director (CPD)** shall have the ability to direct all projects of a programme or all projects of a company/branch or to manage a complex project with major partners from different international cultures.
- **Level B: Certificated project manager (CPM)** shall be able to manage complex projects him/herself
- **Level C: Registered project management professional (RPMP)** can manage non-complex projects him/herself and assist the manager of a complex project in all fields of project management
- **Level D: Project management Fachman/Fachfrau/practitioner (PMF)** shall have project management knowledge and may be applying it on some fields as a specialist


Level	Title	Capabilities	Certification Process			Validity
			Stage 1	Stage 2	Stage 3	
A	Programme or Projects Director	Competence = knowledge + experience + personal attitude	 <ul style="list-style-type: none"> <li>• Application</li> <li>• CV</li> <li>• Self assessment</li> <li>• References</li> <li>• Project list</li> </ul>	Optional	Interview	3-5 years
B	Project Manager			E.g. Project Report		
C	Project Management Professional			Workshop or seminar		Time limited
D	Project Management Practitioner	Knowledge	PMF	Exam	Project Management Fachmann/Professional	Not time limited

Figure 1. IPMA's Project Management Certification Scheme

### APM (UK) Certification Program

(<http://www.apm.org.uk/page.asp?categoryID=2&subCategoryID=57&pageID=0>): The Association of Project Management/APM, the British member of IPMA, lists 32 accredited training organizations and 15 higher educational institutions in the UK. Its program currently offers three award levels: Certified Project Manager (IPMA Level B,) Practitioner Qualification (IPMA Level C,) and APMP (IPMA Level D.) The APM Group ([www.apmgroup.co.uk](http://www.apmgroup.co.uk)) acting on behalf of the UK OGC, presently accredits trainers (currently 150 worldwide) and training organizations (currently 50 worldwide) in the OGC 'Best Practice' Guides (OGC PRINCE2, MSP and M\_o\_R) for IPMA Level C certification.

**AIPM Certification Program** (<http://www.aipm.com.au>): The Australian Institute of Project Management has a certification system based upon the Australian National Competency Standards for Project Management. It is currently available in Australia and will shortly be available everywhere else. AIPM certifies individuals at three levels: project team member, project manager and program manager, and requires individuals to prepare portfolios of evidence showing performance (that is, "output competence"). A guide to this certification program, "The Registered Project Manager Award Program (RegPM)", can be downloaded at [www.pmforum.org/docs/Regpm.doc](http://www.pmforum.org/docs/Regpm.doc).

**asapm Certification Program:** A recently formed PM association, the American Society for the Advancement of Project Management/asapm ([www.asapm.org](http://www.asapm.org)), has announced a certification program that will be rolled out in phases with the first offering targeted at managers of complex projects and

programs. This new certification program is intended to correct the perceived weaknesses in current PMI certification available in the U. S., (not being application-specific, not assessing competence, or not certifying project managers.) According to asapm what makes their program unique is that it is built upon performance based competency standards rather than knowledge-based ones. The program will ultimately include at least four different certification levels; but the initial offering will be for the “asapm Certified Project Manager (aCPM).” See <http://www.asapm.org/> for more detail.

**U. S. Government PM Certification Initiatives:** In the U.S. a number of federal government agencies have PM certification initiatives under way, including the Department of Defense/DOD and its Defense Acquisition University/DAU, Department of Energy/DOE, and the Office of Management and Budget/OMB (*PMI Today* Aug. 2003 p 1, 5). The most advanced U. S. governmental agency that best represents the state of the art in this aspect of PM appears to be that of the National Aeronautics and Space Administration/NASA, which several years ago established the NASA Academy of Program and Project Leadership/APPL ([www.appl.nasa.gov](http://www.appl.nasa.gov)). NASA APPL has implemented a Project Management Development Process/PMDP that leads to APPL certification of individuals within NASA at four levels of competence:

1. Project Engineer/Team Member: Supports basic project needs....
2. Subsystem Manager: Manages in-house or contractor sub-system for a larger system.
3. System Manager: Manages complex system development of several subsystems to be integrated from parallel efforts (both in-house and contracted) in a team environment.
4. Program Manager: Manages total program/complex project of many subsystems over longer period of time, both in-house and contractor work, possibly international. (Source: The NASA Program/Project Management Development Process flowchart, Feb. 2000.)

This process is based on ten ‘competency categories’ covering many individual competencies, plus a large number of individual ‘knowledges and skills,’ and is supported by 27 internal NASA training courses. All NASA Civil Servant employees are eligible to participate in this development process.

**Licensing of Individual Practitioners in the Project Management “Profession”:** Most legally recognized “professions” around the world have formal, official licensing procedures and practices in place, many required by federal, state, or provincial law (engineering, medicine, law, accounting, and others.) To date no country is known to have established legal licensing requirements for the practice of project management. Although this subject has been discussed in PMI and IAPM forums, a cursory search of the public records of minutes of the PMI Board of Directors meetings indicates no record of any official discussions of this subject within that body. A debate is under way presently in the U. K. about the desirability of obtaining a Royal Charter there for APM, which, if achieved, might be a forerunner to some form of government licensure.

In my opinion, in the U. S. and Canada, and probably also in Western European countries, the most likely scenario for licensing project managers or PM specialists, if it ever occurs, will be connected in some way with registered engineers at the state or province levels, perhaps with some sort of cooperative arrangements between the professional engineering and architectural associations (ASME, AIEE, ASCE, AIA, IEEE, and others in the U.S., and the Engineering Institute in Canada). Such licensing will need to be for very specific types or categories of projects. “The chartered institutions in the UK are undergoing change recognizing the need for an umbrella organization and all engineering institutions there are now also a part of an Engineering Council or EC(UK). Qualified members of the subscribing Institutions may apply for registration and use of the designation CEng (Chartered Engineer) after their name” (Wideman 2003.)

In the absence of governmental or other licensure there is a serious question about the validity of calling the practice of project management a “profession.” This topic is discussed further under “The ‘Profession’ of PM” in a following section of this paper.

## ***PROJECT TEAMS***

Leading practitioners on the front edge of the state of the art in PM today recognize the importance of achieving effective teamwork on each of their projects. The human dimension of PM is now the subject of numerous books and articles and training courses. To have an effective project team,

as distinct from simply a group of people working on loosely related tasks, several conditions are necessary:

- Identification of the project team members and definition of the role and responsibilities of each.
- Clearly stated and understood project objectives.
- An achievable project plan and schedule.
- Reasonable rules (procedures regarding information flow, communication, team meetings, escalation of conflicts, and the like).
- Leadership by the project manager.

If any of these conditions is not present it will be difficult to achieve effective teamwork.

Truly effective teams strive to achieve the project objectives and simultaneously satisfy *all* the major stakeholders in the project. Project stakeholders include all those persons who have a stake (a vested interest, responsibility, or decision power) in the project and its results. Advanced practitioners think about good performance and successful achievement along two dimensions: the hard/soft dimension and the acceptable/excellent dimension. The hard/soft dimension refers to two different kinds of *criteria* of performance, and the acceptable/excellent dimension refers to two different *standards* of performance.

“The hard/soft dimension concerns the tangible and intangible aspects of performance. Hard criteria tend to be measurable, the most frequent being to do with time, cost, resources and technical standards. Soft criteria on the other hand are more subjective and difficult to measure. Yet they are clearly used frequently in evaluating performance. They are more about ‘how’ the task was accomplished, the attitudes, skills and behavior demonstrated by the team and its members.... In setting success criteria ordinary teams tend to concentrate on hard criteria only and ask questions such as, ‘How many, how much and when?’ Superteams do all this too (and mostly more punctiliously) but add another dimension. They also draw out clients' and sponsors' more subtle expectations, those to do with ways of working and the relationships with the client, to attitudes adopted on such things as quality, reliability and attention to detail. These are all factors that are crucial to a client's ultimate satisfaction. Equally these soft criteria are explored, clarified and agreed with the sponsor, and service departments....

“The acceptable/excellent dimension on the other hand concerns standards of performance. And it is around this dimension that the whole Superteam idea was originally crystallized. In a world where the best is no longer good enough, the frontiers of performance are always being stretched. ‘The best can always be bettered’ could almost be the Superteam motto. We find many teams who think that their performance is good, but who in fact are underperforming. They may be averagely good when compared with those other teams they see. Their performance is acceptable but in no way outstanding.... Superteams strive to be different, and achieve just a little bit more than the competition. They are constantly looking for ways to do things better, constantly testing their assumptions about what is achievable and searching for ways to overcome any problems that lie in the path” (Hastings et al 1987 pp 35-37).

To achieve effective teamwork, today’s chief executive officers must demand that:

1. The importance of the project team concept be conveyed to all contributors to every project in the organization.
2. Every project team member understands:
  - a. The project objectives,
  - b. The project plan and schedule, and
  - c. The rules to be followed in the project management life-cycle process, including issue and conflict escalation procedures.
3. Every project manager receives adequate leadership, conflict resolution, and commitment building training (Archibald 2003, p 144).

### ***THE ‘PROFESSION’ OF PROJECT MANAGEMENT***

There is continuing discussion within the PM community of practitioners, consultants, teachers, trainers, authors, researchers, editors, publishers, software vendors, and the associations that have taken charge of the several PM bodies of knowledge, certification, accreditation, standards development, ethics,

and PM maturity model development and application, regarding whether or not PM is or will ever be a true 'profession.'

David Pells has said "Contrary to 'PM as a Profession', I have recently come to the conclusion that project management must now be understood and promoted as a 'core competency for every executive in every organization'. The direction our 'profession' must now take, in my opinion, is to show that the benefits of professional PM are so profound and wide spread that they should be embraced by every professional, every executive and every organization. Management by projects is no longer a choice but a practical reality in a competitive world. Enterprise PM and Portfolio PM are simply steps toward a more mature and more profitable enterprise. To survive and/or to prosper, every executive must understand how to organize, plan and complete projects. These opinions are based on my research and thinking during the development of two recent papers (for Russia/IPMA in June and the IPMI in Ireland) on the subject of how 'modern project management makes money' for professionals, project managers, program managers, CEOs and organizations. It is the bottom line and, in my opinion, overwhelming logic" (Pells 2003).

David Curling has expressed a similar opinion, recently saying that "I wrote on the 'Globalization of the Project Management Profession' and presented the paper to PMI in Chicago [in 1998] and to some local PM organizations. Most were horrified when I declared that PM was not a profession but a business discipline and I had some difficulty in seeing that it would ever become a profession. That is, I felt that project management was simply a sub set of general management and there was little probability of 'General Management' becoming a 'legally based profession'" (Curling 2003).

Roberto Morales (2003), Dean of the National University of Engineering in Peru, captured the essence of this current thinking when he recently stated that "Project management is a way of life for all professionals."

#### **4. PROJECT MANAGEMENT IN THE NEXT FIVE YEARS**

This discussion has attempted to present an understanding of what is happening on the various frontiers of PM around the world, and to give the reader readily accessible references (via the Internet wherever possible) to further detail on each topic. It is certain that there are pertinent topics that have not been covered, either in the interest of brevity or the lack of awareness by the author, who will greatly appreciate having these omissions brought to his attention at <[russell\\_archibald@yahoo.com](mailto:russell_archibald@yahoo.com)>.

The discussion of each of these major topics hopefully conveys a reasonable picture of where we stand today in relation to each of these dimensions of PM. Here are a few conclusions and cautious predictions about where the discipline of PM will be in the year 2008.

#### **Characteristics of Project Management**

The described basic characteristics of PM have not changed appreciably in the past 10 years and are not expected to change much within the foreseeable future.

#### **Major Project Management Trends**

Three major PM trends are observed that will continue:

1. Linking strategic and project management through project portfolio management practices.
2. Broadening the application of PM to include the total project life-cycle, from concept through to full realization of project benefits.
3. Continued discovery of new application areas for the PM discipline.

#### **Organization Capabilities and Maturity in PM**

Rather than continue to be developed as a separate specialty within organizational management disciplines, the principles and practices of PM will gradually merge with other areas of management and be an important part of every manager's responsibilities, much like financial management is today: Chief Financial Officers/CFOs set the financial policies and practices of an organization, but every manager has and uses a reasonable amount of financial management skills and expertise. There are numerous financial specialists, including licensed CPA's or their equivalents, who work throughout large organizations within the established policies and procedures. Within the next five years, project-driven and project

dependent organizations will similarly have Chief PM Officers/CPMOs who will set the PM policies and practices of the organization, and every manager will hold and apply a reasonable amount of PM skills and expertise. PM specialists, many “certified” but none “licensed,” will similarly support the PM policies and procedures throughout these organizations.

### **PM Maturity Models**

There will be at least three major models competing in the global marketplace: PMI’s OPM3, Japan’s P2M, and outgrowths from the UK’s OGC PRINCE2 approach. Adaptations of these, as well as new models, will emerge within specific areas of application. Translations of the basic models and their area-specific adaptations into the eight or ten major languages will also appear.

### **Individual Capabilities in PM**

- Certification of individuals in PM will be:
  - Much more heavily based on proven capabilities
  - Almost entirely focused on specific areas of application and/or specific categories of projects
  - Awarded at several levels: Program manager, project manager, and several project specialist categories (cost, estimating, scheduling, risk, and others)
- Demonstrated knowledge of and capabilities in PM, but not necessarily PM certification, will be a prerequisite for advancement to almost all senior management positions by within all project driven organizations, and within many project dependent organizations as well.
- Governmental licensing of PM practitioners will not exist.

The author of this present paper agrees with David Pells, who has said “While I believe that PM should be embraced and used by all executives and organizations, it will also be a ‘career path’ for many individuals and certainly in very projectized industries such as construction, energy, petrochemicals, aerospace, defense and other engineering-based endeavors. Membership in PM professional societies will be a requirement for those actively involved in PM, but also useful as sources of education and information for the much broader set of professionals and executives who must understand PM but who may not be managing projects themselves. In addition, PM should also be recognized as a great training and proving ground for future CEOs because of the broad range of functional and stakeholder issues that a PM on any large or mission-critical project must cover” (Pells 2003).

### **Projects, Programs, and Project Portfolios**

- Project portfolio management will be in widespread use
- A global project classification system based on the characteristics of project results will be accepted by the major PM associations and used by most practitioners
- The characteristics of projects and programs within specific project categories of the classification system will be the subject of intensified research.
- PM certification programs will be offered in consonance with this project classification system.

### **Project Life-cycle Models**

- Catalogs of project life-cycle models related to the project classification system will be available for adaptation and use by practitioners to fit their project categories and environments
- Most projects will be managed on a total life-cycle basis
- The post project phase of “realization of project benefits” will become increasingly recognized as a proper part of the total project life-cycle.

## **Areas of Application of PM**

Within the next five years formalized PM will be in use in essentially all areas of human endeavor.

## **PM Planning and Control Systems and Tools**

- PM software and the information it produces will be fully integrated with all corporate information systems
- PM software will be further specialized to fit the project classification system and the catalogs of project life-cycle models
- Web enabled PM software will be used by all but the smallest enterprises
- Wireless handheld, notebook, and desk top computers will be used by most project teams for planning and control purposes, accessing the complex PM applications that will reside on centralized servers
- The PM software industry will enter its mature phase and we will witness the classic consolidation of a mature technology or industry.

## **Project Teams**

- Virtual project teams will meet regularly via video conferencing on most projects
- The majority of project managers will understand the importance of, and be proficient in, team building and team leadership.

## **The ‘Profession’ of PM**

- Many people within the PM community will still be referring to the ‘profession’ of PM, however there will not be any U. S. state or Canadian province that has an official licensing statute for PM practitioners, program or project managers, educators, consultants, trainers, or software vendors.
- PM disciplines and practices will be widely known and used by managers at many levels in essentially all industries and human agencies in the developed world.

## **Variations in the Status and Applicability of PM Around the World**

While some relatively minor differences will remain in the status of PM between different geographic regions and countries in the developed world, more significant differences will continue to exist between developed and newly developed countries on one hand and less developed countries on the other. For example, in Sub-Saharan African countries, excluding of course South Africa, “implementation of modern PM...is directly tied to projects financed or implemented for organizations from fully developed economies [such as The World Bank or multi-national corporations]. This might lead to some questions (in the future) related to how much the spread of modern PM is also tied to economic and political freedoms within society – where individuals are free and motivated to seek out best practices in other organizations, societies or locations” (Pells 2003).

“This paper has argued that project management concepts are not universally valid because (1) they are based on certain assumptions about what governs human behaviour (e.g. economic rationality) and (2) these assumptions are not valid in some cultures (e.g. values at work and in social settings differing across cultures)” (Muriithi and Crawford 2003).

By 2008 PM is not expected to have permeated the economies of a number of African and perhaps other developing countries to a major extent.

**NOTE:** See related slide presentation October 19, 2005, for further predictions on PM in the year 2010.

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## References

Archibald, Russell D., "A Global System for Categorizing Projects: The Need for, Recommended Approach to, and Practical Uses of the System," 2<sup>nd</sup> Latin American Forum – PM in Government, Brasilia, Brazil, 21-22 September, 2004. This paper can be downloaded at [www.russarchibald.com](http://www.russarchibald.com) .

Archibald, Russell D., and Vladimir I. Voropaev, "Project Categories and Life-cycle Models: Report on the 2003 IPMA Global Survey," *Proceedings of the 18<sup>th</sup> IPMA World Congress on Project Management*, 18-21 June 2004, Budapest, Hungary. This paper can be downloaded at [www.russarchibald.com](http://www.russarchibald.com) .

Archibald, Russell D., and Vladimir I. Voropaev, "Commonalities and Differences in Project Management Around the World – A Survey of Project Categories and Life-cycle Models." *Proceedings of the 17<sup>th</sup> IPMA World Congress on Project Management*, 4-6 June 2003, Moscow, Russia. [www.pmccongress.ru](http://www.pmccongress.ru) . This paper can be downloaded at [www.russarchibald.com](http://www.russarchibald.com) .

Archibald, Russell D., *Managing High-Technology Programs and Projects*. New York: John Wiley & Sons, 2003.

Belanger, Thomas C., "Choosing a Project Life Cycle," *Field Guide to Project Management*, pp 61-73. David I. Cleland, Ed. New York: Wiley. 1998.

Bigelow, Deborah, "Does Your Organization Have a CPO?," *PMNetwork* October 2003, p 20. Newtown Square, PA: Project Management Institute.

Bullock, James, "The Top 10 Ways Software Projects are Different." [http://www.pmforum.org/library/papers/2003/Software\\_Is\\_Different\\_MaxComments.pdf](http://www.pmforum.org/library/papers/2003/Software_Is_Different_MaxComments.pdf) .

Collaborative Strategies LLC, "Executive Summary-Distributed Project Management: A Marketplace and Software Vendor Analysis," 2000; and Executive Summary-Distributed Project Management: Update 2001."

Combe, Margaret W., and Gregory D. Githens, "Managing Popcorn Priorities: How Portfolios and Programs Align Projects With Strategies." *Proceedings of the PMI 1999 Seminars and Symposium*, Philadelphia, PA. Newtown Square, PA: Project Management Institute, October 10-16, 1999.

Cooke-Davies, Terry, John Schlichter, and Christophe Bredillet, "Beyond the *PMBOK® Guide*," *Proceedings of the PMI 2001 Seminars & Symposium*, Nashville, TN, November 1-10, 2001. Newtown Square, PA: Project Management Institute.

Cooper, Robert G., and Elko J. Kleinschmidt, "Stage-Gate Systems for New Product Success," *Marketing Management*. I (4), 20-29. 1993. See [www.prod-dev.com](http://www.prod-dev.com) .

Crawford, Lynn, J. Brian Hobbs, and J. Rodney Turner, "Matching People, Projects, Processes, and Organizations," *Proceedings of the Project Management Institute Annual Seminars & Symposium*, Oct. 3-10, 2002. San Antonio, Texas, USA. Newtown Square, PA: Project Management Institute.

Crawford, Lynn, J. Brian Hobbs, and J. Rodney Turner, *Project Categorization Systems: Aligning Capability With Strategy for Better Results*. 2005. Newtown Square, PA: Project Management Institute.

Curling, David H., private communication to Russell Archibald, 2003. Used with permission. See his 1998 paper "Globalization of the Project Management Profession," presented at the PMI Seminars Symposium 1998, Toronto, Canada. David Curling, CPM, was a Fellow in PMI and APM, and a registered professional engineer in Canada. He was the creator and webmaster for the Project Management Forum ([www.pmforum.org](http://www.pmforum.org) ), one of the most widely read web sites devoted to PM. David died in 2005.

Curtis, Catherine, "Feed Your Mind," pp 35-41, *Projects@Work*, July/August 2003. Waltham, MA: IIR Exhibitions, Inc.

Desaulniers, Douglas H., and Robert J. and Anderson, "Matching Software Development Life Cycles to the Project Environment," *Proceedings of the Project Management Institute Annual Seminars & Symposium*, Nov. 1-10, 2001. Nashville, TN. Newtown Square, PA: Project Management Institute.

Dye, Lowell D., and James S. Pennypacker, "Project Portfolio Managing and Managing Multiple Projects: Two Sides of the Same Coin?" *Proceedings of the 2000 PMI Seminars & Symposium*. Newtown Square, PA: Project Management Institute.

Dye, Lowell D., and James S. Pennypacker, Eds, *Project Portfolio Management – Selecting and Prioritizing Projects for Competitive Advantage*. 316 W. Barnard St., West Chester, PA: Center for Business Practices. 1999

Eskelin, Allen, "Managing Technical Acquisition Project Life Cycles," *PM Network*, March 2002. Newtown Square, PA: Project Management Institute.

Fahrenkrog, Steve, Paul R. Wesman, and Ade Lewankowski, "Project Management Institute's Organizational Maturity Model (OPM3)." *Proceedings of the 17<sup>th</sup> IPMA World Congress on Project Management*, 4-6 June 2003, Moscow, Russia.

Fern, Edward J., *Time-To-Profit Project Management*. 1999. Mission Viejo, CA: Time-To-Profit, Inc. [www.time-to-profit.com](http://www.time-to-profit.com) .

Fleming, Quentin W., and Joel M. Koppelman, *Earned Value Project Management*, 2nd Ed. Newtown Square, PA: Project Management Institute. 2000.

Foti, Ross, "Rise of Restoration," *PMNetwork*, October 2003, pp 28-34. Newtown Square, PA: Project Management Institute.

Githens, Gregory, "Using the Speedbumps Technique to Foster Agility," *Proceedings of the PMI 2002 Seminars & Symposium*. Newtown Square, PA: Project Management Institute.

Goldratt, E. M., *What Is This Thing Called Theory of Constraints, and How Should It Be Implemented?* Croton-on-Hudson, NY: ASQC Quality Press, 1997.

Harpham, Alan, "Successful Programme Management or Managing Successful Programmes," 16<sup>th</sup> IPMA World Congress, Berlin. June, 2002. Contact: [alan@harpham.com](mailto:alan@harpham.com) .Alan Harpham is Chairman, The APM Group [www.apmgroup.co.uk](http://www.apmgroup.co.uk) ; Director, shareholder and an active consultant with **P<sup>5</sup> the Power of Projects**; and former Director of the MSc in Project Management at Cranfield University, UK.

Hastings, Colin, Peter Bixby, and Rani Chaudhray-Lawton. *The Superteam Solution*. San Diego: University Associates, 1987.

Kerzner, Harold, *Strategic Planning for Project Management Using a Project Management Maturity Model*. New York: John Wiley & Sons, 2001.

Kezsbom, Deborah S., and Katherine A. Edward, *The New Dynamic Project Management—Winning Through Competitive Advantage*. New York: Wiley-Interscience. 2001.

Knutson, Joan. 2001. *Succeeding in Project-Driven Organizations: People, Processes and Politics*. New York: John Wiley & Sons.

Leach, Lawrence P., *Critical Chain Project Management*. Norwood, MA, USA: Artech House, Inc., 2000. [www.artechhouse.com](http://www.artechhouse.com) .

Liberzon, Vladimir, "Resource Critical Path Approach to Project Schedule Management," 4<sup>th</sup> PMI Europe Conference Proceedings, London, UK, 6-7 June 2001. Newtown Square, PA: Project Management Institute.

Liberzon, Vladimir, and Russell D. Archibald, "From Russia With Love: Truly Integrated Project Scope, Schedule, Resource and Risk Information," *Proceedings of the 2003 PMI World Congress – Europe*, The Hague, Netherlands. Newtown Square, PA: Project Management Institute.

Lewin, Marsha D., *Better Software Project Management—A Primer for Success*. New York: Wiley. 2002.

Lichtenberg, Steen, *Proactive Management of Uncertainty Using the Successive Principle—A practical way to manage opportunities and risk*. Lyngby, Denmark: Polyteknisk Press, 2000. Contact: [www.polyteknisk.dk](http://www.polyteknisk.dk).

Morales, Roberto, Opening Remarks at the 2<sup>nd</sup> PMI-UNI National Congress on Project Management, Lima, Peru, 24-25 October, 2003.

Morris, Peter W. G., *The Management of Projects*. London: Thomas Telford. 1994.

Muench, Dean, et al. 1994. *The Sybase Development Framework*. Oakland, CA: Sybase, Inc.

Muriithi, Ndiritu, and Lynn Crawford, "Approaches to project management in Africa: Implications for international development projects," *International Journal of Project Management*, V 21, No. 5, July 2003, 309-319.

Murphy, Patrice L., "Pharmaceutical Project Management: Is It Different?," *Project Management Journal*, September 1989. Newtown Square, PA: Project Management Institute.

NASA 2002, "The PBMA Life Cycle and Assurance Knowledge Management System (KMS)"; <http://pbma.hq.nasa.gov/index2.html>

OGC *Management of Risk/M\_o\_R: Guidance for Practitioners*. 2002. London: The Stationery Office. [www.ogc.gov.uk](http://www.ogc.gov.uk).

OGC *Managing Successful Projects/MSP*. 1999. London: The Stationary Office. [www.ogc.gov.uk](http://www.ogc.gov.uk).

OGC *Managing Successful Projects with PRINCE2*. 2002. London: The Stationery Office. [www.ogc.gov.uk](http://www.ogc.gov.uk).

Patterson, Dan, 2002, "The Necessity of a Collaboration Tool in Today's Projects—A Welcom White Paper," available at [www.welcom.com](http://www.welcom.com).

Pellegrinelli, Sergio, "Programme Management: Organising Project-Based Change," *International Journal of Project Management*. Vol 15, No. 3, pp 141-149. 1997. International Project Management Association. [www.elsevier.com/locate/ijproman](http://www.elsevier.com/locate/ijproman).

Pells, David L., "Licensing in the PM Profession," private communication to Russell Archibald, David Curling, and Max Wideman, October 10, 2003. Used with permission. David Pells, PMP, [pells@sbcglobal.net](mailto:pells@sbcglobal.net) is a PMI Fellow and former member of the Board of Directors of PMI. He is also active in IPMA, and began the Global PM Forum ([www.pmforum.org/globalpm/globpmndx.htm](http://www.pmforum.org/globalpm/globpmndx.htm)) initiative that once or twice each year brings together members of the total spectrum of the PM community from around the world.

Piney, Crispin (Kik), "Critical Path or Critical Chain—Combining the Best of Both," *PM Network*, December 2000, pp 51-54. Newtown Square, PA: Project Management Institute.

*PMI Corporate Council Update*, March 2003. Newtown Square, PA: Project Management Institute. [www.pmi.org/prod/groups/documents/info/GMC\\_CCUpdte.asp](http://www.pmi.org/prod/groups/documents/info/GMC_CCUpdte.asp)

*PMI PMNetwork*, August 2003, "Critical Path to Critical Chain Marks Positive Move for Navy." Newtown Square, PA: Project Management Institute.

*PMI® Project Management Software Survey*. Newtown Square, PA: Project Management Institute. 1999.

*PMI Today*, August 2003. Newtown Square, PA: Project Management Institute.

*PMI Today*, October 2003. Newtown Square, PA: Project Management Institute.

Spina, Rick, "How GM Speeds to Market." *PMNetwork*, October 2003, p 23. Newtown Square, PA: Project Management Institute.

Taketomi, Tametsugu, "Reshaping Japanese Enterprise Through P2M." *Proceedings of the 17<sup>th</sup> IPMA World Congress on Project Management*, 4-6 June 2003, Moscow, Russia. <http://www.sovnet.ru/english/index.htm>

Tanaka, Hiroshi, "Projectized Organizations in the Century of Changes and Challenges," *Proceedings of the 17<sup>th</sup> IPMA World Congress on Project Management*, 4-6 June 2003, Moscow, Russia. <http://www.sovnet.ru/english/index.htm>

Thamhain, Hans J., "Accelerating Product Developments via Phase-Gate Processes," *Proceedings of the Project Management Institute Annual Seminars & Symposium*, Sept. 7-16, 2000. Houston, TX. Newtown Square, PA: Project Management Institute.

Timmons, John, "Web-Enabled Project Management—Your Ticket to Success," *Proceedings of the Project Management Institute Seminars & Symposium*, September 7-16, 2000, Houston, Texas. Newtown Square, PA: Project Management Institute. 2000.

U. S. DOD Department of Defense Instruction 5000.2 (Final Coordination Draft, April, 2000.) Washington DC: U. S. Government Printing Office.

Whitten, Neal, *Managing Software Development Projects*. New York: Wiley. 1995.

Wideman, R. Max, private communication to Russell Archibald, October 10, 2003. Used with permission. Max Wideman, PMI Fellow, was Chairman of PMI in the 1980s, is a Fellow in the Engineering Institute of Canada and in the UK Institute of Civil Engineers, and a member of the UK Institute of Engineers. His web site at [www.maxwideman.com](http://www.maxwideman.com) is one of the most heavily visited PM sites on the Internet.

Wideman, R. Max, "Progressive Acquisition and the RUP Part I: Defining the Problem and Common Terminology," December 2002, and see also Parts II through V. [http://www.therationaledge.com/content/dec\\_02/m\\_progressiveAcqRUP\\_mw.jsp](http://www.therationaledge.com/content/dec_02/m_progressiveAcqRUP_mw.jsp) See also [www.maxwideman.com](http://www.maxwideman.com).

Wideman, R. Max, Editor, *Project and Program Risk Management – A Guide to Managing Project Risks and Opportunities*. Newtown Square, PA: Project Management Institute. 2000. 1992.

World Bank Institute, Knowledge Products and Outreach Division, *Managing the Implementation of Development Projects, A Resource Kit on CD-ROM for Instructors and Practitioners*. 2002. The World Bank, Room J-2-105, Washington, D.C., 20433 USA. Contact John Didier at [Jdidier@worldbank.org](mailto:Jdidier@worldbank.org).

Youker, Robert, "The Difference Between Different Types of Projects," *Proceedings of the PMI 1999 Seminars & Symposium* Philadelphia, PA, Oct. 10-16, 1999. Newtown, PA: Project Management Institute.