Linking the Comprehensive Six-Phase Project Life Cycle Model and Project Team Cognitive Readiness with the TCM Framework[1]

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ABSTRACT

This paper describes and justifies how the comprehensive six-phase project life cycle model plus the concepts of project team cognitive readiness are linked to the TCM Framework through holistic management and systems thinking. This project life cycle model recognizes that there is always a **Project Incubation/Feasibility Phase** prior to the currently existing Project Starting Phase of most project management standards, and also that there must be an additional **Post-Project Evaluation Phase** after the current standard Project Close-out Phase. These phases are defined and discussed for two basic types of projects: 1) delivery or commercial projects and 2) innovative, transformational projects.

It is recommended that this Comprehensive Project Life Cycle Model be adopted as the standard for important projects. The Project Incubation/Feasibility Phase provides the opportunity to introduce the TCM Framework properly as an integrated component of the project management methodologies to be used throughout the project life cycle. Regarding the Post-Project Evaluation Phase the need to differentiate between 'project success' and 'project value' is discussed. This new phase is also consistent with TCM practices and enables effective project evaluation from the total cost engineering viewpoint. Finally, the concept of Project Team Cognitive Readiness, applying recently acquired knowledge from cognitive psychology of human behavior in teams, is described briefly and related to potential improvements in effectively using TCM processes.

This paper contains original recognition of the need for improvements in project management standards and best practices, as indicated by the final recommendations and conclusions, which are:

Recommendations

Adopt as a Standard the Six-Phase Comprehensive Project Life Cycle to Include the Incubation/Feasibility and the Post-Project Evaluation Phases: Adoption of this comprehensive project life cycle will bring the standard up to widely used best practices that are described in this paper.

Revise the AACE International TCM Framework to Recognize the Comprehensive Six-Phase Project Life Cycle: Such revision will link the TCM Framework more closely with current best practices in project, program, and portfolio management.

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Conclusions

Project Management Principles and Practices Provide Benefits When Used Throughout the Strategic Asset Management Processes in the TCM Framework: These principles and practices are equally beneficial when applied throughout the entire TCM Framework, and not just during the project planning and execution phases.

More Research is Required to Develop and Apply Project Team Cognitive Readiness to all Important Projects: All projects are planned and executed by people, but the discipline of project, program, and portfolio management has neglected to capitalize on the advances of the cognitive sciences to achieve high-performance teamwork on projects.

Keywords: project management, systems thinking, project life cycle, total cost, TCM, team cognitive readiness.

1 SYSTEMATIC AND HOLISTIC MANAGEMENT APPROACH

A company that wants to compete in the international market knows the importance of adopting a Business Process Management (BPM) model as a systematic and holistic management approach based on systems thinking (Senge 1990, Gharajedaghi 1999.) The BPM Model is the set of activities needed to define, optimize, monitor and integrate business processes in order to create the desired outcome for each stakeholder. In addition to driving a company's on-going operations, Business Process Management (Table 1, List 1), which includes the concept of Business Performance Management, also drives its projects and programs, integrated with the company's multi-project portfolios (see Table 1, list 2.)

Table 1. Illustrative List of Business Process and Project/Program/Portfolio Digital Management Systems

1. Some Business Process Management Systems

- IBM WebSphere Business Modeler: http://www-01.ibm.com/software/integration/webphere-business-modeler/advanced/features/
- IBM Rational Process Library: http://www-01.ibm.com/software/awdtools/rmc/library/
- Oracle Business Process Management Suite: http://www.oracle.com/us/technologies/bpm/029418.pdf
- SAP Business Suite: http://www.sap.com/lines-of-business/finance/business-suite-apps/index.epx
- JBoss jBPM: http://www.jboss.org/jbpm/
- WSO2 BPS: http://wso2.com/products/business-process-server/
- Bonita BPM: http://www.bonitasoft.com/products/bonita-open-solution-open-source-bpm
- Intalio BPM**:** http://bpms.intalio.com/product

2. Some Project/Program/Portfolio Management Systems

- Spider Project: http://www.spiderproject.com/
- Advanced Management Solutions Realtime Enterprise: http://www.amsusa.com/company/intro.htm
- CA Technologies: http://www.ca.com/us/project-portfolio-management.aspx
- Compuware Changepoint: http://www.compuware.com/business-portfolio-management/
- Dekker, Ltd: Decker Trakker: http://www.dekkerltd.com/trakker.aspx
- Planview Enterprise Portfolio Management: http://www.planview.com/
- HP Project and Portfolio Management Center: http://www8.hp.com/us/en/software-solutions/software.html?compURI=1171920#tab=TAB1
- Microsoft: MS Project and Project Server: www.microsoft.com
- Oracle Primavera P6 Enterprise Project Portfolio Management: http://www.oracle.com/us/products/applications/042373.htm
- SAP Portfolio and Project Management: http://www.sap.com/index.epx

This approach achieves high performance that is characterized by new success criteria, where project management metrics are based on performance indices as shown by a matrix between KPIs and CSFs:

- ***Key Performance Indicators (KPIs)*** *are commonly used by an organization to evaluate its success or the success of a particular activity in which it is engaged.*

- ***Critical success factor (CSF)*** *is the term for an element that is necessary for an organization or project to achieve its mission successfully, and for ensuring the success of a company. Critical success factors are those few things that must go well to ensure success for a manager or an organization, and therefore they represent those managerial or enterprise areas that must be given special and continual attention to bring about high performance.*

In achieving improved success in project, program, and portfolio management there are two desirable goals:

- A new way to define more broadly and manage more comprehensively the Project Life Cycles for both the transformational and the delivery projects and programs within an enterprise; and
- The proper and effective use of Information Technology (IT) with Business Process Management (BPM) plus Project, Program and Portfolio Management (PPPM.)

1.1 Use of Information Technology (IT): In order to implement the powerful and widely used Business Process Modelling software systems and the business software systems for managing projects, programs, and their portfolios, we must have integrated information models of those projects and programs. Examples of these software systems (applications) are listed in Appendix A. In fact, these powerful systems are the enablers that make it possible to gain the insights of systems thinking in improving all management processes, procedures, and practices. The greatest challenge in this regard today is to properly integrate project management software with corporate and operations management software within a large organization. The full benefits from application of these powerful information systems can only be achieved through development of fully integrated project life cycle models that are described in this paper.

1.2 Project versus Product Life Cycle Management and Models: Since a project ends when its final results (or products) have been delivered to the owner, investor, marketer, or user in accordance with the project contract or internal project charter, the standard project life cycle comes to an end when the project close-out phase is complete. The *product life cycle* begins at the moment the product begins to be used, sold or placed in operation, thus producing the benefits that justified the project in the first place. There may be some overlap between the standard project close-out phase and the initiation of the product usage and thus its product life cycle. For consumer products the product life cycle typically has five phases: introduction, growth, maturity, decline, and termination. There may of course be product improvements (new projects) to extend the product life. If the project produces a new facility, such as a petrochemical processing plant, the product life cycle will consist of these phases: commissioning (usually also an overlapping phase with the project that produced the plant), operation (with periodic maintenance and modification projects interrupting productive operation), decommissioning, and demolition (including any ecological clean up.) For an IT software project that produces an information system, the product life cycle phases will include commissioning (placing the system in full operation), operation, and decommissioning (usually replaced by a new system.) When agile project management methods are in use, there will often be a long period of continuous improvement as new features are added or unforeseen deficiencies are corrected during the project execution phase. In these cases it may be difficult to know when the original project scope has been achieved and to identify exactly when the project has been closed out and the system (product) operation phase begins.

1.3 Significant versus Small or Trivial Projects: This paper focuses on *significant* projects within human organizations. Of course there are many small, simple, relatively unimportant projects (perhaps fairly informal 'task forces') that exist in any organization, and they can usually be managed without the application of the ideas presented here. Determining whether or not a specific project is 'significant' enough to require application of these ideas must be accomplished

by the responsible managers within each organization. Any project that is considered to be strategically transformative will be significant regardless of its size in terms of cost or number of people involved.

1.4 The Importance of Project Life Cycle Models: All projects consist of a number of different phases that form the life cycle (or life span) of each project. In the early years of the development of modern project management practices it was common to see each phase of a project being planned, scheduled, and managed as a separate project, from start to finish of each phase. Frequently a new project manager would take over as the next phase was started. This usually resulted in many un-resolved design or other conflicts being swept forward into the next phase, especially in design/construction/field operation projects, as well as in IT projects. The field project manager of a new process plant, for example, had to solve the problems during that construction phase that should have been solved during the design phase. The cost of operating the plant was often increased because the designers and constructors took short-cuts to reduce their costs and increase their profits, but these short-cuts increased the cost of operating and maintaining the plant.

As the project management discipline matured it was recognized that overlapping these phases when practical will save a considerable amount of time and money, and assuring that one project manager maintains responsibility for the entire project life cycle forced the resolution of conflicts as early as possible in the project life cycle. This led to 'fast-tracking' in the engineering-procurement-construction categories of projects, as well as in many other project categories. As the power of business process and project management information systems grew over recent decades, building on the rapid advances of computer supported systems and information technology in general, the power and benefits of documenting and integrating all of the project life cycle phases became more evident and more important. This led to the development and use today of a number of project life cycle process models consisting of a number of phases or stages and related decision points for the many different project categories and sub-categories that exist (Archibald, 2003, pp 45-46.) The models within each category and sub-category show similarities but in most cases there are significant differences from one category/sub-category to the next. To be sure, the simplest four-phase life cycle model (starting or concept, organizing or definition, execution, and closeout) will be the same for all categories (PMI 2008, p 16.) But such a simple model is of little practical value in actually planning, authorizing, scheduling, and controlling any complex project.

1.5 Purposes of Project Life Cycle Process Models: The purposes of designing and documenting the overall project life cycle process for any project or project category (Archibald 2007) are to:

- Enable all persons concerned with creating, planning and executing projects to understand the processes to be followed throughout the life of the project.
- Capture and document the best experiences within the organization so that the processes within each project phase can be improved continually and applied on future similar 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; this includes most importantly assigning qualified persons to the roles of Project Executive Sponsor and Project Manager at the proper points in the project life cycle phases, as discussed later in this paper.
- Enable the effective application of project management software application packages that are integrated with all appropriate corporate information systems.

In other words a well-documented project life cycle model enables us to apply **systems thinking** to creating, planning, scheduling, and managing the project through all of its phases, and to evaluating both the success and the value of both the project and the results that the project has produced. This is of greatest benefit to the project owner, key stakeholders, the ultimate user of the project results, and the social beneficiaries of those results -- whether it is a new process plant, a highway, a new business process or system, or a new product. It will not be of similar interest to a project manager or an organization that only holds responsibility for one phase, or one aspect of one phase, of the entire project. Unless a well-documented, integrated, understandable picture of the overall life cycle process – the model -- for each project category/sub-category exists and is properly used, it will be difficult to achieve the full benefits of modern, systematic project management.

1.6 Life Cycle Phases and Decision Points: There is generally held understanding (PMIa 2008 p 16) that the four broad, generic project phases are as shown in Figure 1:

- Starting the project (concept, authorization, initiation, identification, selection, project charter and business case, planning, scheduling.)
- Organizing and Preparing (definition, feasibility confirmation, development, demonstration, design prototype, quantification.)
- Carrying out the work (execution, implementation, realization, production and deployment, design/construct/ commission, installation and test.)
- Closing the project (handover of the project results to the user, project termination, sometimes including post-completion evaluation.)

Each of these phases contain critical decision points (proceed, cancel, revise scope/cost/schedule/quality.)

Figure 1. Typical current "standard" top level project life cycle model. (PMIa 2008, p 16)

An "Extended life cycle" model is promulgated in the widely used Association for Project Management/APM Body of Knowledge is shown in Figure 2, in which these four basic phases are clearly shown and labelled "Project life cycle." This model also shows an "Extended project life cycle model" that moves toward the comprehensive model proposed in this paper, but is still incomplete, as discussed below.

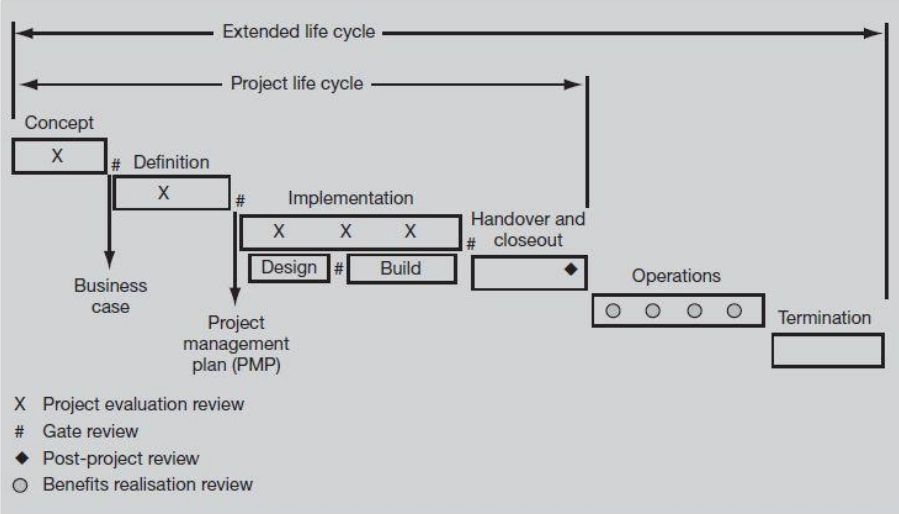

Figure 2. A second "standard" project and extended life cycle model. (APM 2006 p 80.)

The phases shown in these two models are so broad and the titles so generic that they are of little value in documenting a specific project life cycle process so that it can be widely understood, used, reproduced, and continually improved. What is needed is the specific definition of six to ten (or more as needed) basic phases for each project category and sub-category, usually with several sub-phases defined within each of the basic phases. Archibald (2007 and 2003 Chapters 2.5 and 3.5) discusses in detail the need for such specific project life cycle models and the application of systems thinking to such models, and presents a number of examples of both predictive and adaptive project life cycle models:

- **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.

- **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. The IBM Rational Unified Process (RUP) (see Table 1), driven by risk and customer need is a good example of an adaptive software development model.
  - **Spiral:** Repetition of the same set of life-cycle phases such as plan, develop, build, and evaluate until development is complete.
  - **Extreme Programming/XP:** Teams of developers, managers, and users; programming done in pairs; iterative process, collective code ownership.
  - **Agile and SCRUM:** Similar to above adaptive life cycle models with iterations called "sprints" that typically last one week to 30 days with defined functionality to be achieved in each sprint; active management role throughout.

1.7 Project Life Cycle Models for Specific Project Categories: To emphasize the importance of developing and using more detailed project life cycle models for specific categories, Figures 3 through 5 illustrate some typical examples of project life cycle models now in use for a few of the many different project categories. See Archibald (2004) for further discussion of these and a number of other project categories.

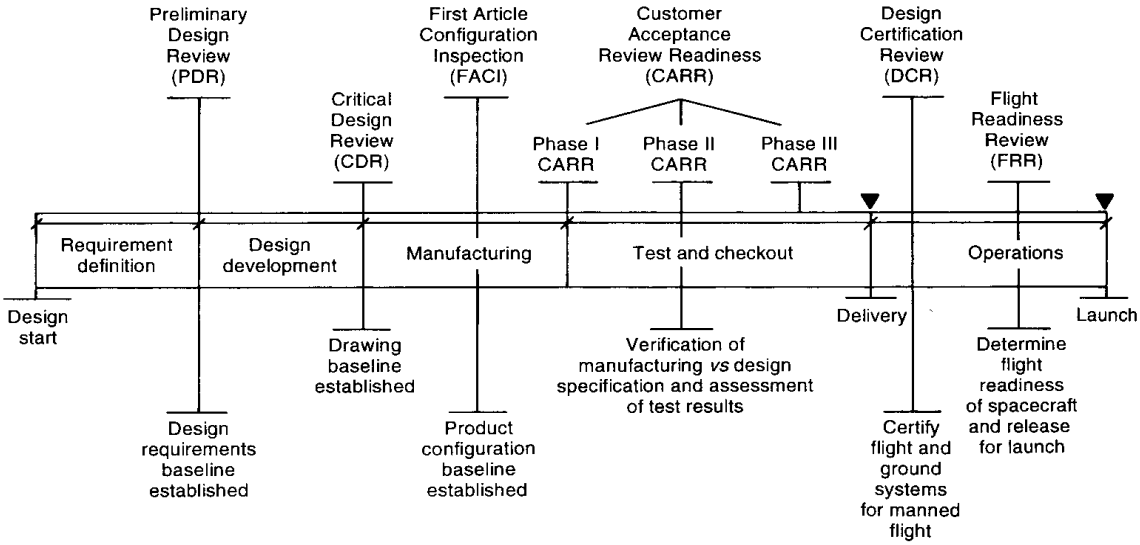

Figure 3. NASA's Project Life Cycle Process.
See http://spacese.spacegrant.org/uploads/Project%20Life%20Cycle/PPF_WallChart_color.pdf
for a very detailed wall chart that expands this simplified version.

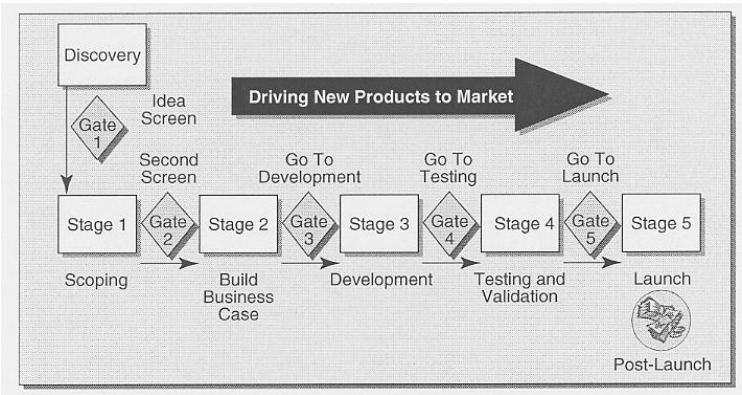

Figure 4. Overview of a typical Stage-Gate™ project life cycle process for new product development.

Source: Robert G. Cooper et al, Portfolio Management for New Products (Cambridge, MA, 2001), p. 272.
www.perseuspublishing.com

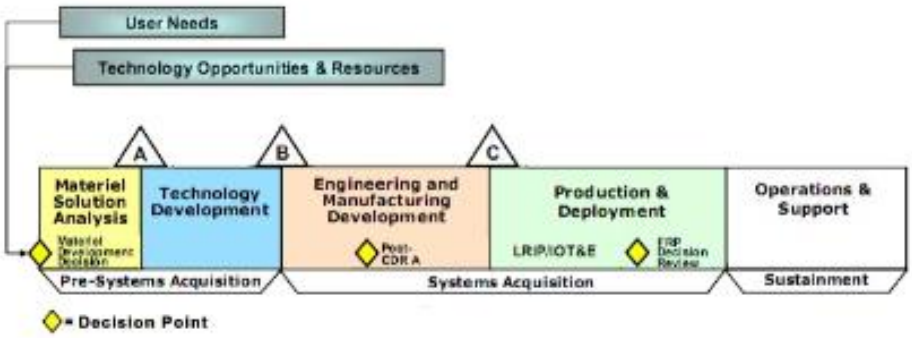

Figure 5. United States DoD 5000 Defense Acquisition System Life Cycle
Source: DoD Defense Acquisition System https://dag.dau.mil/Pages/Default.aspx

2 PROPOSED COMPREHENSIVE PROJECT LIFE CYCLE MODEL: TWO ADDITIONAL PROJECT PHASES ARE REQUIRED[6]

> "Traditionally, the field of project management begins with the 'initiation' of a project. The most well-known treatment of the project management process is included in the Project Management Institute's Project Management Body of Knowledge (PMBOK). However, the PMBOK does not address what happens before a project is initiated; i.e., how does a project come into being?, how is the project identified and decided upon among other operating, maintenance, or investment options available to an enterprise. Total Cost Management maps the process upstream of project management. In TCM, what precedes project management is referred to as 'strategic asset management' or more traditionally, 'portfolio and program management'. A unique element of the TCM process is that it integrates all the steps that an organization must take to deploy its business strategy. This includes monitoring and becoming aware of a performance issue with an asset in its asset portfolio (i.e., capital asset base), to completing a project and delivering a modified or new asset to the company's portfolio." (From Wikipedia's discussion of the AACE International's TCM Framework.)

To reinforce what the AACE International TCM Framework states: The project life cycle models that are described in the project management standards today fail to fully recognize the genesis of projects prior to the standard "project starting or concept phase" and fail to include the importance of post-project evaluation of the success of both the project and its product or operating results. We propose in this paper that the standard Comprehensive Project Life Cycle must include these two additional phases: **Project Incubation/Feasibility Phase** and **Post-Project Evaluation Phase**, as shown in Figure 6. These two additional phases are described in the following sections.

Figure 6. Proposed six-phase comprehensive top level project life cycle model.

[6] Sections 3 and 4 of this paper are excerpted from Archibald, Russell, Ivano and Daniele DiFilippo, "The Six-Phase Comprehensive Project Life Cycle Model Including the Project Incubation/Feasibility Phase and the Post-Project Evaluation Phase," 2012, which includes important comments from Wayne Abba, Franco Caron, Prof. Gianluca di Castro, Prof. Dr. Jean-Pierre Debourse, Prof. Dr. Harold Kerzner, Prof. Dr. Stanislaw Gasik, David Pells, Dr. Parci Prado, Bob Prieto, and Prof. Jorge Tarazona.

These additional phases are required when the intermediate phases are expanded to show the detailed life cycle model for specific projects within any of the various project categories. As we discuss later (Sections 3.11 and 4.7), the Project Incubation/Feasibility Phase is directly linked to the AACE International Total Cost Management/TCM Framework within the Strategic Asset Management and Project Control, Figure 7, plus the Projects Implementation (4) Process; and the Post-Project Evaluation Phase is linked within the TCM Strategic Asset Measurement (5) and Assessment (6) Processes, plus as an extension of the Project Performance Assessment Process (10).

Figure 7. AACE International TCM Framework Logo.

> "Total cost management (TCM) is the effective application of professional and technical expertise to plan and control resources, costs, profitability and risk. Simply stated, TCM is a systematic approach to managing cost **throughout the life cycle of any enterprise, program, facility, project, product or service.** The *TCM Framework* is a representation of that 'systematic approach.'" (AACE International TCM Framework, page ix. Emphasis added.)

The proposed comprehensive project life cycle model shown in Figure 6 is thus completely compatible with and supportive of the TCM Framework.

3 The Project Incubation/Feasibility Phase

3.1: When does a project truly start? How does it grow from an idea in someone's head (or several heads) into an approved concept for which a Project Charter can be written? In almost every case the standard "Project Starting Phase" must begin with a reasonable understanding of what the principal objectives, scope, schedule, and cost of the project are expected to be, including:

- What the project will create (new product, facility, service, information system, organization, other principal deliverables);
- What business benefits will be produced for the organization that will pay for the project, as will be detailed in the Business Case that is produced during the Project Starting Phase;
- Verification that the project is aligned with the strategic plans and objectives of the sponsoring organization;
- A reasonable idea of the overall scope of the project together with its expected time schedule and cost, and whether the needed money and other key resources can reasonably be expected to be available, as will be verified and detailed in the Project Charter that is produced during the Project Starting Phase.
- Preliminary or conditional approvals that the project will require from governmental authorities or other agencies (environmental, economic, health, others) as well as any intellectual property and physical rights of access that are needed for the project to succeed.

- Overall economic, technological, political, social, and physical feasibility of the project, including the level and acceptability of the various risks that are involved.

A project will not normally be authorized to enter the Project Starting Phase (as that phase is now described in various project management standards) until sufficient information, as listed above, is available and its feasibility has been established. The basic question here is "Where does this initial 'embryonic knowledge and understanding' about the potential project come from?" This information must be accumulated through a process of "information buffering" (Di Filippo 2011) over a period of time prior to authorizing any project to enter the current standard Project Starting Phase, and this occurs in every case during the previously undefined but always present **Project Incubation/Feasibility Phase**. This information buffering is similar to downloading a movie on your television set: the movie (or the project) cannot begin until sufficient data and knowledge has been obtained and compiled locally.

3.2 Project Empowerment during the Incubation/Feasibility Phase: During this incubation/feasibility period we also begin creating the project empowerment. While we are compiling the information we are simultaneously loading the cognitive strengths needed to go till the end of the project. We begin attenuating the Cognitive Constraints (Archibald et al 2012) during this phase within the stakeholders and potential project team members, and during the project starting, planning and execution we will work to remove them completely. Our objective here is to create the "heuristic consent" by the key decision makers, which is that particular mental state that can build the:

- Real COMMITMENT to the project,
- Maximum EFFORT threshold (that will bring resilience to the team),
- TUNING UP among the potential team members (Esopo experiment[7]),
- MOTIVATIONAL FACTOR (that leads to the Agency[8]),
- The P INCLUSION (P for project)[9],
- GOING TO A RESULT: we communicate to the potential members of the project team and the key project stakeholders the positive feeling of "moving towards", "moving to creating", "getting something done".

This enables a rapid transition between the Project Incubation/Feasibility Phase and the Project Starting Phase when the project is formally authorized to begin.

3.3 Origins of Projects: To fully understand the several sources or origins of projects we must point out that there are two types of organizations that plan and execute projects (Archibald 2003, p.7):

1. **Project-driven organizations** that derive most (if not all) of their revenue and/or other benefits from creating and delivering projects (software systems developers, engineering/construction contractors, consulting firms, some government agencies such as NASA, others); and

2. **Project-dependent organizations** that derive most (if not all) of their revenue and/or benefits from producing and selling products or services, or otherwise providing services

[7] In the Esopo Experiment some people are asked to act together to remember something. At the end of the experiment you usually can see the creation of a new team (almost self-generated) who did not even know each other. The cognitive overload perceived by the participants became the motivation to overcome the cognitive dissonance overload.
[8] "Agency" in the Bandura theory can be defined as the ability to act, both actively and proactively, in a context in which someone has to achieve a result. The perceived self-efficacy is the engine of agency.
[9] "P inclusion" is for "Project inclusion." The stakeholder involvement is important, the team member involvement is essential; everyone can become the success key of the project.

(as most governmental agencies do), and depend on projects to create or improve new products and services, enter new markets, or otherwise improve or change their organizations.

Frequently there are project-driven departments (such as the IT or new product departments) within large, otherwise project-dependent organizations.

Within both of these organizational types there are two general types of projects (Archibald 2011):

1. **Commercial or Delivery Projects** that are similar to projects that the organization has planned and executed before, including as examples projects to modify and install a new information system; to design and construct a building, plant, or other facility with minor site adaption changes to a previous facility; and similar mostly repetitive projects; and

2. **Innovative, Development or Transformational Projects** that are substantially different from other projects that the organization has executed or purchased, including as examples new products or services development using new technologies or materials; new management or physical production processes; creating new organizations; acquiring and/or merging existing organizations; and other projects that transform the organization in some significant manner. These projects may be innovative in regard to the project management processes themselves, or to the results that the project creates, or in regard to both of these aspects.

Table 2 indicates the usual sources of the "embryonic knowledge and understanding" of these two types of projects within the two organizational types described above.

Table 2. Origins of two project types within project-driven and project-dependent organizations.

Project Type > Organization Type	Commercial or Delivery Projects	Development or Transformational Projects
Project-Driven Organizations	**>** Marketing or Business Development Department develops four project portfolios: 1) customer relationship, 2) network relationship, 3) delivery, and 4) offering portfolios.[10]They evaluate **requests for proposals/RFPs** from customers that result from usually long-lasting relationships and extensive marketing efforts, or develop proposals initiated internally: **> Project proposals** that comply with well-established strategic goals and are within the known capabilities of the organization are prepared and approved prior to submittal to the customers. **> Project Starting Phase** is not initiated until a proposal is negotiated and a contract is signed by both parties. **>** A full-time **Project Manager** is usually appointed only during the Project Starting Phase. **> Project management functions** must be applied in proposal preparation but frequently they are not. **>** Few if any commercial/delivery projects exist in these organizations. If so the above comments apply.	> Statements below for Project-Dependent Organizations also apply here to Project-Driven Organizations.
Project-Dependent Organizations		**>** Ideas for **projects** for major organizational change; acquisitions; mergers; or new markets, products, processes or services **come from** strategic managers, marketing/business development, R&D, past customers, consultants, or individuals. **>** Development of the idea into **project object- ives, scope, et al** occurs over a period of time prior to the project entering the Starting Phase. **>** Only when **the 'embryonic understanding' of the potential project** has been approved does the project

[10] Tikkanen et al 2007.

		enter the Project Starting Phase.

It is worth noting that many transformational projects or programs include the purchase of delivery projects from outside suppliers that are actually project-driven companies or agencies. This depends on the internal decision whether to "buy" or to "make" the products or results for selected portions (sub-projects) of the transformational project or program.

3.4 Definition of the Project Incubation/Feasibility Phase: The Project Incubation/Feasibility Phase in the Comprehensive Project Life Cycle is the phase prior to initiation of the Project Starting Phase, during which the necessary information and "embryonic knowledge and understanding" of the potential project is collected, compiled, buffered, and analysed sufficiently to enable a well-informed decision to proceed with initiation of the Project Starting Phase. The time required for this Project Incubation/Feasibility Phase will vary from a few days to many months, depending on the nature of the industrial, business or governmental sector; the project itself, its category and its complexity and risks; the time required to obtain the needed clearances, approvals, technology and physical access; and the availability of the pertinent information. The time, money, and skilled resources that are expended during the Project Incubation/Feasibility Phase are provided, justified, and recovered in several ways, as indicated in Table 3, for both the organization types and whether the project is either a delivery or transformational type.

3.5 Project Incubation/Feasibility Phase for Commercial/Delivery Projects: Within project-driven organizations the Marketing (or Business Development) Department devotes essentially all of its efforts to this phase of potential new projects, which are the life blood of such organizations. They develop long-lasting relationships with old and new customers and prospects, and buffer many kinds of information about their established and potential markets. As prospective new project offerings are identified specific new project opportunities are conceptualized and developed. Frequently the marketing department actually prepares the customer's Request for Proposal to which the organization will subsequently respond with a formal project proposal, leading to approval of a contract for the new project.

Table 3. Sources and recovery of the cost of the Project Incubation/Feasibility Phase.

Project Type > Organization Type	**Commercial or Delivery Projects**	**Development or Transformational Projects**
Project -Driven Organizations	**>** Developing project proposals is the normal function of the Marketing and/or Business Development staffs. **>** The **associated costs are recovered** in the contract price for each project as agreed with each customer, usually in the overhead rates used in the project hourly labor rates. **>** These costs for project bids, including 'offering projects' that are speculative in nature and not in response to specific request for proposals, that are not accepted by the customer are included in the overall general & administrative overhead rates for the organization. Of course these costs are accounted for and must be recovered in future contracts if the company wished to continue in business.	**>** Statements below for project-driven organizations also apply here.
Project-	**>** Few if any commercial/delivery projects will exist in these organizations. If they do the above comments	**> Costs** related to the Incubation/Feasibility Phase of any transformational project are generated by staff members and

Dependent Organizations	apply.	consultants who 1) develop the organization's strategic plans, 2) identify potential mergers and acquisitions, 3) develop plans for major organizational changes, 4) create new product and service ideas, and 5) conduct market, product and process research activities. **> They include** costs associated with obtaining regulatory agency approvals and use of proprietary knowledge or physical access, etc. **> These costs** are usually included in the appropriate General and Administrative or Research and Development costs of the organization, or they may be accounted for and recovered as either direct or overhead costs.

3.6 Project Incubation/Feasibility Phase for Transformative Projects: Within both project-dependent and project-driven organizations the initial ideas for transformative projects, which are in every case significant innovations of some type, may come from any one of the several sources listed in Table 3. Those organizations that conduct periodic strategic planning activities find that many of their transformative projects emerge from that activity. Good practice demands that an Executive Sponsor and a Project Manager be assigned to each potential transformative project as soon as it has been decided that the project should be incubated and its feasibility established.

3.7 Commercial Projects are often part of Transformative Projects (or Programs): In many if not most cases, commercial projects delivered to a second organization are vital parts of a larger transformative project or program within the organization that purchased the commercial project. Thus the owner of the transformative project/program must include the commercial delivery project (often there will be more than one of those) within its overall plan for the transformative project or program.

3.8 Front End Loading (FEL) Phase in Design/Procurement/Construction Projects illustrates the importance of recognizing the Project Incubation/Feasibility Phase: The excellent 'front end' work done on project governance in Norway recognizes the importance of this phase in DPC projects. In a series of conferences held every two years, the Ministry of Finance has explored and implemented new models for selecting the 'right' projects thru systematic evaluation. The conference website, including presentations over the years, is at http://www.concept.ntnu.no/symposium/index.htm.

As stated by the **Independent Project Analysis (IPA)** group (2012):

> "Front-End Loading (FEL) of a [facilities design and construction] project can be described as the process by which a company (and project team) translates its marketing and technological opportunities into capital projects. In other words, during the FEL phase, the questions of Why, What, When, How, Where and Who are answered.
>
> "The goal of the total FEL phase is to secure a detailed definition of a project's scope needed to satisfy the business objectives for the capital investment. By providing a detailed project definition that can be communicated and agreed upon by all project participants prior to authorization *[this usually means prior to authorization of the Project Start Phase]*, the FEL phase aims to reduce the number of changes in later project stages. Thus, the project outcomes should be more predictable. The FEL phase is defined as the period from when a business opportunity is identified and to the point at which a project capitalizing on the business opportunity is authorized."

Jones Milton (Archibald et al 2012) has this to say about FEL: "This paper has attempted to indicate the overall desirability (improved safety, enhanced operability, etc.) and the specific financial benefits available from pre-investing time and resources in project pre-planning (Front

End Loading) and in the use of risk reduction techniques such as constructability studies. It has been conclusively demonstrated from a review of available industry statistics that improvements in ROI and TIC of between 6% and 23% are possible and have historically been achieved as a direct result from employing either one or (even better) a combination of these methodologies. We have also shown that it is possible (and, indeed, both practical and advisable), using established and creditable processes and systems, to employ available and industry-accepted methodologies (Project Definition Readiness Index) that measure (using easily quantifiable metrics) the relative readiness of projects to proceed through the quality "gate" to full authorization (funding)."

David Pells states (Archibald et al 2012) that "[This] is not a new phase. Otherwise known as the Project Feasibility Phase, this stage is well established in the project finance and economic development fields, and in aerospace, defense and some other sectors where the business models/financing processes drive the entire project. Of course, this phase has been generally ignored in the life cycle models advanced by professional bodies like PMI, primarily because project managers and project management are seldom assigned/implemented until after the investment decision has been made. There are many in the PM field who have recognized and complained about this weakness for many years."

Bob Prieto says (Archibald et al 2012): "Your addition of an incubation or feasibility phase I think is a correct one but I am not sure that this is necessarily a new construct. In today's large capital projects; the FEL phases, linked to stage-gates, are preceded by an extensive "Conception" period during which extensive and often time consuming activities are undertaken. In some instances these will be synonymous with FEL, but in other instances they will include pre-FEL efforts often generically referred to as "studies". (See Table 4.) These activities typically include: a) Computer models, b) Conceptual level estimates, c) Environmental studies, d) Feasibility studies, e) Labor and wage studies, f) Master plans, g) Permitting, h) Project financing, i) Scope definition, j) Siting, k) Technology/licensor selection, l) O&M readiness reviews....With respect to FEL, terminology varies by owner and even by EPC firm as you can see in the following example. I discuss FEL stage focus in 'The GIGA Factor' published by CMAA[11]….A Studies Phase or as I referred to it above, a 'Conception' Phase, precedes FEL, and it is where strategy is translated into tactics that respond to an 'efficient frontier' (Prieto 2013) created by what I believe is increasingly multi-dimensional optioneering. One may argue that this Conception Phase and Strategy Phase should be grouped but I see different skills sets and focus being brought to bear."

Table 4. Various Terms Used for FEL Phases. Source: Bob Prieto

Project Phase	Contractor Definition	Owner A Definition	Owner B Definition
FEL Phase 1	Business Plan	Appraise	Conceptual
FEL Phase 2	Conceptual Engineering	Select	Feasibility
FEL Phase 3	Preliminary Engineering	Define	Front-End Engineering
Phase 4	EPC	Execute	Execution
Phase 5	Startup and Operation	Operate	Operation

3.9 Project Management Practices Can and Should Be Employed Prior to the Project Starting Phase: Peter Morris (2005) states:

> "Two conclusions stand out from these two studies. One, that following the *PMBOK Guide*® elements may be sufficient to deliver projects properly in process and practice terms but probably is not enough to ensure that the project is successful. Two, that to do the latter one needs to concentrate more on the managing the front-end.

[11] See https://online.cmaanet.org/cmaassa/ecssashop.show_product_detail?p_product_serno=214&p_mode=detail&p_cust_id=&p_session_serno=204812&p_order_serno=214233&p_promo_cd=

> "But it is the contention of this paper that one can take the argument a stage further: project execution is itself improved by concentrating more on the front-end; and that the project (and program) management professional has a significant role to play managing projects and programs for business success. Benchmarking data in the oil and gas industry for example shows conclusively that effort spent (up to a point) on front-end definition (so-called 'Front-end Loading' – FEL) correlates positively with project outcome performance. And second, there are a number of practices which the 'project management' professional can deploy which will positively enhance the strategic value of the project to the sponsoring organization(s). It is these contentions that this paper explores.….
>
> **"Summary and conclusions:** We have come full circle. What you give out, you get back. If we position project management as an execution-only discipline, we will be seen as just that and cut-off from the really important parts of the project: those where value can most be created: the front-end…. The reality, as shown by the results of two separate surveys, is that the overwhelming majority of practitioners polled believe that project management does apply in the pre-execution stages."

3.10 The Project Executive Sponsor and Project Manager Roles Exist during the Project Incubation/Feasibility Phase but are Rarely Formally Assigned: Common practice in almost all industry and government sectors today is to assign the Executive Sponsor (if indeed one is assigned) and a Project Manager only when the Project Starting Phase begins. However, both of these roles actually exist when the original idea or concept starts to be investigated as an embryo project. There is a need for a person at the executive level to take on the Executive Sponsor role at this early stage, for both commercial and transformative projects. At the same time there is a need for one person to take on the integrative role of the Project Manager, even if this may not require that person's full time, in order to apply the project manager perspective to the embryo project. The same advantages accrue from filling these roles during the Project Incubation/Feasibility Phase as accrue from assigning these roles during the Project Starting, Definition, Execution, and Close-Out Phases. Usually during the Incubation/Feasibility Phase these two roles are scattered between various people within the Business Development, Marketing, and Strategic Planning executives and managers. In the case of the Project Executive Sponsor it is very desirable for the same person to carry that responsibility throughout the entire project life cycle, but it becomes more problematic to maintain the Project Manager responsibility throughout the entire project with the same person, even though that is equally desirable.

3.11 The Incubation/Feasibility Phase is Directly Linked to the AACE International Total Cost Management/TCM Framework: Prior to any important project beginning to take shape in the Project Incubation/Feasibility Phase, its genesis comes from the strategic decisions that have been made by the strategy managers of the organization. Most organizations today conduct an annual – or more frequent – review and re-formulation of their strategies for survival, growth and improvement over the coming year, and also for three to five years in the future. The achievement of the organization's strategic goals and objectives will, in most if not all cases, occur through the formulation and execution of projects and programs. The primary linkage of the Incubation/Feasibility Phase with the TCM Framework occurs within Item 4, the Projects Implementation Process, within the TCM Strategic Asset Management Process, shown in Figure 8.

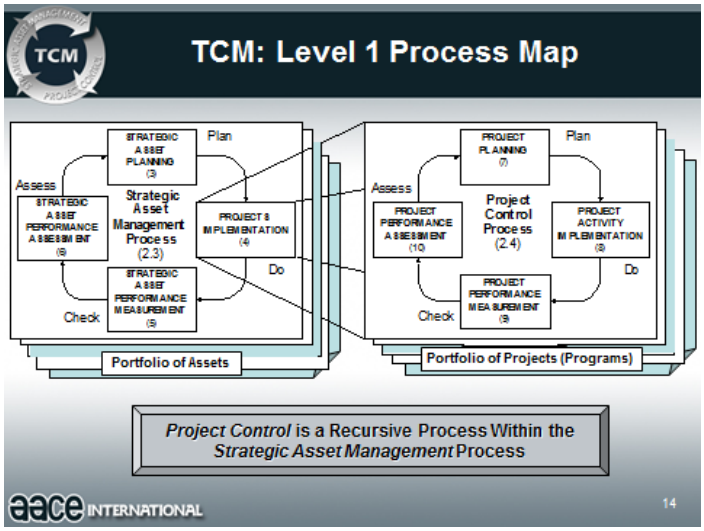

Figure 8. TCM Level 1 Process Map. Source: AACE International http://www.aacei.org/resources/tcm/

There is also some linkage for this project phase with TCM Item 3, Strategic Asset Planning Process, especially when a major project is in its early incubation stage. The TCM Project Implementation Process is described as follows (AACE International 2011, page 69):

> **"4.1[12] Project Implementation**
> **"4.1.1 Description**
> "The project implementation process governs the project control process by putting into effect the decisions and will of the enterprise in respect to its projects. The decisions of the strategic asset management team that initiate the first phase of project scope development are implemented by establishing project team leadership and then, working together, developing initial project direction and guiding documents including a description of the asset scope (product of the project that addresses a business problem or opportunity), project objectives, constraints, and assumptions. These outputs of the process are referred to as the "project implementation basis." Initial inputs to the project implementation process include information about the physical and functional characteristics (i.e., design basis) of the selected asset investment option, and the business constraints and assumptions (i.e., business decision basis, business case, or justification) upon which the asset investment decision was made (Section 3.3).
>
> In addition, the enterprise maintains a project system (i.e., a process and attendant set of capabilities and tools) that supports project team's efforts to manage and control its projects. At project initiation, the system and other enterprise capabilities and resources are made available to the project team to use as appropriate or as required. The project team, using the project system capabilities, then develops the project implementation deliverables into a controllable project scope definition.
>
> "Typically, the implementation process is reviewed as the project scope and execution strategy development process (Section 7.1) progresses through proscribed or controlled phases (i.e., phases and gates process). A gate review at the end of each phase results in updated direction (i.e., a decision to proceed to the next phase, a request for additional work or information, or a halt to the project) and resource authorizations (i.e., phased project funding). A project system with scope

[12] Note that this is the section number within the TCM Framework, and not within this paper.

development phases and gates ensures that the project scope definition and project plans are always aligned with the asset scope and the enterprise's objectives and constraints. When project scope development and control planning reach a level of definition such that baseline project control plans are unlikely to change significantly during project execution, then final directions are given to the project team and full project funds are authorized.

"After full funds are authorized, the project team proceeds with the full project control process, while the strategic asset management team measures and tracks the project performance as one project investment in its project portfolio (Sections 5.1 and 5.2) and typically only intervenes in the project management to the extent required by the project change management process (Section 10.3). When all or parts of the project scope are complete and ready for turnover from control of the project team, the project implementation process is used to formally review and accept that scope and initiate management of the asset."

This is an excellent description of what must be accomplished for any significant project prior to it entering the standard Project Starting Phase shown in Figures 1 and 6. The Framework should be revised to refer specifically to the Project Incubation/Feasibility Phase as appropriate.

4 The Post-Project Evaluation Phase

4.1 Evaluating Both the Project and the Product: Following the current standard Project Close-Out Phase, the proposed Post-Project Evaluation Phase is devoted to the effort needed to first determining and also maintaining, improving, and even perfecting the ultimate success of:

1) The project from a project management viewpoint ("Managerial success" according to Turner et al 2010, p. 87.)
2) The project's products and results ("Products and products success" and "business success of project owner(s)" according to Turner et al 2010, p. 87.)
3) All project stakeholders' perspectives of both the project and its results, including turnover of people both during the project and after the Project Closeout Phase, and subsequent application of lessons learned for use on future projects,
4) The overall project and its products from the cognitive readiness perspective (see dimension 4 with Section 4.2 below.)

This evaluation phase will also identify weaknesses and threats that can be turned into opportunities that lead to the incubation/feasibility phase for future projects for the organization.

4.2 Four Dimensions for Determining Project Success and Value During the Post-Project Evaluation Phase: There are at least four main dimensions for measuring the overall project success and value:

1. **Project Management Dimension:**
   - How closely did the project achieve the original objectives as defined in the Project Charter or Project Business Case?
   - Did the project meet the specified **product** specifications, budget, schedule, scope?

2. **Product Dimension:**
   - How well does the product meet the functional and business objectives that were used to establish the Project Charter and Business Case?
   - How well does the product achieve its Key Performance Indicators/KPIs?

- What are the established Critical Success Factors (CSF) and how well does the product measure up against these?
- Does the market like and buy the product?
    - Does the public like the new motion picture that the project produced, and do they buy the number of tickets that were specified in the Project Business Case?
    - Does the new chemical plant produce the specified products at the specified costs and comply with the established regulations?
    - Do the users of the new IT system like and actually use the system, and achieve the specified benefits from using it?

3. **Stakeholder Satisfaction Dimension:** What level of satisfaction or dis-satisfaction (accomplishment, enjoyment, pleasure, anger, conflict, frustration) exists in each of the project stakeholders, which can be either positive or negative stakeholders:

- The project manager, including their sense of perfecting their project management hard and soft skills;
- Project core team members, including "Team Growth " in terms of self-efficacy and self-esteem in order to be able to count on a growing potential future (using the project to grow a team that is stronger and more efficient for the next project);
- Internal project executive sponsors;
- Functional contributors to the project and to its product;
- Owners of the final product of the project;
- Investors in the project and its product;
- Users and operators of the final product, including their:
    - enthusiastic appreciation of both the project and the product enabling them to perceive an even higher level of quality and differentiation, and
    - ability to perfect their skills in using the products of the project, thereby continually improving the original project results;
- Affected regulatory agencies;
- Communities (local, regional, and even virtual) that are affected by the project and its products or results:
    - Immediate neighbors of new construction of facilities;
- Users of communication systems and devices.
- And others?

Stanislaw Gasik states: “I would add success as seen by stakeholders other than the project owner (after all the owner is the most important stakeholder). But we must have in mind that there are negative stakeholders for whom “project success” will be project failure. So success from the stakeholder perspective is success for positive stakeholders and converting as many negative stakeholders as possible to a positive attitude.” (Archibald et al, 2012.)

High project stakeholder satisfaction will enable the project organization to become the leader in its market. If the project manager and the team members are not satisfied, the project will lose effectiveness and efficiency and the project results will not be the best that

they could have been. Similarly, if other key stakeholders are not well-satisfied the perceived success of both the project and the project results will be adversely affected.

4. The Project Team Cognitive Readiness Dimension[13]: The discipline of project management has created highly developed processes, methods and information systems that form the primary basis for our numerous professional certifications. But:

- **A project only exists when its team is assigned:** In spite of the fact that every project only becomes real when a project team is assigned to perform the work under the direction of a project manager, insufficient effort has been expended to understand and achieve the potentially significant benefits of developing *high-performance project teams.*
- **Preparing project plans versus preparing project teams:** We typically spend large amounts of time and money to develop detailed project plans, establish and justify a project's business case, identify its funding sources, and authorize its execution. However, too often little time and money is planned for or used to build and develop the project team as part of the project startup phase to reach the team's high-performance potential.
- **Some project teams achieve high-performance:** It is true that some project teams achieve high-performance capabilities over a period of time, but substantial benefits will have been lost to the project during that process.
- **Project team-building methods now enable us to capitalize on advances in the cognitive sciences:** The advances in cognitive psychology and cognitive neuroscience in recent decades have enabled the development of the concept of *project team cognitive readiness*, which is believed to hold a key to building high-performance project teams.

Full evaluation of project success and value during the Post-Project Evaluation Phase must include this dimension of Project Team Cognitive Readiness.

4.3 Project Success and Project Value: Some PM practitioners, including the present authors, believe that project success is not the same as project value[14]. The concept of project value is wider than project success. **Gasik** says that "The concept of 'project success' should be related only to those goals which were precisely defined in the project charter or any other 'official' document like that. The business goals achieved are the core project value, and everything which is gained outside of the initial (or officially changed during project execution) project goals should be added to the project value. So, for example, new relationships belong to the area of project value and not necessarily to the area of project success, although I can imagine a project which "official" goal was developing of relationships." (Archibald et al 2012.) Project value includes both tangible and intangible benefits, such as the willingness of a customer to contract for additional project after having a good experience with your company on the last project. We believe that the

[13] For a full discussion of project team cognitive readiness Archibald, Russell D., Ivano Di Filippo, Daniele Di Filippo, and Shane Archibald, Nov. 2013 "Unlocking a Project Team's High-Performance Potential Using Cognitive Readiness: A Research Study Report and Call to Action," The PM World Journal, Vpl II, Issue XI. This paper includes important comments from these PM authorities: Gregory Balestrero, Prof. Dr. Antonio Bassi, Dr. Federico Fioravanti, Dr. Stanislaw Gasik, Ing. Pier Luigi Guida, Prof. Dr. Harold Kerzner, Prof. Federico Minelle, Bob Prieto, Prof. Dr. Marco Sampietro, Miles Shepherd, Max Wideman, Rebecca Winston, Murray Woolf, and Shakir Zuberi.
[14] We are indebted to Stanislaw Gasik for introducing this concept.

above proposed four dimensions for post-project evaluation of projects will enable measurement of both the project success as well as the project value.

4.4 Comparison of the Project Close-out Phase and the Post-Project Completion Phase: The traditional Project Close-out Phase encompasses the Closing Process Group that "…consists of those processes performed to finalize all activities across all Process Management Groups to formally complete the project, phase, or contractual obligations." (PMI PMBOK 2008, p.65.) Regarding the Project Evaluation Phase in PRINCE 2: "This is the internal project evaluation. The aim here is to assess how successful the project has been, not how successful the end product is. There may be a separate external evaluation – for example, from a quality assurance group." (OGC 2002, p. 158.) These standards deal only with some aspects of Item 1 above in Section 4.2, the Project Management Dimension, and they do not include the Product, Stakeholder, or Team Cognitive Readiness dimensions.

4.5 Timing and Duration of the Post-Project Evaluation Phase: Measuring success of the first dimension (Project Management) can usually be done soon after the project is closed or ended. The second (Project Product/Results/Benefits Dimension) and third (Project Stakeholder Satisfaction) will usually take longer, and in some cases months after the project is closed to properly evaluate the success of the system, plant or other results created by the project. This Post-Project Evaluation Phase obviously requires a flexible amount of time depending on the type of product that the project has produced. The fourth dimension (Project Team Cognitive Readiness Dimension) will also require a time period after project closure to properly measure the project's final success in that regard. If the project results are an operating plant, for example, this evaluation phase can be accomplished after the plant has been in operation for a reasonable period of time, with estimates of future maintenance, modification, demolition and remedial costs. These estimates can then be revised if and when the plant is actually demolished.

4.6 Who does the Post-Project Evaluation Phase benefit? The primary party that benefits from the Post-Project Evaluation Phase obviously is the organization that has made the major investment in creating and executing the project. Typically we refer to that organization as the "project owner." The results of the four-dimensional evaluation described above will provide the owner valuable information regarding the wisdom of initiating, creating, and authorizing the investment in the project and its products in the first place, and also how well the project was actually conducted and how well the final results achieved the initial project and product objectives.

For those project-driven organizations that only planned and executed a portion of the overall project or program this Post-Project Evaluation Phase will be of less interest and benefit. For those organizations the first 'project management' dimension will be of primary interest, but they can also benefit a great deal from the results of the other three evaluation dimensions.

4.7 Linking the Post-Project Evaluation Phase with the TCM Framework: This proposed additional project phase is linked within the TCM Strategic Asset Measurement (5) and Assessment (6) Processes, plus as an extension of the Project Performance Assessment Process (10) (see Figure 7.) It is not sufficient only to measure and assess a project's success and value during the standard Project Close-Out Phase. In order to carry out the processes included for

these Strategic Asset Measurement and Assessment requirements of TCM, all four of the evaluation dimensions described in Section 4.2 above must be included. The benefits and value of the products of the project to all stakeholders must also be measured and assessed together with the project itself.

Only when the total costs and benefits associated with the entire project, including the costs associated with the Incubation/Feasibility Phase through all the project phases including the Post-Project Evaluation Phase, can a reasonable value be placed on the project and its products. This crucial valuation will provide important information on which to make key decisions regarding future Strategic Asset Planning (TCM part 3) choices.

Asset Performance Assessment is described in the following excerpt from Total Cost Management Framework (AACE International 2011, page 93.)

> **"6.1 Asset Performance Assessment**
> **"6.1.1 Description**
> "The asset performance assessment process analyzes cost accounting and performance measurement data to identify asset performance problems, opportunities, and risks for which the requirements for a solution can be assessed. Performance problems with existing assets (which are also improvement opportunities) are generally identified by analyzing variances between planned and actual performance.
>
> Through internal and external benchmarking and intelligence gathering, the assessment process also identifies new business opportunities. Identified asset portfolio performance improvement opportunities and risks are assessed and managed through the requirements elicitation and analysis and asset change management processes (Section 3.1 and Chapter 6.2, respectively), which close the strategic asset management cycle loop. Findings and experiences from the performance assessment process are captured in the asset historical database (Section 6.3) for use in future asset management.
>
> "The primary inputs to the process are internal asset cost accounting and performance measurement data (see Sections 5.1 and 5.2, respectively). The quantitative measurement data are analyzed for variances against the asset performance requirements (Section 3.1) and the investment decision basis (Section 3.3).
>
> Measurements of the attributes and performance of other enterprises' assets are another basis of comparison; these are generally obtained through benchmarking methods. Root cause analysis and lessons learned methods identify improvement opportunities and risks (generally from a more qualitative perspective) for immediate assessment and for future requirements assessment when captured in a historical database."

Evaluation of the combined project and product costs and benefits using the four dimensions described in Section 4.2 will provide important data that will improve the information used in Asset Performance Assessment within the TCM Framework. The TDM Framework should be revised to require this evaluation during the Post-Project Evaluation Phase.

5 Recommendations

5.1 Adopt as a Standard the Six-Phase Comprehensive Project Life Cycle to Include the Incubation/Feasibility and the Post-Project Evaluation Phases: Adoption of this comprehensive project life cycle will bring the standard up to widely used best practices that are described in this paper.

5.2 Revise the AACE International TCM Framework to Recognize the Comprehensive Six-Phase Project Life Cycle: Such revision will link the TCM Framework more closely with current best practices in project, program, and portfolio management.

6 Conclusions

6.1 Project Management Principles and Practices Provide Benefits When Used Throughout the Strategic Asset Management Processes in the TCM Framework: These principles and practices are equally beneficial when applied throughout the entire TCM Framework, and not just during the project planning and execution phases.

6.2 More Research is Required to Develop and Apply Project Team Cognitive Readiness to all Important Projects: All projects are planned and executed by people, but the discipline of project, program, and portfolio management has neglected to capitalize on the advances of the cognitive sciences to achieve high-performance teamwork on projects.

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Definitions of terms and further reading on concepts referenced in this paper:

1. **Business Process Management**: http://en.wikipedia.org/wiki/Business_process_management
2. **Key Performance Indicator(KPI):** http://en.wikipedia.org/wiki/Performance_indicator
3. **Critical Success Factors (CSF)**: http://en.wikipedia.org/wiki/Critical_success_factor
4. **Cognitive psychology:** http://en.wikipedia.org/wiki/Cognitive_psychology

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