A Systematic Approach for Architecting a Knowledge Management System for Project Management

by

Roshanak Gilani

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Signature of Author ___
Roshanak Gilani
System Design and Management Program

Certified by ___
Thomas Roemer
Thesis Supervisor
Assistant Professor, School Of Management

Accepted by ____
Steven D. Eppinger
Co-Director, LFM/SDM
GM LFM Professor of Management Science and Engineering Systems

Accepted by _____
Paul A. Lagace
Co-Director, LFM/SDM
Professor of Aeronautics & Astronautics and Engineering Systems

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Executive Summary

A. Problem statement

Complex projects pose a number of challenging requests on project managers across industries. Among the most pressing challenges are product and resource dependencies, slow traffic of vital information (incomplete and inaccurate) within a project and a general lack of project control (tools to guide the utilization of resources). While best practices and industry standards (e.g. CMM, TQM, etc.) have been found to mitigate some of these problems, they are far from being comprehensive solutions. Moreover, no generalized and automated tool exists, that captures successful practices under one umbrella.
This thesis proposes development of an automated tool to support a comprehensive solution for project management processes and practices. Using this tool collectively enables project managers to plan, track and oversight, as well as to manage changes, communication, and interdependencies required for a successful project. In addition, the project history will be stored and can be utilized for future projects.

B. Originality requirement

In our framework projects are evaluated from three viewpoints: strategy, purpose and target. A survey was conducted and focused on these views to conclude a generic project management framework or life cycle model. This framework has been translated into System Architecture principles (Need, Goals, Function, Concept, Forms) from Upstream and Downstream influences. The System is designed using the Project Management Architecture (PMA) for each sub-system, defined as protocols. Common tools are defined to be available at each protocol to respond to the project management needs.

C. Content and conclusion(s)

This thesis proposes developing a tool that automates many of the management and technical requirements within a project to use at different stages within the project's lifecycle.
This thesis results in:

- ✓ Pre defined processes and tools to eliminate overhead and facilitate process management.
- ✓ Improved process management.
- ✓ A shift of focus from process to project management.

- ✓ The elimination of the need for extensive project management skills.
- ✓ A smooth adoption of organizational changes.

Thus we provide project managers independent of industries with a framework to support their day-to-day activities with real time and accurate information. As a next step, beyond the scope of this thesis, we recommend to implement and market this design into a knowledge management software package.

D. System design and management principles

In developing the architecture for such a tool, an industry survey was conducted among leaders from academic, government, and commercial organizations to determine common approaches and obstacles prevalent in executing projects. The system architects' design of this tool is in response to user needs for defining and allocating functionality, decomposing the system, and defining interfaces. This paper presents an approach toward a synthetic view of system architecture: the allocation of functionality and its projection on organizational functionality, the analysis of complexity and methods of decomposition and reintegration, and the trades between optimality and reusability. The architecture of this project management framework tool is comprised of varying protocols that create an environment that minimizes the additional burden on project managers, and enables the project's culture to adopt more mature processes.
System and project management principles are used to ensure technical progress towards objectives, proper deployment and conservation of human and financial resources, and the achievement of cost and schedule targets.

E. Engineering & Management Content

System Architecture, Design, and Engineering principles were used to provide a fundamental understanding (supported by case studies) of the principles of system architecture for a project management tool.
To develop such system, we were able to:

- ✓ structure and lead all the early, conceptual phases of the system development process,
- ✓ follow through with subsequent system engineering and design phases, and
- ✓ evaluate current modes of architecting using the process upstream and downstream of architecting a product development process in architecture framework for thinking holistically, underlying and enduring principles of system architecture, design, management, and methods of critical evaluation.

As a result a framework was developed for project management. This framework is comprised of sub projects inheriting common protocols and tools to mitigate project risks and manage dependencies and critical path of the project as well as ensuring the quality targets are met. Building on existing management models, a unique project life cycle model was developed and expanded to the best practices to manage each phase of this life cycle model. This thesis introduces modeling

methodology and supporting tools to support project preparation, planning, tracking and oversight, as well as maintaining communication between inner and inter projects.

F. Statement of authorship and originality

The work performed to write this thesis is the author's, and is original.

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ABSTRACT

Project managers from varying industries face common challenges that exist in complex projects. Examples include: product and resource dependencies, poor communication of critical information within a project, lack of project control, lack of adequate tools to manage resources, etc.

Best practices and industry standards (e.g. Capability Maturity Model, Total Quality Management) have been found to mitigate many of these problems when fully implemented. However, no automated tool exists that collectively implements and supports these practices. This thesis proposes a tool that automates many of the requirements management processes and project management processes across all stages of a project's lifecycle.

In developing the architecture for such a tool, an industry survey was conducted among leaders from academic, government, and commercial organizations to determine common approaches and obstacles prevalent in managing projects. Based on the survey data, this thesis describes the system architecture and design of a project management tool comprised of numerous protocols. These protocols help to create an environment which minimizes the resistance to change as a result of organizational culture. This tool provides a new set of standards and practices for more mature project management. The results of following these standards and practices are: a left shift of project targets with less variation from estimates to actual results, formal defined project processes for inner and inter-project coordination, project configuration control and maintenance of requirements and historical data, risk management for dependencies and critical paths, automated tools that reduce project overhead and a project tracking and oversight mechanism.

Although this thesis is based on an analysis of best practices and industry standards, the resultant framework is original. The proposed architecture can be utilized to develop a world class project and knowledge management software application.

Thesis Supervisor: Thomas Roemer
Assistant Professor, School Of Management

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1.0 The Project, Inception and Development

There are various view points for managing a project. The following section is the analysis of these view points and description of how these view points tie into the ultimate goal of project inception and development.

The industry view

In the big picture, the trend (or fad) is for companies to upgrade or improve their operations. Many industries are becoming leaner, and more responsive to their customers through business approaches, and operational or technical innovations. This results in smaller windows of opportunity (time wise) for companies to capture value within the industry/market segments. This overall effect is encountered in the form of rapidly changing requirements, increased complexity, shrinking budgets and schedules.
The basic measurable unit to capture value is the delivery of a product (service). To do so requires increased levels of skill to manifest a product. This skill is referred to as Project Management. It is the Project Manager who is stepping into the limelight. It is this role that makes or breaks a company because a project slippage equates to less revenue captured or even effort obsolescence. Successes of projects are less and less the result of 'heroic' efforts of maverick champions and more of a team's pre-planned systemic approach to product development.
The temptation is to look for and create the ultimate silver bullet management approach in meeting the deadline. Mistakes are encountered when companies follow fads in the form of best practices and adopt new project management approaches without knowing strategically why.

– One company's meat is another's poison –

Every industry depends on effective project management to develop a product. Everybody, at some level, is a project

manager and project executive responsible for producing multiple deliverables.
This paper could have been titled "Managing Project Management". It would focus on the Manager's tactical viewpoint based on the use of the project controls, approaches, and culture styles. This paper could also have been titled "Project Management Management" which utilizes the Executive's strategic viewpoint in managing a company's portfolio of projects. To respond to the dynamic needs encountered in "Project Management", both viewpoints were required to establish an approach to designing, and framing a Project Management Architecture

The company view

In the beginning, there is always a void, a need waiting to be filled. An executive steps in and sheds some light on this emptiness and charters a project to develop a product to meet this need. Needs in general are realized by (un) intentionally following the "Purpose Target Strategy" Model as depicted below.

Figure 1 Project management circle

This model can be applied to all levels in an organization with each level dovetailing the other. The application of this is presented from three different viewpoints in the following table:

Table 1 Project management viewpoints

Viewpoint	Purpose	Target	Strategy
Executive	Increase bottom line	Capitalize on a particular opportunity	Varies (e.g. 1st to market)
Manager	Develop product	Beat thresholds (e.g. schedule, meet commitments, budget, etc.)	Need, concept, design, development, launch, maintenance
Designer	Develop component	Meets requirements	Multi-discipline design

Before tackling a project, the original need must first be understood.

What is the real problem?
What is its size and scope?
How long will the problem exist?
How long will the solution designed be effective?
Etc.

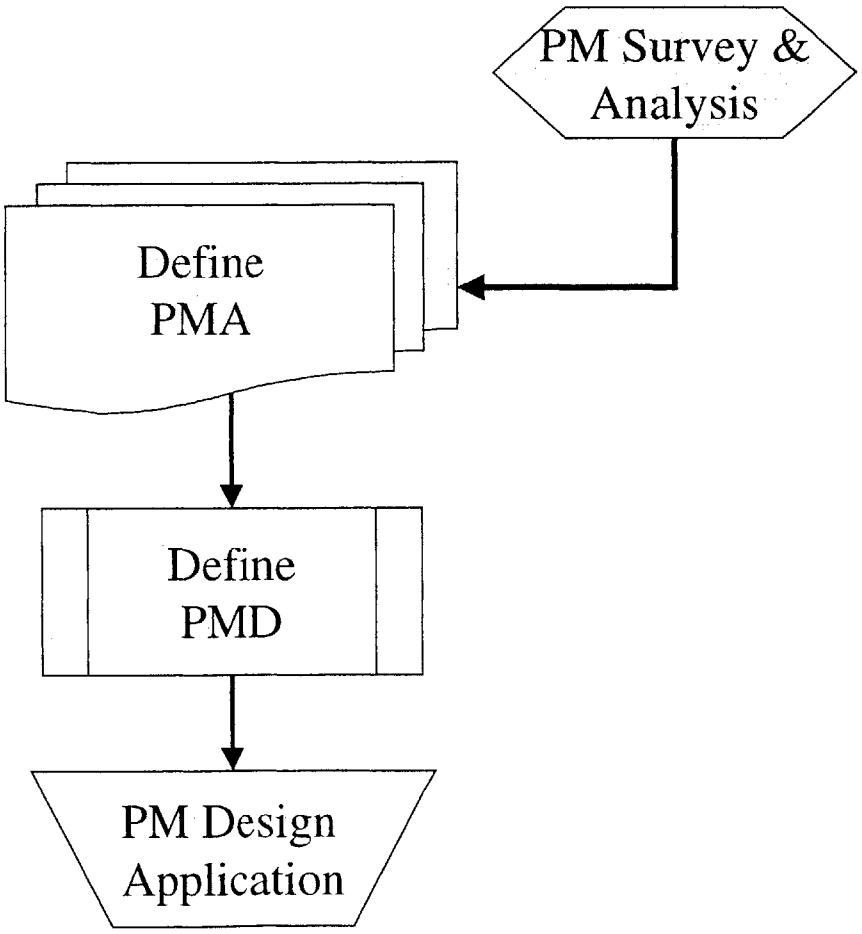
The answers to these questions define the parameters that project managers have to work with in creating an optimal approach to solving the problem. For the project to remain of value, the project is defined within certain criteria. These criteria are governed by the window of opportunity (schedule), foreseen revenue, and the allocation of resources for this project. This requires a higher (executive) view to balance efforts in making sound judgment. Such a view is proposed in the Project Portfolio table below as a tool to strategize amongst the projects. There are different types of projects for various market demands, investment opportunities and potential revenues. Each project may have different dependencies that will make or break the project. For example, project type C has high hopes for higher revenue because of lower dependencies indicated in the table below. Although this table is hypothetical, at the end of this paper we hope to establish a framework for similar tools. These tools could be used by all layers within an organization, to assist in decision-making within a project.

Table 2 Project Portfolio

Project	Product Dependency	Time to Market	Market Demand	Invest Req'd	Market Maturity	Potential Revenue
A	Med	Low	Hi	Low	Decline	$
B	Hi	Med	Med	Low	Growth	$$
C	Low	Hi	Unknown	Hi	Birth	$$$$
D	Med	Med	Low	Med	Mature	$$

An Engineer functions as a Manager and as an Executive. These two frameworks serve as the top level of the project architecture. Further iterations drill down into tasks.
This paper examines the project management need and transforms this need to a Project Management Architecture (PMA) and Project Management Design (PMD) as a system adopted in the MIT/SDM project.
The thesis process view is show in the following figure.

Figure 2 Thesis process view



2.0 Project Management Architecture (PMA)

With the assumption that there are no silver bullets, the Project Management Architecture (PMA) in this paper is structured using the "Purpose, Target, Strategy" circle to adapt to the dynamic project environment. Many variations of this model exist. This chapter utilized the Crawley method[1], the "Need, Goal, Function" format and system architecture templates to architect the PMA for a project management tool.

System/product goals

A goal is a product attribute and is defined as[2]:

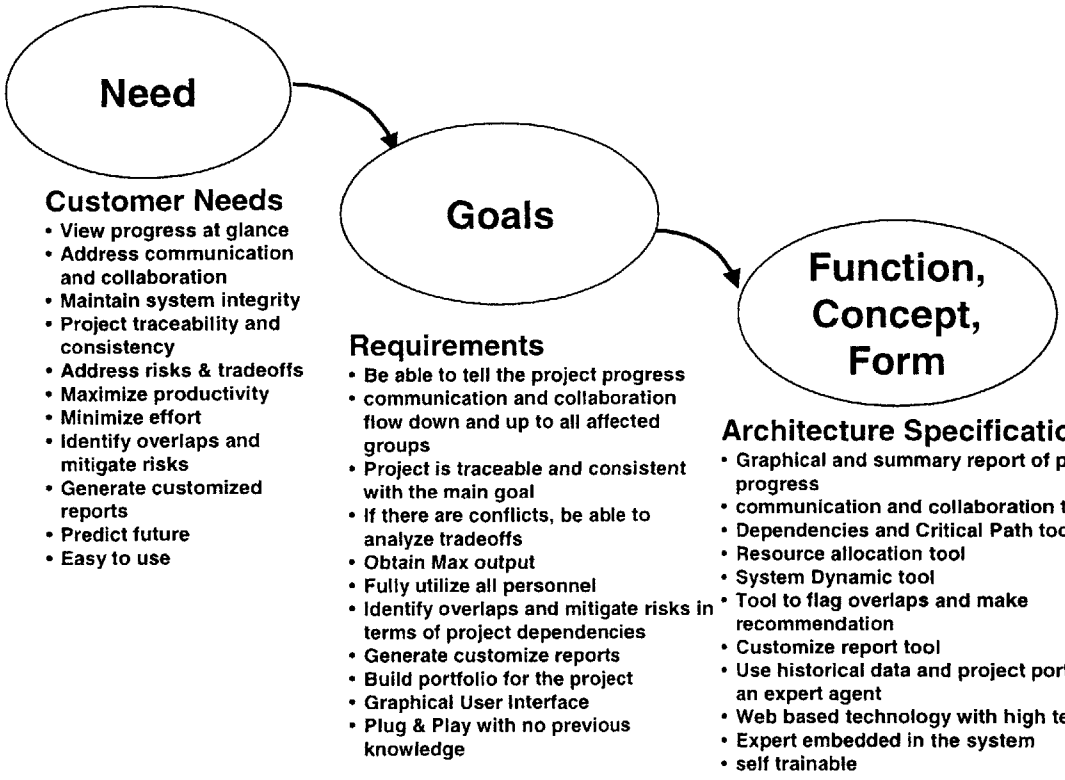
- An accomplishment
- A purpose
- A performance
- What the designer hopes to achieve or obtain

According to Crawley, "goals" are derived from user needs, i.e. the external functional corporate strategy goals embodied in requirements.
Goals are often traded against form and function in design; therefore, they are considered an independent attribute.
In a simple system external functional goals and internal functional behavior are nearly identical. External functional goals drive metrics to be used in success criteria. The following figure is the PMA in regards to the model defined by Crawley.

[1] Massachusetts institute of Technology, Ed Crawley 2000 Lecture

[2] Massachusetts institute of Technology, Ed Crawley 2000 Lecture

Figure 3 [3]Needs, Goals, Function, Concept, Form



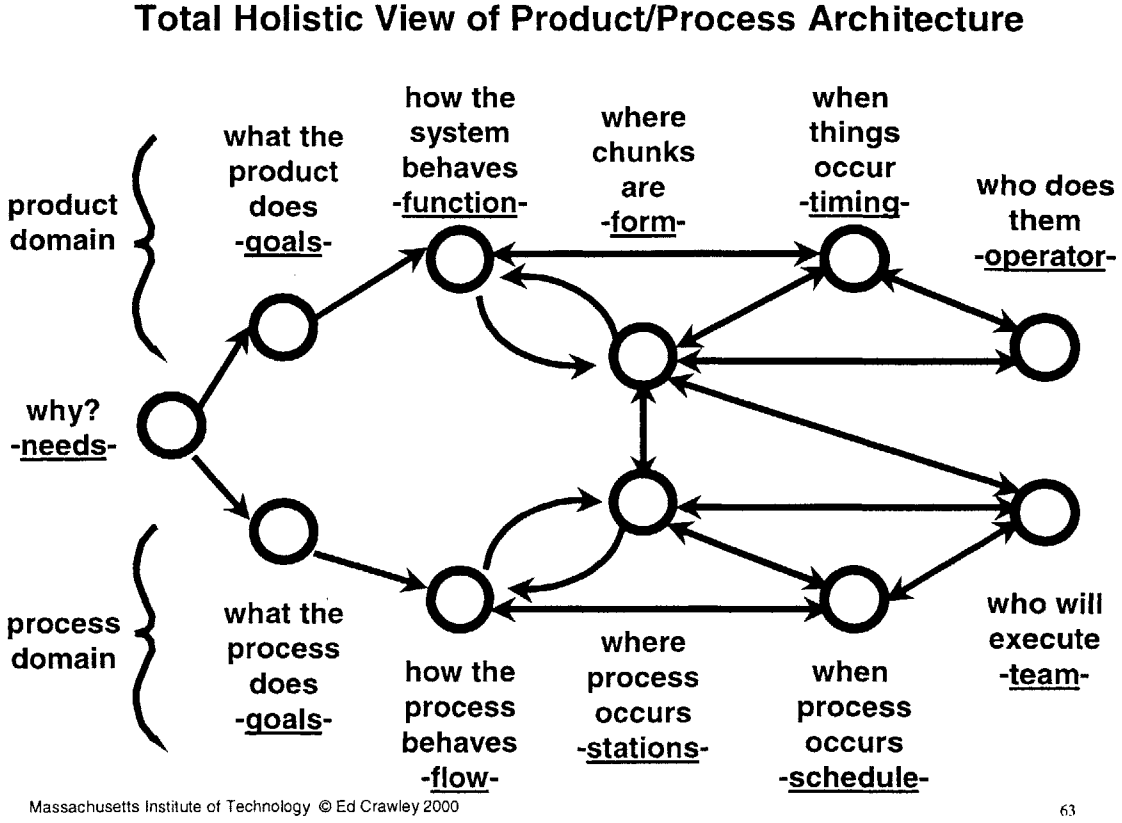
Holistic View

When defining any architecture, two domains can be used – product and process. Process domain is related to the steps and procedures that lead us to the Goal. Product domain is related to the physical and tangible artifacts as a result of execution of the Process. Further dissection of the architecture, whether by process or product domain, reveals the "Needs Goals Function" layering in determining the form and concept of the PMA. The following figure depicts this phenomenon. [4]

[3] Model is adopted from, Ed Crawley, Massachusetts Institute of Technology 2000 Lecture

[4] Ed Crawley, Massachusetts Institute of Technology, 2000

Figure 4 Crawley's Total holistic view[5]



Considering this total holistic view, the PMA needs to be designed from two perspective "Process" and "Product". In both cases, six key questions (why->what->how->where->when->who), are to be partially answered and resolved with some concluding thoughts.

Influences that shape the PMA

The PMA is strongly guided by two powerful influences – upstream and downstream[6]. The optimal PMA is the closest alignment of these two influences. The following sections will discuss these in greater detail.

[5] Reprinted with the permission of Ed Crawley, Massachusetts Institute of Technology, 2000 Lecture.

[6] The upstream and downstream influences are the revised templates provided by Ed Crawley, System Architecture, Massachusetts Institute of Technology 2000 Lecture.

[7]Upstream influence

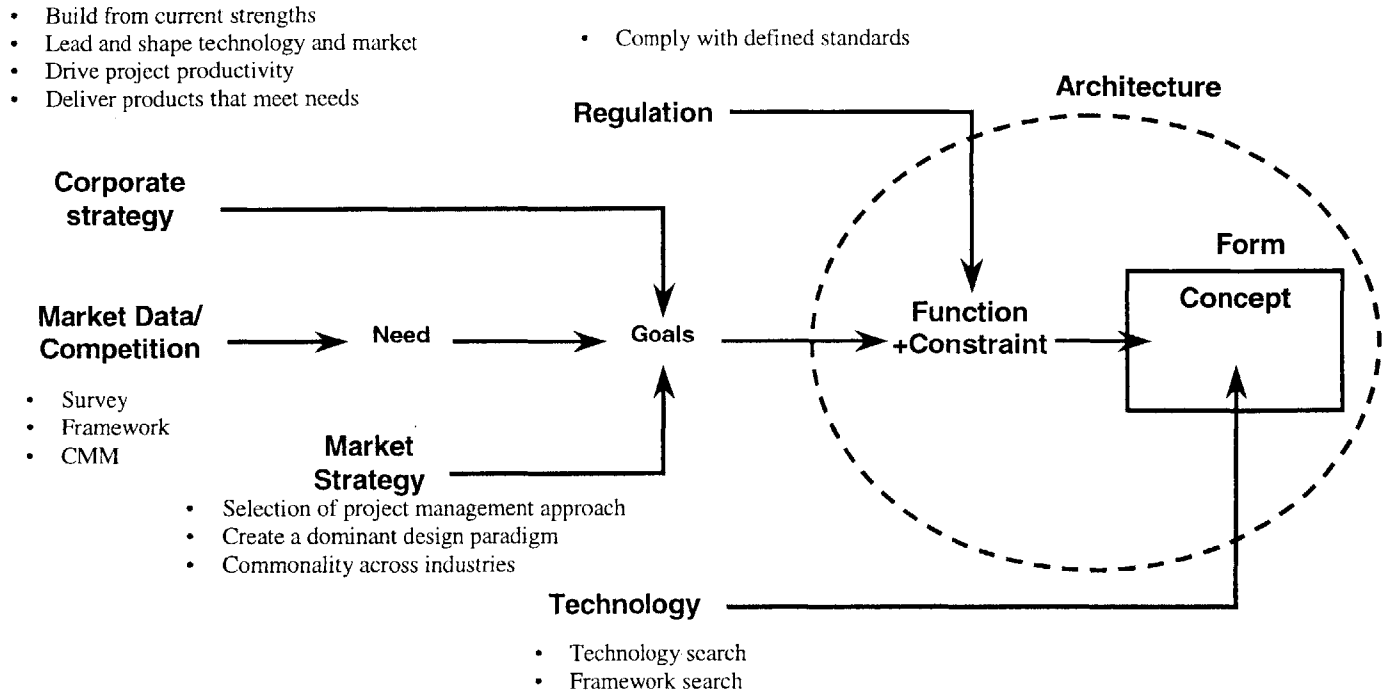
The Upstream influences reflect Executive concerns in Project Management Management. The Project Portfolio depicted earlier used in conjunction with the "Needs, Goal, Function" model enables the Executive to begin the architecture process in defining a project with respect to common upstream influences such as:

- Corporate strategy - "what the company does, what are its core competencies, how it accomplishes this, what the return to investors is, how it will maintain competitiveness."
- Market strategy – "in what markets it competes, with whom, how (price vs. functions vs. type)"
- Technology – "how products incorporate new technology or reuse old"
- Regulation - "how products meet existing or envisioned regulation operations strategy - sourcing vs. in-house development"

A complete example of these influences within the "Purpose, Goals, Function" model for each influence – developed in a team environment consisting of the Marketing, Engineering, Sales, etc. executives - would depict a proprietary business and product model. However, focusing only on the "Goals" portion reveals what are commonly called Best practices. Obviously goals vary among each organizations; one example is depicted in the following figure:

[7] Model is adopted from, Ed Crawley, Massachusetts institute of Technology 2000

Figure 5 Project management upstream influences on system architecture



The culmination of these influences leads to defining the project functions, constraints, and form. Once the project form is defined, the project manager steps forward and makes the handoff to guide the downstream influences.

[8]Downstream influences

The downstream influences are directly influenced by the Manager's viewpoint, which is Managing Project Management – a tactical viewpoint. The Manager architects the project with respect to the following common downstream influences such as:

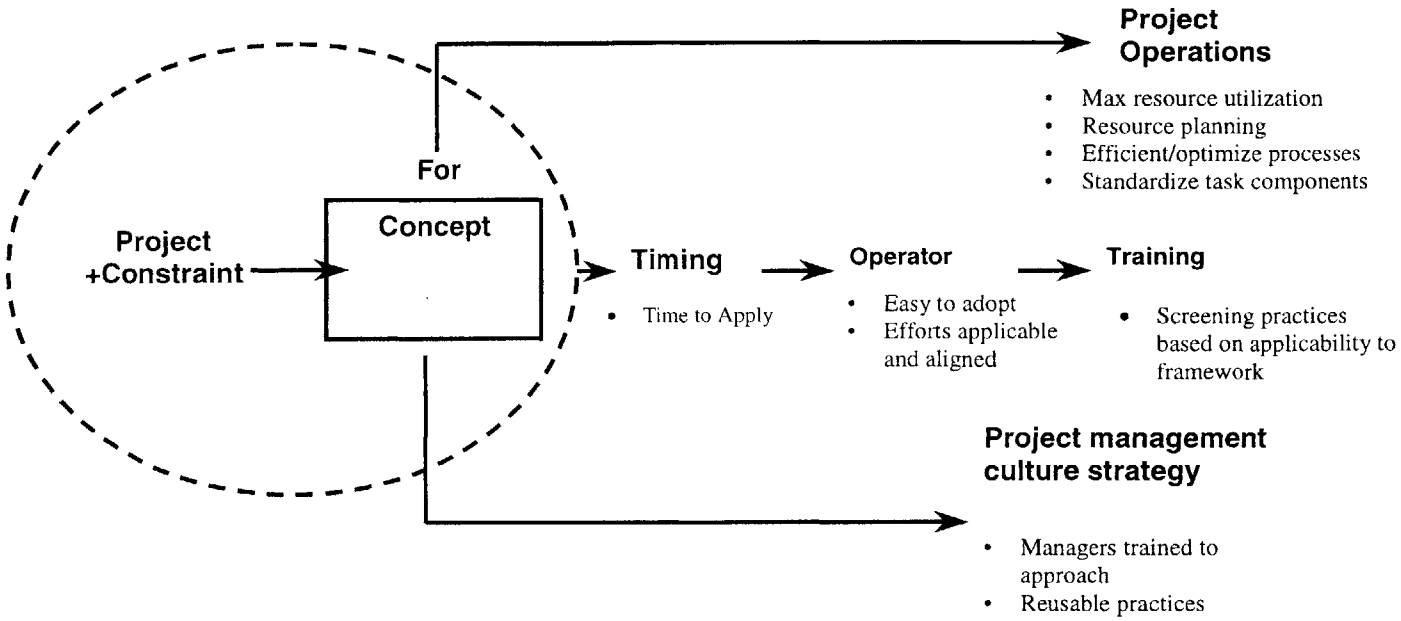
- Project Operations – resource management, planning, optimizing, standardizing
- Timing – Time to apply operations

[8] Model is adopted from, Ed Crawley, Massachusetts institute of Technology 2000 Lecture

- Operators – Project Staff complying with project plan
- Training – enabling operators to execute plan
- Project Management culture strategy – managing changes to the project organization

The Manager's architectural view of these influences is shown below:

Figure 6 Project management downstream influences on system architecture



The culmination of these influences leads to a well defined hierarchy of project plans for Project Engineers to execute. As a reality check for designing the PMA, a survey was conducted amongst top professionals from several commercial, academic, and government organizations.

Industry survey on PMA

The survey was developed to determine if and how prevalent the downstream and upstream influences guide and affect their project management in both process and product domains. The survey was conducted via Zoomerang, a web survey tool. There was an overwhelming response with respect to the distribution domain, even beyond the capabilities of the web survey tool to properly process the data. Although this

phenomenon occurred, a threshold snapshot of the compiled data was captured for analysis and research. See Appendix A for more detail.

The questions in the survey were developed in compliance with the upstream and downstream influences in reference to the six key questions related to basic project management activities with respect to both "Process" and "Product" domain. The "evaluating criteria" of these influences are shown as "Qualifying Factors" in terms of questions and answers in the format of single or multiple choices, and ranking method. The traceability of "Evaluating Criteria" and "Qualifying Factors" relating to particular project management functions are shown in the following two tables:

Table 3 Qualifying factors for upstream influences

Evaluating Criteria	Qualifying Factors	PM Gaps Based on Survey
Corporate Strategy		
Project management core competency	How satisfied are you with the project management in your organization? How satisfied are you with the project management tools used in your organization?	▪ Limited tools are used ▪ Processes and methods are ad hoc
Market Data/Competition		
Various methods or approaches to the project management.	A systematic approach to project management is value-add in my organization? How do you describe the current status of your most recent project?	▪ Nearly half of the projects are delayed and cancelled for variety of reasons.
Market Strategy		
Selection of project management approach to create a design paradigm for commonality across industries	How do you handle specific communication in your project?	▪ Projects are highly depending on real time communication system, which is difficult for geographic dispersed team.
Regulation		
Compliance with defined standard	The approach used to develop a project schedule.	N/A
Technology		
Search on framework and technology suitable to address	Benchmarking using "other"	▪ Frameworks such as CMM is used in some projects, but not adopted into the organizational culture.

Table 4 Qualifying factors for downstream influences

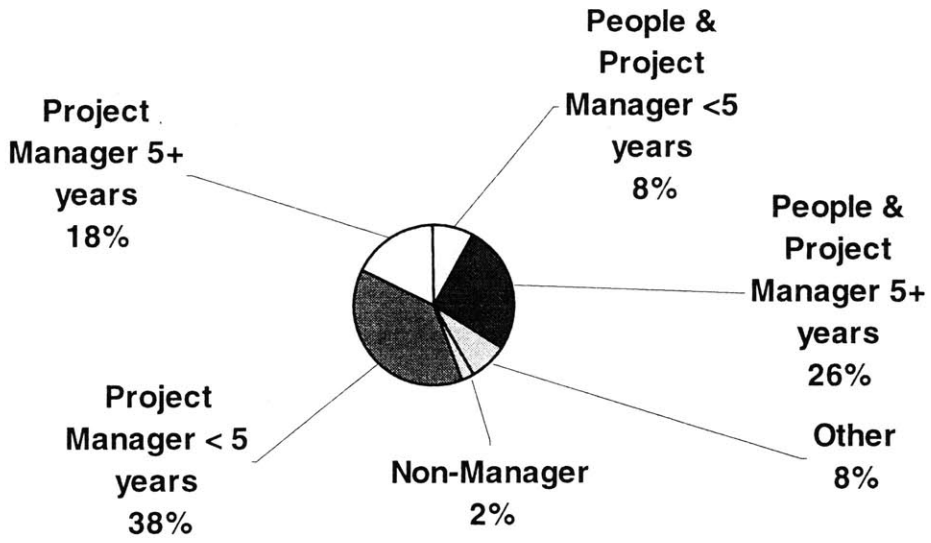
Evaluating Criteria	Qualifying Factors	Gaps
Project Operations		
Resource planning and utilization for effective and efficient task.	How do you manage task assignment in your project? How do you track project schedule? How do you analyze project data? How do you manage risks and problems in your project?	✗ One third of PMs use automated tools to: – Assign project roles & responsibilities – Track project schedule – Manage risks
Project Management Culture Strategy		
Reusable data used for managing project and methods of its use.	Do you use historical data? What makes historical data useful? Have you maintained management control of you project?	✗ Historical data is important, but only 15% utilize project data ✗ Miscommunication, lack of shared leadership and trust, and undefined boundaries are responsible for not having management control
Timing		
Timing to apply the most important factors	How would you rank the importance of Time, Quality, Cost, Reward and Recognition, as they relate to your project?	N/A
Operator		
Most common, applicable and aligned methods used to reduce efforts	Would you like the project deliverables summarized in a single page report format?	✗ Majority would like a single page report summary.
Training		
Screening practices based on applicability to framework	Benchmarking using "other"	N/A

Survey analysis

Given the following professional background of the survey respondent's that are evenly broken down into the following categories, 8 findings are discussed in the following sub sections:

- 80% managed people and/or project
- 56% managed project
- 34% managed people
- 46% managed less than 5 years
- 44% managed more than 5 years

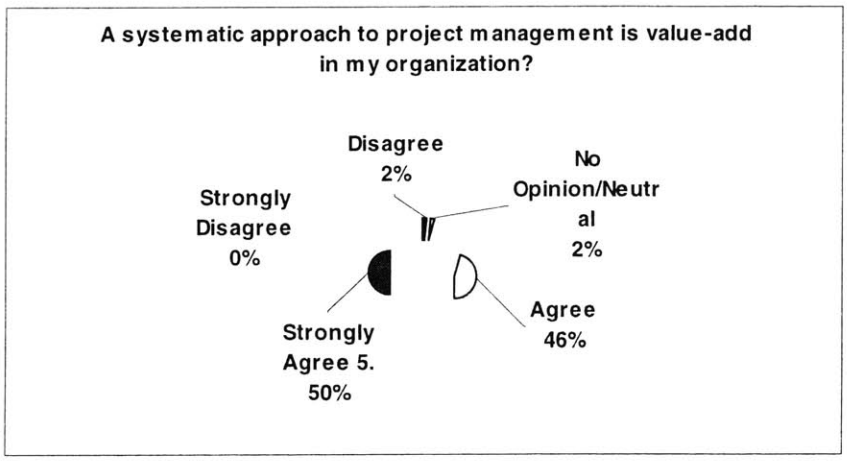
Figure 8 Survey demographic information

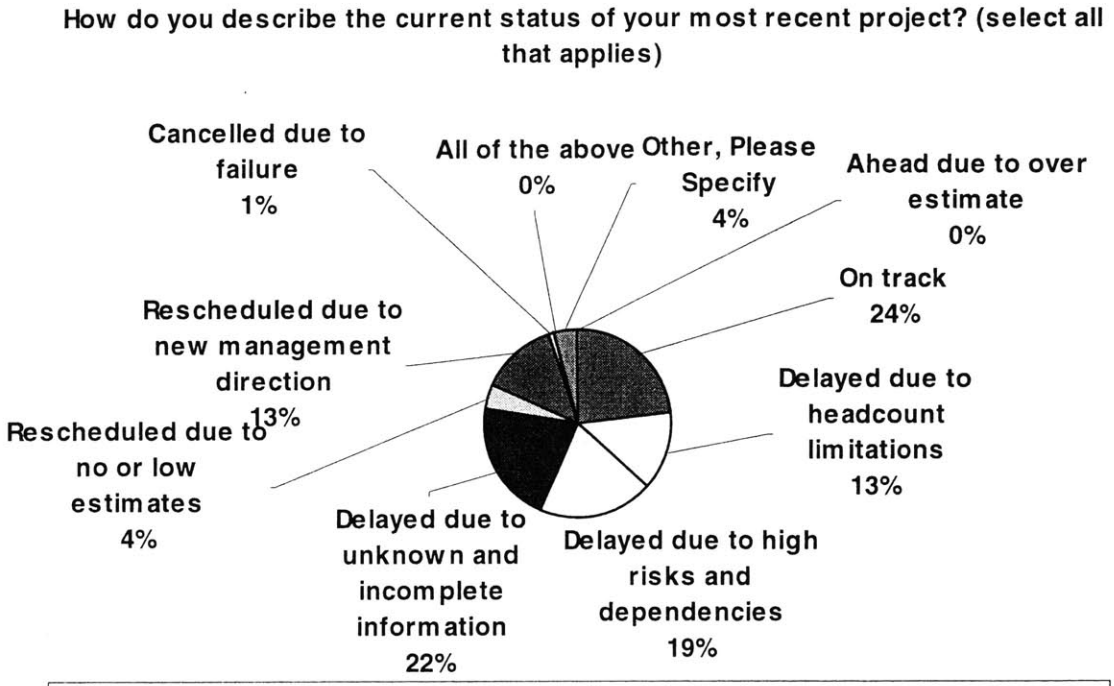


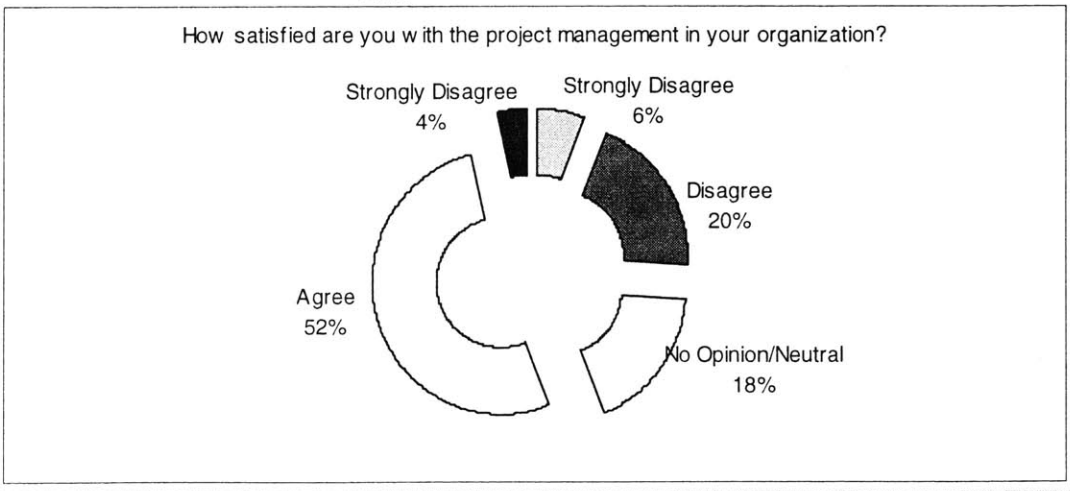
Finding #1

96% of the respondents responded positive to the need for a systematic approach for managing projects. In most areas project activities are performed either manually or automated with limited project management activities functions. The results reveal that managing projects are ad hoc. Even though nearly half are satisfied with their organizational project management approach, nearly half of the projects are delayed or even cancelled for a variety of reasons shown below:

Figure 9 Survey results on project's current status







Finding #2

The results indicate that 50% ± 10% organizations manage their Work Breakdown Structure (WBS) in the following order:

- Major deliverables
- Major milestones
- Customer requirements

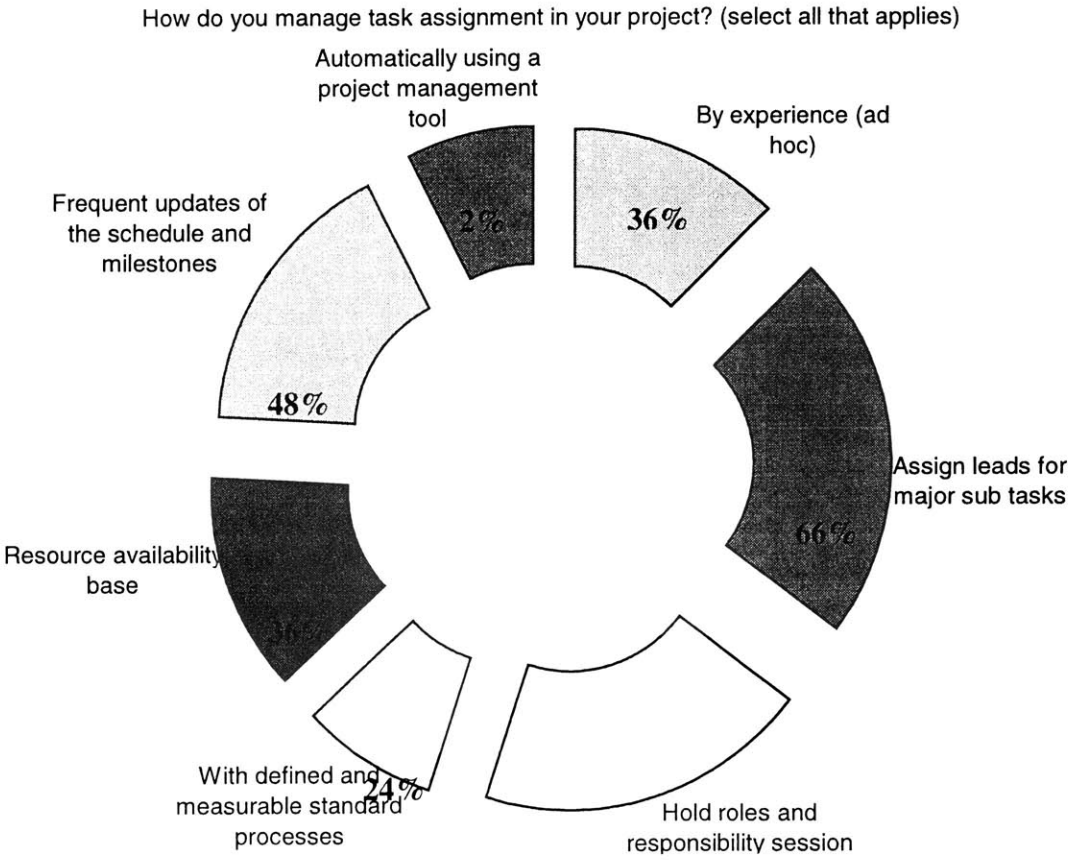
Finding #3

One half reported that project tracking need to be done frequently, but only one quarter use an automated tool.

Finding #4

1 in 4 used measurable standards and an automated tool for task assignment. The following figure shows the task assignment techniques used:

Figure 10 Task assignment techniques according to the survey



56%

Finding #5

Although 80% claimed that they have management control, in the subsequent question, 1 in 5 claimed losing project control due to:

- Miscommunication, undefined boundaries, lack of leadership and trust
- No communication, inadequate funding, lack of processes, and lack of cooperative goals

90% of project communications is done via electronic mail, and 80% are done by team collaboration and periodic formal reviews. Only 1.5 in every 10 use an automated tool. Team collaboration is a major key to project communications, yet only 1 in 2 define a proper communication protocol for their project activities.

Finding #6

1 in 4 use an automated tool to manage risks. 7 out of 10, risk is managed on an event driven or ad hoc basis.

Finding #7

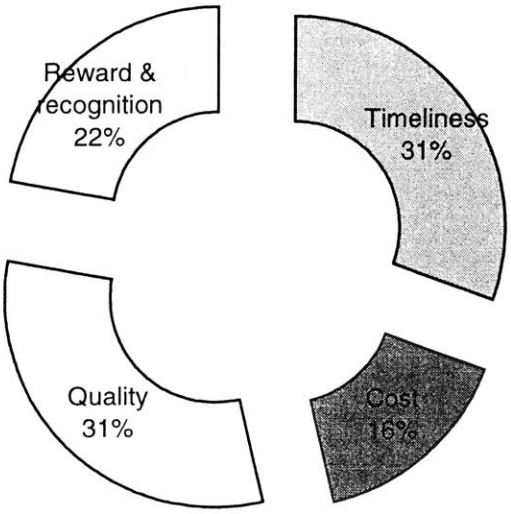
8 in 10 use historical data, the rest believe that the historical data is valuable for corrective actions and communication.

Finding #8

The ranking of importance of project priorities is Timeliness and Quality, with equal ranking, followed by Reward and Cost. Needless to say that timeliness is associated with higher cost, as well as reward and recognition is tied to employee retention ultimately delivering a high quality product. See below for a graphical view of the analysis.

Figure 11 Ranking of project deliverable importance

How would you rank the importance of the following as they relate to your project?



Survey opportunity/limitation

Although, the survey findings provided valuable information for designing an effective management tool, the survey and survey tool contained some limitation which is noted in the caveat section of the survey results documented in the Appendix A.

Furthermore, as an opportunity beyond the scope of this thesis, the survey can be reconstituted after completion of the design of the project management system, to validate the design specifications.

The concluding thought of the above findings coupled with PMA should now lead us to the design approach of the project management system.

3.0 Project Management Design (PMD)

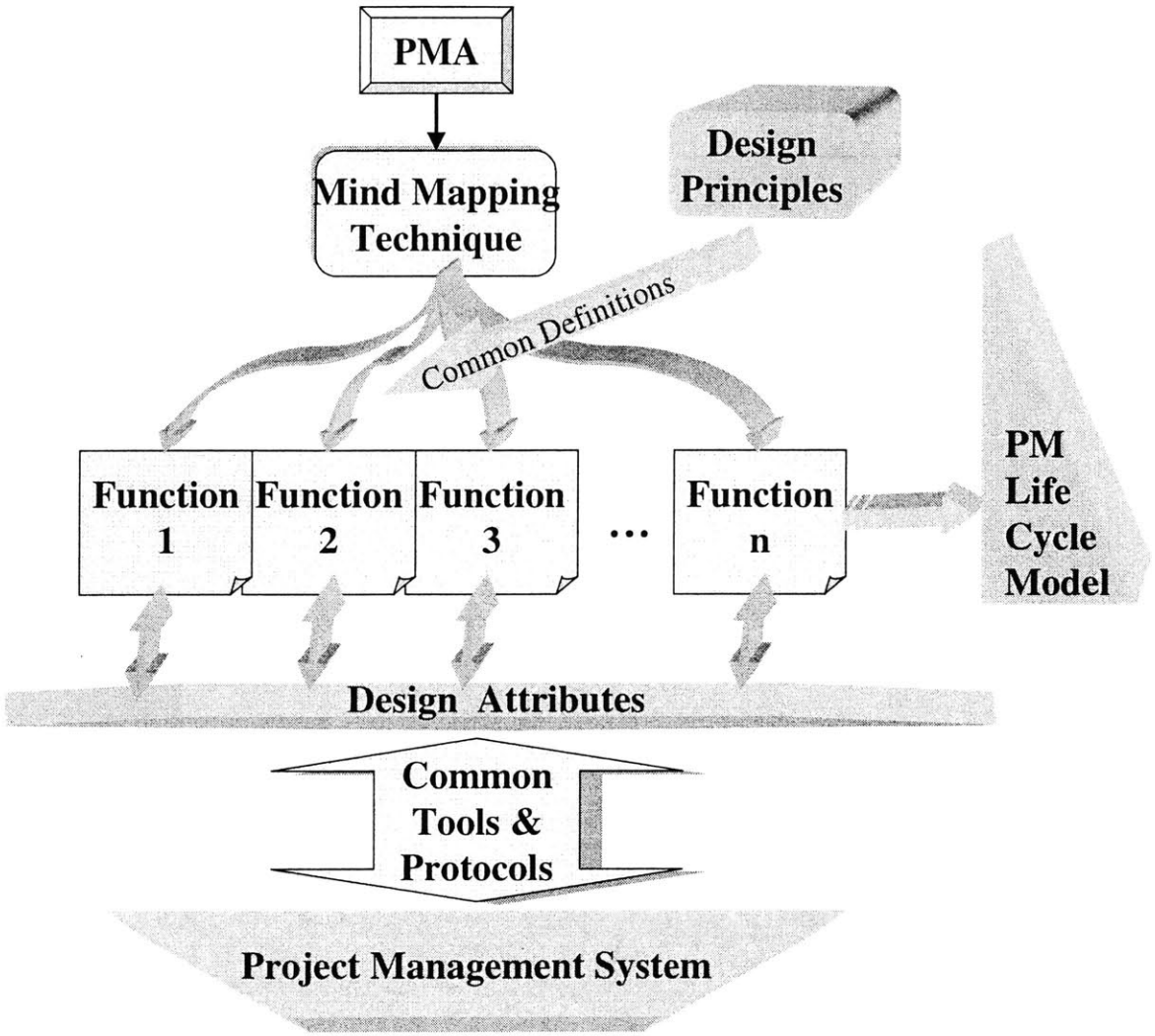
Having established the PMA based on the upstream and downstream influences, and identified common project management gaps, design of the project management system can proceed to meet the need. The following figure depicts the approach to devise the Project Management Design (PMD).

Starting with the Mind Mapping (MM) technique the three dimensions of the design, principles and definitions, functions and Gilani Project Management Lifecycle model lead to the design specification. The design specification is governed by design attributes, consisting of common tools and protocols to form the project management system.

The following figure depicts the progression of the design methodology used in this paper: As shown in the figure, the system design requires proposed functionality of the system. The functions of the proposed project management system, are driven from the three dimension of Gilani project management lifecycle model, the sketch of the design (Mind mapping) and design principals (common definitions).

Then the identified functions will be translated into the design attributes of the system followed by the application of these attributes in the form of common protocols and supporting tools holistically viewed as the project management system.

Figure 12 Project management model design method



The following sub sections are the detail of the design process documented above.

Mind Mapping dimension

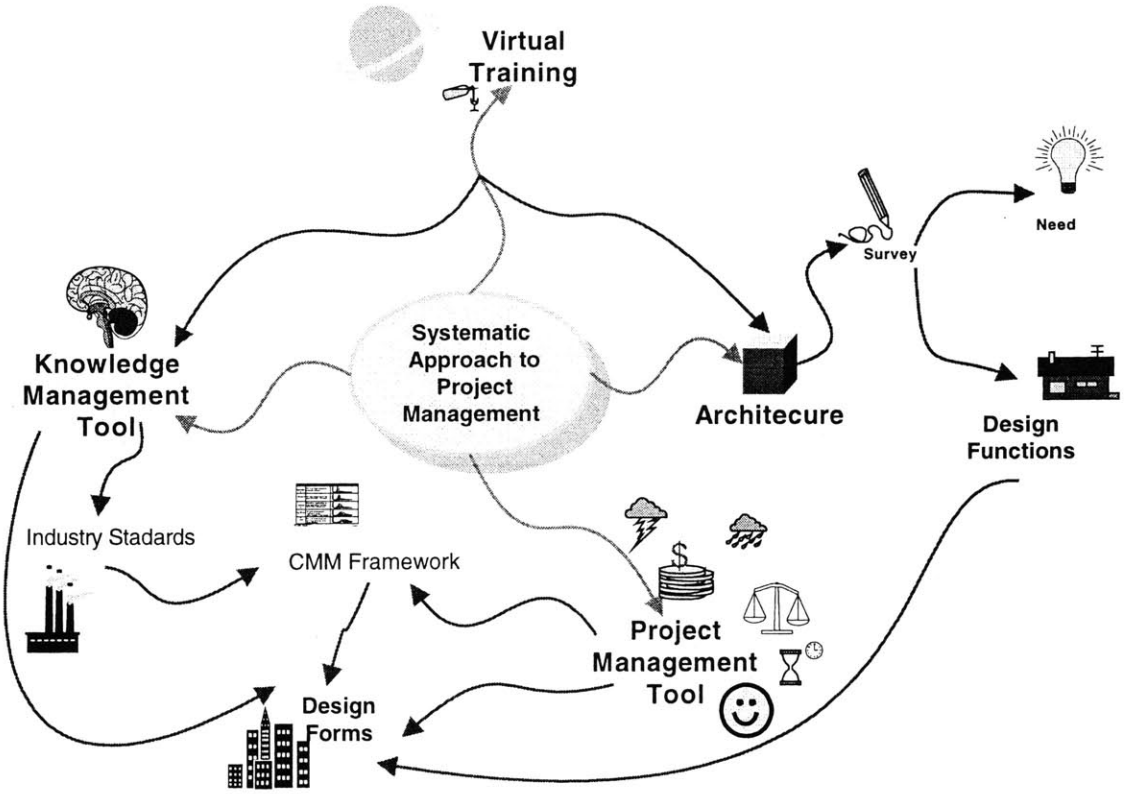
Starting with the objective, the Systematic Approach to Project Management, supporting functions were captured as a branch for functional area of the system. In general, Mind Mapping (MM) [9]

[9] Buzan, T. (1996), *"The Mind Map Book"*, Plume, ISBN 0-452-27322-6.

technique is used to develop the design sketch or preliminary requirement of the desired purpose.
Every project manager desires that the product deliver on-time, within budget, according to specification. To do so, requires the organization to perform in a predictable manner in accordance to project plans. Mind mapping clusters the ideas generated by key project mangent requirements.

The following diagram indicates that for an effective project management tool, we need an architecture and design corresponding to the needs. These needs are the project management functions performed in general terms. Industry's best practices are major contributors in understanding the project management needs in designing the best form of the implementation. In addition, this tool requires an embedded virtual training (effort free), and capable of managing project knowledge and information.

Figure 13 Mind mapping for project management tool



Design principles dimension

Common definition for project

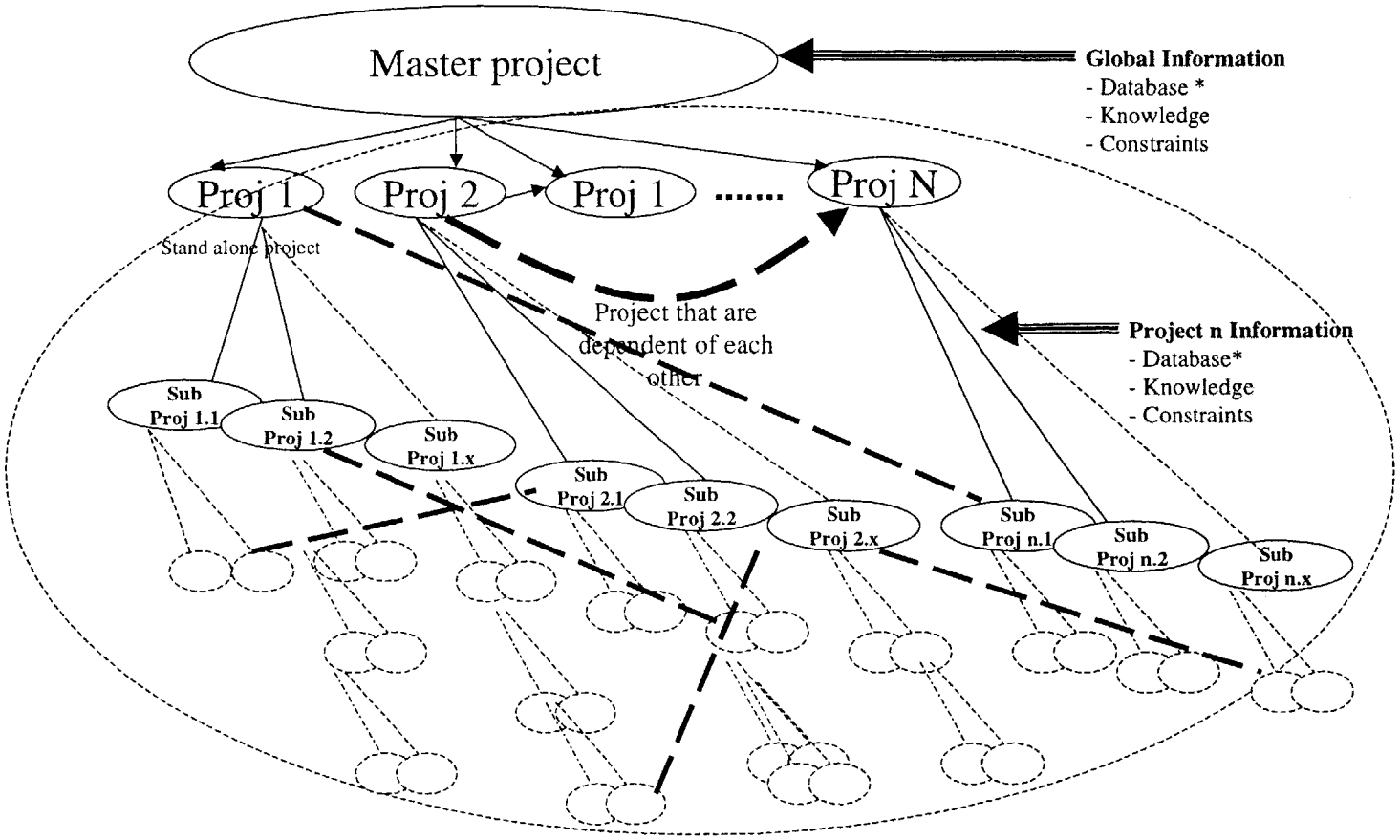
Project is defined as set of planned activities delivering Process and/or Product; and can be viewed as n-tiered Process or Product(s).

In order to simplify a complex project, the following principles are assumed:

1. Partition the project into sub projects, then further subdivide them into tasks until there are no tangible entities left to subdivide.
2. For each master and sub project, define the knowledge that can be shared across or independently managed within the sub projects.
3. Identify links and constraints between each sub project.
4. Include knowledge and constraints as global and project specific information

These principles are shown in the following figure.

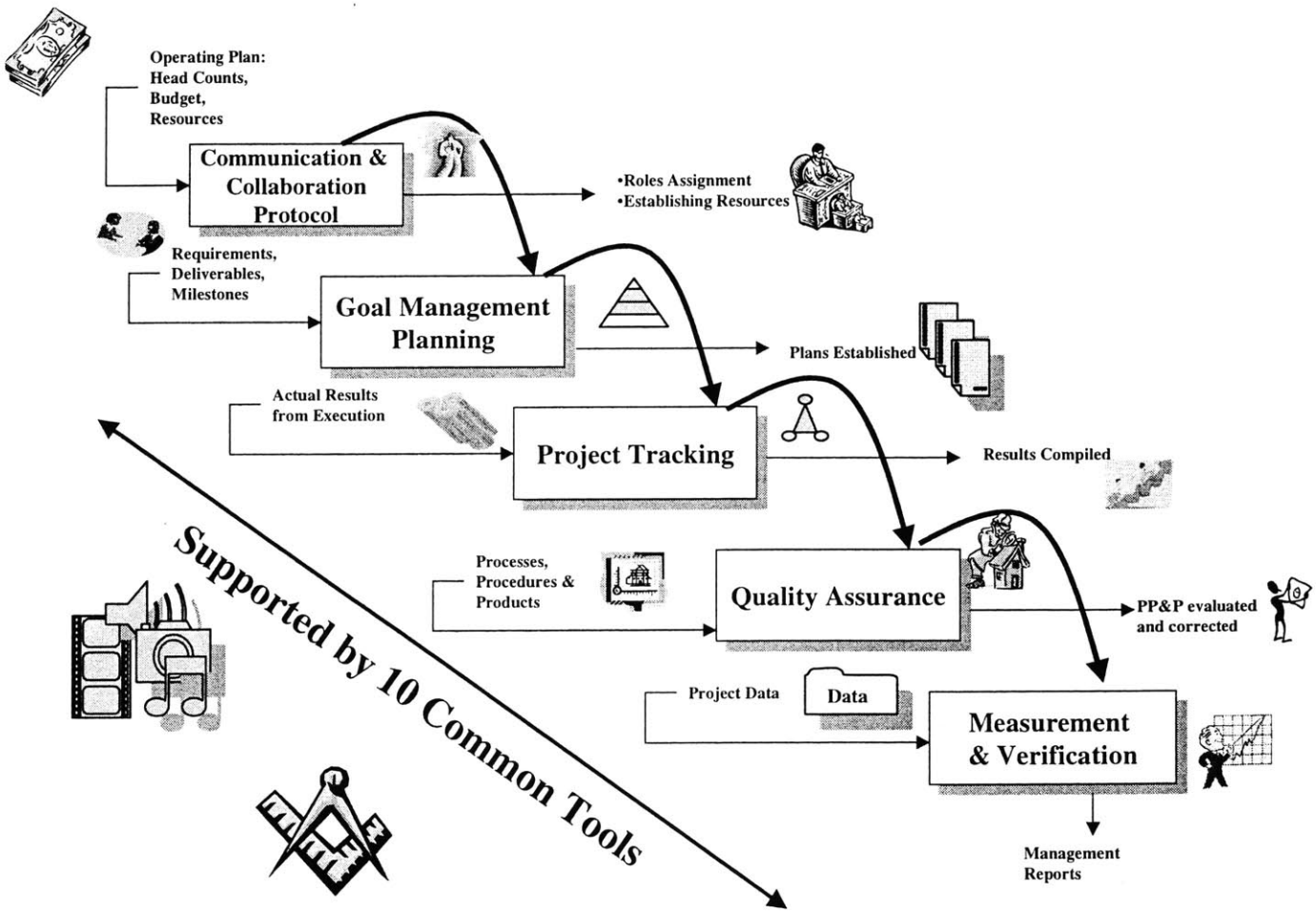
Figure 14 Design principles



Project management life cycle model dimension

The system is a project management life cycle model consists of common functions performed by project managers.
Functional design of this project management system includes interactions between functions, and sequencing of functions, captured in Functional Flow Diagrams (FFDs).
Common elements are the breakdown of processes and/or products of the defined project into common boundaries and definitions. A project is consist on a series of paths defined as phases. At each phase there are inputs and outputs that hand off each phase to the next. These phases may be repeated until the process and/or product goals are met. The 10 common tools to support this life cycle are discussed in the following sub sections.

Figure 15 Proposed project management life cycle model, Roshanak Gilani ©



Design functions

Based on the following research:

- internet research summarized in Appendix B,
- the survey results, and
- software Engineering Institute (SEI), Capability Maturity Model (CMM) summarized in Appendix C,

the following project management functions are defined to integrate people, tools, and methods for the proposed project management tool. The project planning establishes reasonable plans for managing the project functions, such as:

- Establish commitments
- Develop Statement of Work (SOW)
- Define the project life cycle, discipline and standards for common processes, procedures, methods and tools used to accomplish objectives
- Define communication protocols
- Define change management throughout the life cycle of the project for consistencies and tractability of objectives
- Manage knowledge
- Develop estimates for work to be performed as Work Breakdown Structure, broken down into either product or process as:
    - Deliverables
    - Milestones
    - Requirements
- Develop risks associated with estimates and dependencies
- Define thresholds to balance the projects
- Define dependencies, risks, and critical path
- Quality assurance that establishes standards are followed
- Define measures
- Collect measures
- Track progress
- Evaluate dynamics of the project in case of tradeoffs and influences of the tactics to the final results[8]

[8] This is an opportunity feature function, beyond the scope of this paper.

Design attributes

As a next step in the design process, two attributes are described in detail:

1. Common tools (total of 10 out of 11) to support project phases/functions.
2. Common protocols tied to five phases/functions performed by project managers.

Common definition for tool

Tool is defined as automated procedures and disciplines to be utilized across the projects in this thesis. The following tables are the detail descriptions of the 10 supporting tools for the desired project management tool. The following is the description of the common tools defined for the proposed project management tool.

Common tools in project management

Common tools are defined to support each phase of the project management model. These tools are defined in detail at the later sub sections. Details include tool name and id, function and form, and the method by which the training shall be available to users.

The following tables are the specification of the 10 common tools defined in this paper. The table format is used for describing the specification of each tool for consistency purpose. The elements of the stand table are defined as follow:

- **ID#** - graphical representation and the tool id#
- **Tool -** the tool name
- **Function** – specific function that the tool performs
- **Form** – the physical form of the tool
- **Training** – the operator training form
- **Industry's best practices** – the best practices or applications that can be utilized for the development of the tool
- **Proposed practices** – a proposal as to what was identified as a project management need for the functional tool

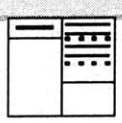
Tool specification

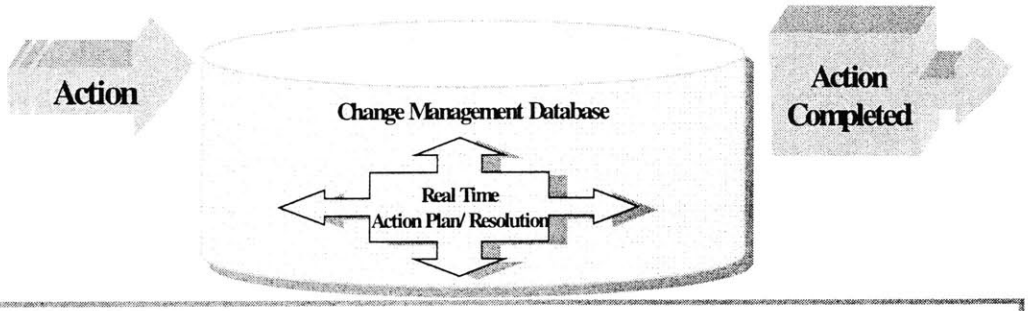
The following is the detail design specification of the common tools identified to support the project management system. This paper proposes 10 common tools to support Gilani project management life cycle model which is also defined as protocols.

Table 5 Communication tool

ID#	Tool	Function	Form	Training
				
1	Communication Tool	To flow the communication top down and across to whole or key project members	E-mail notification or other forms	Instruction Links
Industry's best practices: Microsoft outlook, standard electronic communication **Proposed practice**: Define roles assignment, collaboration, other. The communication tool shall also determine the inner/inter dependencies.				

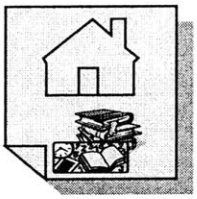
Table 6 Change management tool

ID#	Tool	Function	Form	Training
2 	Change Management	Tractability and configuration control	Web database	Step by step instruction links



Industry's best practices: Rational ClearQuest, others
Proposed practice: Changes entered to a web based database and affected groups are notified on the action and resolution. Project tasks also considered as action with specific assigned owner. The change management tool shall also manage the inner/inter dependencies.

Table 7 Document management tool



ID#	Tool	Function	Form	Training
3	Document Management	Project assets configuration control Historical Data	Web/Version Control document management tool Historical view of the project	Step by step instruction links

Industry's best practices: Xerox Docushare, MIT Command, etc.
Proposed practice: A web database tool, for storing projects plans and other information, capable of version controlling and permission lists, with defined standard structures, such as, plans, tools, processes, procedures, data, news, etc.
The Document Management tool shall also manage the inner/inter dependencies.

Table 8 Problem solving tool

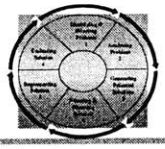
ID#	Tool	Function	Form	Training
				
4	Problem Solving	Stimulus methodical approach to diagnose a problem	Step by step methods that compiles the results for final view	Step by step instruction links
Industry's best practices: Xerox Problem Solving Technique, etc. **Proposed practice**: Xerox Problem Solving Technique or the simplified version described in Appendix E. The Problem Solving tool shall also manage the inner/inter dependencies.				

Table 9 Critical path/dependencies tool

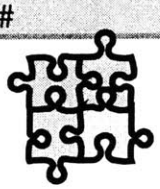
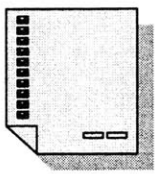
ID#	Tool	Function	Form	Training
5 	Critical path/depen-dencies	Manage dependencies and critical path across projects	Tractability tables and graphical view	Interpretation and recommenda-tion
Industry's best practices: Rational RequistPro. **Proposed practice**: virtual links and traceability tables, e.g. at any level be able to link. The Critical path/dependencies tool shall also manage the inner/inter dependencies.				

Table 10 Tracking/verification/quality tool

ID#	Tool	Function	Form	Training
6 	Tracking/verific ation/quality	To verify and quality as a result of continuous tracking	Red shades for unqualified functions and forms	Interpretation and recommendatio n

ID#	Tool	Function	Form	Training
Industry's best practices: Time tracking, estimation tools, Microsoft Excel **Proposed practice**: use a web base estimate/tracking database. The tool shall use the algorithm described in Appendix D for quality reports. The Tracking/verification/quality tool shall also manage the inner/inter dependencies.				

Table 11 Plan builder tool

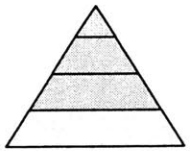
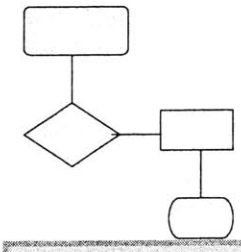
ID#	Tool	Function	Form	Training
7 	Plan builder	To build the statement of work, key deliverables, assumptions and risks	One page standard plan	Step by step instructions
Industry's best practices: N/A **Proposed practice**: A web base tool that prompts for specific project information, start and end dates for the deliverables, or milestones, or requirements and capable of capturing key risks and inner/inter dependencies.				

Table 12 Process builder tool



ID#	Tool	Function	Form	Training
8	Process Builder: Graphical, Descriptive	To build the standard process to be used for the project	One page graphical and procedures	Step by step instructions
Industry's best practices: Visio pro **Proposed practice**: A web base tool that prompts for specific tasks, inputs and outputs, measures and verification method, roles and entry/exit criteria capable of version control. The Process builder is graphical and descriptive and shall also manage the inner/inter dependencies.				

Table 13 Report builder tool

ID#	Tool	Function	Form	Training
9 	Reports	To track the results To provide project's value for executive and managerial views	Global view, Dependencies view, Main view for schedule and progress	Step by step instructions Automatic or customized
Industry's best practices: Microsoft Office **Proposed practice**: A web base tool that can show a single page view of a project and the project with respect to sub and super projects with specific links to dependencies. The graphical view of the reports can be shown in the order of milestones, or deliverables, or requirements, depending on the defined plans. Based on the efforts and resources tracked the report shall provided statistical information such as resources plan vs actual, as well as capability of comparing one project relative to other.				

Table 14 Memo tool

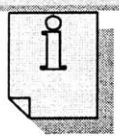
ID#	Tool	Function	Form	Training
10 	Memo	Collect side information	White pages	None
Industry's best practices: Web messaging tools. **Proposed practice**: either very basic memo web messaging tool, or use the change management tool for tracking information. The Memo tool shall also determine the inner/inter dependencies.				

Table 15 System dynamics/optimization tool - opportunity

ID #	Tool	Function	Form	Training
11 [8]	System Dynamics/Optimization	To analyze the dynamics and optimize the tradeoffs	Recommendation report with graphical view of the system flow	Automatic

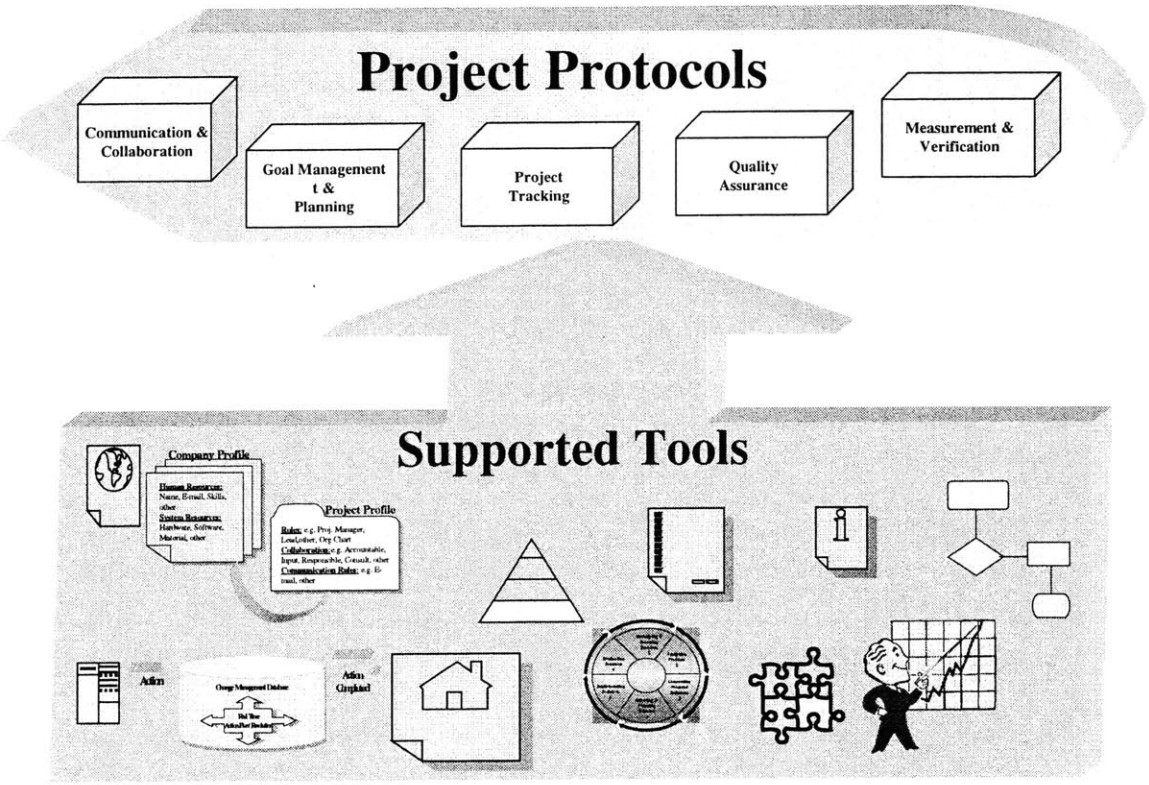
Industry's best practices: System Dynamics tools.
Proposed practice: N/A

[8] Opportunity tool beyond the scope of this paper.

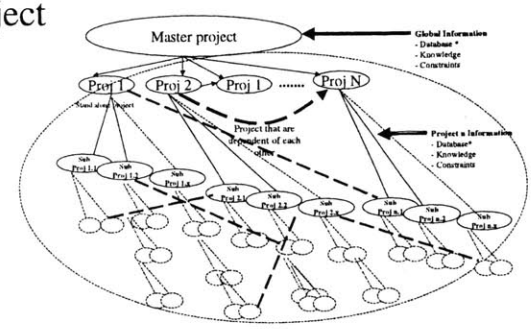
Project management system

The integrated system is comprised of the system protocols referenced in Gilani life cycle model, and the 10 supporting tools defined earlier. As shown in the following figure, a project management system consists of five project protocols and ten supporting tools as indicated below.

Figure 21 Holistic view of a project management system



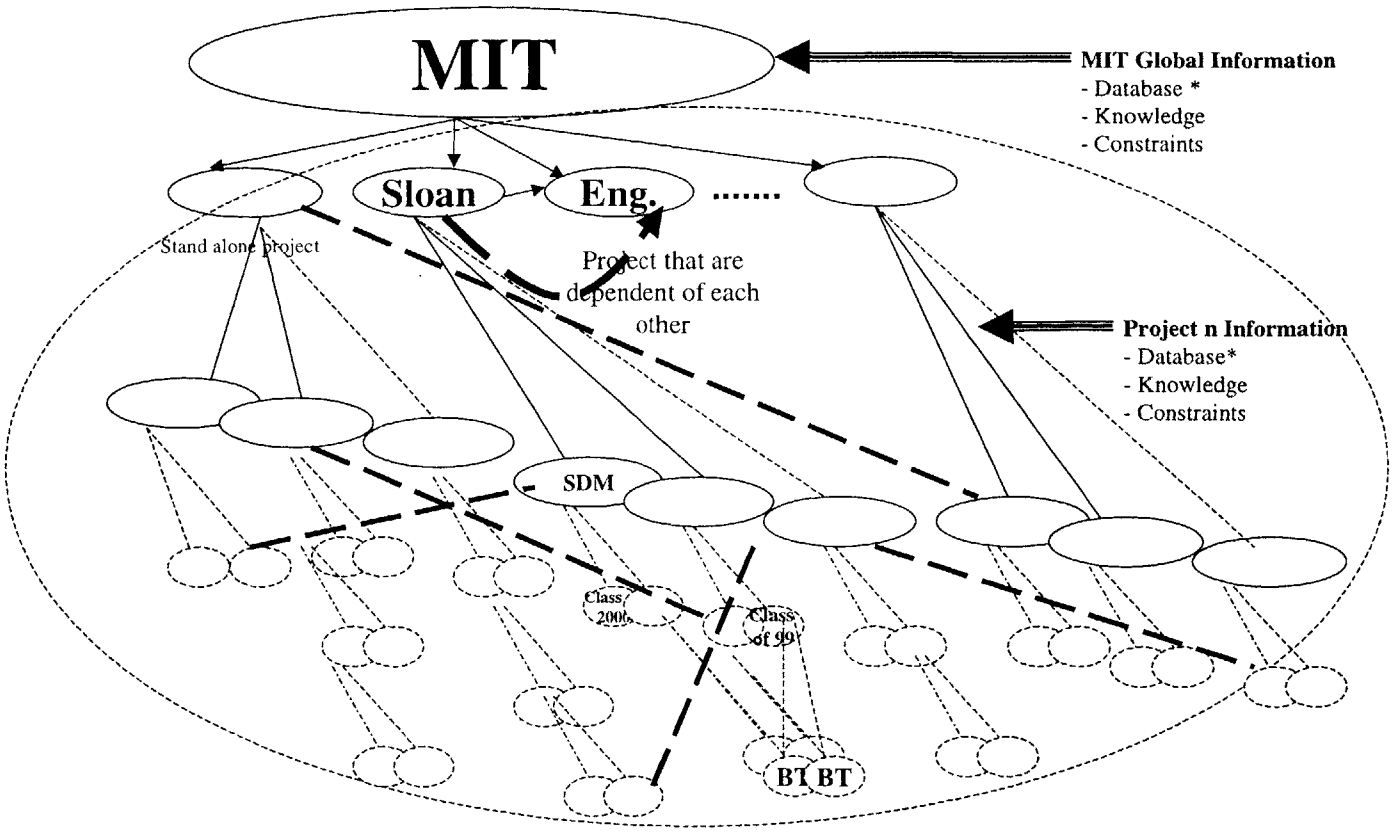
This system depicts the generic element of a master project management system. The system can be the master project or it can be the sub projects of the master project. The figure shows the holistic view of a complex project consists of multiple systems with various dependencies.



4.0 Application of Project Management Tool

To illustrate how such a tool may be applied in a real life case, this chapter explores the example of the MIT/SDM program. This analysis is hypothetical and may not exactly map to the existing MIT projects.

The following is how SDM will fit in as a project into the big picture, master project, called MIT.



The proposed project protocols and supporting tools are available at any project level, such as,
MIT->Sloan->SDM->Class of 2000->Fall Business Trip-> Speakers->Class Schedules->...
The chain can infinitely grow as project becomes more complex and the dependencies and project information are defined using the proposed project system tool at each project level. The parent-child relationship exists between projects, where the children are capable of inheriting the characteristics of their

predecessors. Due to limitation of the design, further drill down of the application is beyond the scope of this paper.

5.0 Conclusion

In the effort to make products better, faster, and cheaper, new methods of improvement initiatives need to be employed to focus and align company functions and structures (e.g. product development and delivery) to meet drifting customer expectations.
Business Leaders are constantly looking to improve competitive footing. From experience, the best way is to establish and control improvement initiatives through a framework that measures progress enhancements back to the company's overall performance. Typical metrics are:

- Increased Return On Asset (ROA)
- Improved Time-to-Market
- Reduced product defects
- Reduced costs
- Improved predictability
- Improved Product Quality
- Employee morale (productivity)
- Increased communications

Various initiatives experienced at our places of employment have yielded common experiences. Often starting with a bang (e.g. new training, new ways to conduct business, new forms to fill out, extra categories in performance evaluations, etc.) and ending with a fizz because there is no way to gauge improvement or value added. This lack of information often fuels political or cultural resistance and the company ends up losing competitive footing, time, money invested, and ultimately, employees.
A systematic approach to implementation of a management framework minimizes risks and 'unforeseen problems.' Control and order are maintained as the company migrates to the new approach.
The types of company changes being conducted affect the basis for clustering people (e.g. product, geography, target market, etc.), which in turn alters structures, relationships, and

communications. For example, engineers are exchanging ideas with salesmen and manufacturers. These new interactions cause an environment that fosters a culture of idea exchange. Because people usually want to be heard, understood, and given an opportunity to demonstrate their skills, the corporate community usually welcomes these new 'listening' forums. However, these forums are tested to see if there is any responsiveness to honest communication. Cultural buy-in and contribution will occur according to the veracity of the information from these forums (positively or negatively).

The tools proposed in this paper, are invisible process changes diminishing the amount of effort required to execute the project management activities.

Adoption of this tool primarily occurs in three domains (organizational lenses):

- Strategy - target markets the company is pursuing
- Politics - how the company controls its operations
- Culture - work-life conditions for its employees

There are many challenges to implementing changes to strategy, politics and culture. One CEO said 'if we don't manage change then we will enter into change management.' Change is imminent. If a company is no longer able to keep up with changing environments, then it too will become extinct like the mighty dinosaur.

Change starts from the established business goals, where the change would be most appropriate and beneficial. Change does not happen overnight nor is it painless. Without solid management of change through all three organizational lenses, the company will be doomed to wander aimlessly in confusion, anxiety, and frustration as depicted in the table above. Solid leadership that is able to frame solutions within the context of the three organizational lenses will lead the company on to successful change; making it adaptable and competitive for future business ventures.

Developing reliable and usable tools that are delivered on time and within budget is a difficult endeavor for any organization. As a software project continues to increase in size and importance, problems become more magnified. These problems can be overcome through sustained effort focused at building a model for effective management practices.

The ultimate goal is the ability to predict and achieve positive results. This Project Management tool is prepared to meet total requirements in the bulk of project management. Long term profitability is obtained through providing a competitive product and personalized service, as well as managing the bottom line. The tool proposed in this paper, will provide instant project supervision and Just In Time (JIT) training – online training through usage - for the operators. The training instructions are provided in English using a simple language.
As an opportunity beyond the scope of this paper, the model presented in this paper can be developed as a project and knowledge management software package for commercial use. In addition the system hardware and software requirements of such a tool is not evaluated in this paper.

The system proposed in this paper may posses some limitations. Due to incomplete and accurate information, the proposed management system may be challenged for delivering accurate results; in addition, historical data is not available for a master project defined in the overall model.

Appendix A

Project Management Survey

Survey Results

Launch date	**7/23/01**
Closed date	**8/3/01**
Total respondents	**81**
Total responses compiled by the tool	**50**

Please take 10 minutes to complete the following Questions!

1.	**Demographic information:**		**Number of Responses**	**Response Ratio**
Non-Manager			1	2%
Project Manager < 5 years			19	38%
Project Manager 5+ years			9	18%
People & Project Manager <5 years			4	8%
People & Project Manager 5+ years			13	26%
Other, Please Specify			4	8%
1 XBS MANAGER, CLIENT OPERATIONS 2 Project Manager for lot more than 5+ years, but only a people manager for about 4+ years 3 5+ years as mgr. of projects & people; currently a proj. mgr. 4 Project Mgmt Coordinator		**Total**	**50**	**100%**

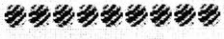
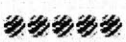
Benefit: Please rate your agreement on a scale of 1-5.

2.	A systematic approach to project management is value-add in my organization?	Number of Responses	Response Ratio
Strongly Disagree 1.		0	0%
Disagree 2.		1	2%
No Opinion/Neutral 3.		1	2%
Agree 4.	■■■■■■■■	23	46%
Strongly Agree 5.	■■■■■■■■■	25	50%
	Total	**50**	**100%**

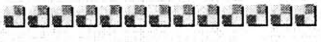
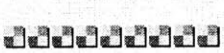
3.	How satisfied are you with the project management in your organization?	Number of Responses	Response Ratio
Strongly Disagree 1.	*	3	6%
Disagree 2.	****	10	20%
No Opinion/Neutral 3.	****	9	18%
Agree 4.	**********	26	52%
Strongly Disagree 5.		2	4%
	Total	**50**	**100%**

4.	How satisfied are you with the project management tools used in your organization?	Number of Responses	Response Ratio
Strongly Disagree 1.	■■	4	8%
Disagree 2.	■■■■■	9	18%
No Opinion/Neutral 3.	■■■	8	16%
Agree 4.	■■■■■■■■■■	26	52%
Strongly Agree 5.	■	3	6%
	Total	**50**	**100%**

5.	Additional Comments			
1	My disagree means dissatisfy	**Total**	**50**	**100%**
2	Need selections but not mandate its use.			
3	Focus from quality to delivery			
4	Difficult to share MSProject files electronically			
5	ad-hoc proj. mgmt; CMM gets lip service			

6.	How do you describe the current status of your most recent project? (select all that applies)	Number of Responses	Response Ratio
Ahead due to over estimate		0	0%
On track		23	46%
Delayed due to headcount limitations		13	26%
Delayed due to high risks and dependencies		19	38%
Delayed due to unknown and incomplete information		21	42%
Rescheduled due to no or low estimates		4	8%
Rescheduled due to new management direction		13	26%
Cancelled due to failure		1	2%
All of the above		0	0%
Other, Please Specify		4	8%

1 Testing technology at customer site.
2 Waiting final customer approvals

7.	What approach have you used to develop project's Work Breakdown Structure (WBS) for schedule?	Number of Responses	Response Ratio
Major deliverables		32	64%
Major milestones		25	50%
Customer Requirements		24	48%
Other, Please Specify		2	4%

1 Customer Deadlines
2 resources

8.	How do you track project schedule? (select all that applies)	Number of Responses	Response Ratio
By experience (ad hoc)		14	28%
Frequent review sessions		28	56%
Frequent updates of the schedule and milestones		29	58%
Track baseline & re-plans		10	20%
Track Plan vs. Actual		30	60%
Automatically using a project management tool		14	28%
Other, Please Specify		1	2%
1 Microsoft project			

9.	How do you manage task assignment in your project? (select all that applies)	Number of Responses	Response Ratio
By experience (ad hoc)		18	36%
Assign leads for major sub tasks		33	66%
Hold roles and responsibility session		28	56%
With defined and measurable standard processes		12	24%
Resource availability base		18	36%
Frequent updates of the schedule and milestones		24	48%
Automatically using a project management tool		11	22%
Other, Please Specify		1	2%
1 Resource skills and experience			

10.	Have you maintained management control of you project?	Number of Responses	Response Ratio
Yes		39	81%
No		9	19%
	Total	**48**	**100%**

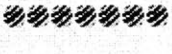
11.	If not please selects all that applies:	Number of Responses	Response Ratio
Rapid changes to the schedule cause inaccurate status of the project		3	23%
Inadequate tools		3	23%
Inexperienced personnel		3	23%
Inadequate funding		5	38%
Miscommunication		6	46%
No communication		5	38%
Virtual teams confusing hierarchy and lowerarhy influence		4	31%
Undefined boundaries		6	46%
Cross functional teams		3	23%
Ad hoc processes		5	38%
Undefined input and output		3	23%
Lack of shared leadership		6	46%
Lack of cooperative goals		5	38%
Lack of trust		6	46%
Lack of team protocols such as communication plans, team member's profile, etc.		3	23%
Loss of project links and networks		1	8%
Oversight on external critical		0	0%

decencies linked to my project			
Schedule overlaps due to lack of consolidation of other related projects		3	23%
Not being able to identify critical path in my project		0	0%
Lack of interest		4	31%
Other, Please Specify		2	15%
1 territorial and political disputes 2 lack of customer support of critical dependencies			

12.	**How do you handle specific communication in your project? (select all that applies)**	**Number of Responses**	**Response Ratio**
Ad hoc on event driven basis		21	42%
Define communication protocols		27	54%
Through major sub-task leaders		24	48%
E-mail to Distribution Lists		44	88%
Periodic formal reviews		37	74%
Daily status		7	14%
Team collaboration		40	80%
Automated tool		7	14%
Other, Please Specify		2	4%
1 Status meetings (frequency depends on the project and team requirement) 2 DocuShare			

13.	**How do you manage risks and problems in your project? (select all that applies)**	**Number of Responses**	**Response Ratio**
Ad hoc on event driven basis		23	49%

Automatically via problem tracking tool		11	23%
Using committees to develop solutions and recommendations		20	43%
Assign specific actions to individuals and track to closure informally		31	66%
Assign specific actions to individuals and track to closure via the following tool		9	19%
Other, Please Specify		3	6%
1 FMEA 2 Change deployment tactics to eliminate forseeable risks.			

14.	**How do you analyze project data? (select all that applies)**	**Number of Responses**	**Response Ratio**
Ad hoc		9	18%
Periodically by using automated tracking tool(s)		10	20%
By define thresholds for critical dependencies, track and measure periodically		16	33%
Hold periodic lessons learned sessions during the project		23	47%
Hold lessons learned sessions at the completion of the project		29	59%
Identify key problems, develop corrective actions and track to closure periodically during the project		38	78%
Identify key problems, develop corrective actions and track to closure for the next		16	33%

project			
Not applicable		3	6%
Other, Please Specify		2	4%
team expertise and feedback/discussion			

15.	**Do you use historical data?**	**Number of Responses**	**Response Ratio**
Yes		38	76%
No		12	24%
	Total	**48**	**100%**

16.	**If not what makes historical data useful? (select all that applies)**	**Number of Responses**	**Response Ratio**
Archive in organized fashion		9	18%
Easy access		10	20%
Action plan lessons learned		16	33%
Estimation resource for similar projects		23	47%
Refine processes and standards		29	59%
Improve communicationcorrective Graphical and analytical reports		38	78%
Other, Please Specify		2	4%

17.	**Would you like the project deliverables and summarized in a single page report format?**	**Number of Responses**	**Response Ratio**
Yes		37	74%

No		1	2%
Neutral	●●●●●	12	24%
Other, Please Specify	●	2	4%
1. In a project charter or SOP at the beginning of the project			

18.	**How would you rank the importance of the following as they relate to your project?**				
Percentage indicates total respondent ratio and parenthesis indicate actual number.	**1 Strongly Disagree**	**2 Disagree**	**3 Agree**	**4 Strongly Agree**	**N/A**
1. Timeliness	4% (2)	2% (1)	28% (14)	66% (33)	0% (0)
2. Cost	8% (4)	10% (5)	42% (21)	34% (17)	4% (2)
3. Quality	6% (3)	2% (1)	24% (12)	68% (34)	0% (0)
4. Reward and recognition as a result of contribution to the project	4% (2)	8% (4)	30% (15)	48% (24)	4% (2)

19.	**May we contact you to follow-up on your answers to the survey?**	**Number of Responses**	**Response Ratio**
Yes	●●●●●●●	16	33%
No	●●●●●●●●●●●●●●●●	33	67%
	Total	**49**	**100%**

20.	**If yes, please enter your name and contact information:**			
No.	**Last Name**	**First Name**	**E mail address**	**Phone Number**
17 respondents released their contact information for further questions.				

Survey caveats and limitations

When survey was deployed there were some limitations and typos where might have influenced the results. However, it is highly unlikely that the reported results are influenced by theses errors. Those error are listed as survey caveats and limitations below:

1. Although there were 71 respondents, the survey tool only compiled 50 responses.
2. Question #3 has a bug -- has 2 "strongly disagree" buttons, one on the agree side, one on the disagree side.
3. Question #4 has a typo, delete the "y" from disagree, and nuetral should be neutral
4. Question #5, after 50 characters, a warning message appears in error.
5. Question #10, change "you project" to "your project" (Have you maintained management control of YOUR project?)
6. Question #11... two errors
   - ✓ lowerarhy is confusing in the "virtual teams confusing hierarchy and lowerarhy influence" bullet
   - ✓ Typo for dependencies in the "Oversight on external critical decencies linked to my project" bullet
7. Question #14 "By define thresholds for critical dependencies", need to be clarified as "track and measure periodically by defining thresholds for critical dependencies."
8. Question #18 is confusing because of including the legend, but it was just a stack rank, not an agree/disagree

Appendix B

Evaluation of tools and techniques

Virtual project management (VPM) is the Information Age equivalent of management by walking around. Most recently, the rise to dominance within organizations of Internet-based collaboration tools offers new possibilities for web-based project management.

Doing, sharing, measuring "A virtual project is a collaborative effort towards a specific goal or accomplishment which is based on 'collective yet remote' performance," according to a seminal paper on the topic. Another source sets "working together, apart" as the goal of enterprise networking. These modes of work share a need for management tools that enable communication and coordination at a distance.

In addition, many projects require the concerted effort of several individuals sharing a common set of tools. For example, an engineering team might use a computer-aided design (CAD) program to develop and compare design alternatives without holding a physical meeting. Look at the kind of project management activities associated with this process:

A task must be defined to develop alternative designs based on project requirements:

Resources -- people, time, expenses, if any -- must be allocated to the task.

The team members involved must communicate before and during the task, both with each other (design issues) and with the Project Management (PM) (administrative status reporting). The PM needs to track the task, and based on performance relative to allocated resources, administer course corrections. There is room in these activities for several layers of information system support:

Communication implies e-mail, phone calls, memoranda (hopefully as e-mail attachments but possibly as paper), and other media.

Collaboration goes beyond basic communicating to sharing design information, which for all but the simplest projects, will reside in specialized repositories such as CAD programs, CASE tools, simulation software, etc.
Tracking and leveling resources are functions performed by traditional PM products.
In addition, some organizations are required by regulation or commitment to a specific methodology (e.g., ISO 9000), to maintain complete configuration control over project artifacts. A pharmaceutical firm, for instance, might need to store not only the final specification for a new drug but all alternatives and iterations leading up to it. In such cases the dimension of process management can consume more resources than the projects themselves.
Drug manufacturers and bridge builders weren't exactly on hold until the advent of distributed computing. All of the activities mentioned so far have been handled for years -- since the start of the Industrial Revolution, in a sense -- with pencil, paper and human ingenuity. How do electronic information systems change this, and how do web-based applications, in particular, add value?

Communication

This is networking's quick hit. E-mail allows ideas to flow asynchronously (i.e., without parties online at both ends), enabling work to flow across holidays and time zones. E-mail also creates, with no incremental labor, a searchable audit trail, key to many formal processes.
Taking this idea a step further, consider how products like Microsoft® Outlook™ support and extend project communication. Outlook integrates a multi-protocol e-mail client with directory, scheduling, and journaling functions. Through journaling, the process of keeping a record of work performed, Outlook extends the concept of automatic audit trail creation to include phone calls, faxes and other non-integrated communications.
Unfortunately, Outlook97 happens to be painful to use and miserably insular when it comes to sharing project information. But the integration potential is there, and hopefully, will be

better realized in future releases. Meanwhile, similar functionality is on tap in competing Web-based messaging clients, such as Netscape Communicator™ and Lotus Development Corp.'s Notes 5.0 client.

Remote collaboration

The ability to "work together, apart" is hardly possible without shared storage and concurrency control -- solved problems, thanks to client/server database technology. A good example of a product that enables web-based collaboration is NetObjects TeamFusion, reviewed in this issue of IDM. TeamFusion facilitates the construction and maintenance of complex web sites by multi-developer teams.

In addition, TeamFusion allows contributors not directly involved in web development, to add content through a form-based Java applet, accessible with any browser. Browser-based project collaboration is going to be one of Java's "killer apps," you betcha, and a theme you will see more of in Part II of this article.

Of course, Java is not the only distributed computing platform on the block. Microsoft's Component Object Model (COM), lately folded into a new marketect called DNA (Distributed interNet Architecture), holds out much the same prospect as Java for providing remote access to shared workspaces and applications. CORBA, on the other hand, does not. While the Common Object Request Broker Architecture standard is arguably more mature and better integrated than DNA, it lacks the visual control elements present in both Microsoft's ActiveX and Java's AWT. This relegates CORBA to adding value behind the scenes while Java and DNA duke it out on your desktop.

Project management

Integrated messaging tools like Lotus Notes and design collaboration tools like TeamFusion do an adequate job within their respective domains. When a project manager needs to asses tasks, assign resources and track performance, he/she must look elsewhere -- specifically, to project management software. PM software adds value by facilitating the administrative chores

associated with teamwork, from schedule production and cost estimation to critical path analysis.

"Is the project on target?" PM software's agenda is to answer this question, and as anyone familiar with tools like Microsoft Project, Primavera Systems SureTrak Project Manager or Scitor Inc.'s PS6 can attest, they do little else. These products are intended for use by professional managers, not by members of project teams. They add no value as task collaboration tools because they do not understand the vertical knowledge of specific problem domains.

This kind of tool is, of course, indispensable within a narrow administrative domain. Some products, like SureTrak Project Manager from Primavera Systems Inc. and Microsoft Project 98, can publish current project data to a web server, making status information and associated files available to all comers through a standard issue browser. Web publishing is much more efficient from both a cost and client configuration standpoint than the per-seat licensing model of older PM products, which requires every user who might conceivably need access, to install a full copy of the client software.

Both SureTrak and Project 98 also feature extensive e-mail integration. In SureTrak's case, users can send messages about project data, screen captures, and selected activities through a gateway called Primavera Post Office to team members who can then review, approve and merge updates back into the project schedule. Microsoft Project 98 goes these workgroup capabilities one better by giving users a choice between e-mail and web-based communications.

These features bring aspects of "management by walking around" to the virtual project realm. It is important to remember that collaboration in PM software remains strictly limited to project management functions. Even 'best in class' products like Project 98 and SureTrak Project Manager cannot "reach out and touch" vertical applications. For instance, a drafting tool such as AutoCAD for construction projects, or Rational Rose, Rational Software Corp.'s system modeling tool, could be used for software development projects.

As a result, teams have had to turn to a hodgepodge of non-integrated tools, each of which supports a facet of virtual work -- project/process management, project communication, or

collaboration on project tasks. Only recently have tools capable of providing a complete process management framework for virtual work begun to appear.

Web-based project infrastructures

Let's recap. Virtual projects -- "working together, apart" -- require communication, collaboration and project management. The present generation of software aims to support work within each of these domains by leveraging client/server technologies such as shared data access, standards-based messaging and browser economies.

Not until now, with the impending rise of web application technologies such as Java, ActiveX and XML, have project teams had access to integrated environments that bridge project domains. The goal of integrated process management through a suite of cooperating tools seems at hand.

For the next issue I will describe how corporate webs are becoming project infrastructure. In particular, I will profile two web-based products that support virtual project teams. One is Mesa/Vista Project Manager by Mesa Systems Guild, Inc., a high-end offering that provides comprehensive process management through a rich mix of Java, JavaScript and XML technologies. The other, WebProject by WebProject, Inc., offers a more traditional PM feature set enhanced by an all-Java implementation.

One of the more effective methods of organizing and tracking work is management by walking around: the simple act of popping your head in a team member's office and shouting, "Hey James! How's it going?" Do this across the team a few times a month and your project will either perform, or you will know you need a new team.

The trouble is, today's "teams" often have upwards of the half-dozen people it is feasible to visit on a stroll, and these folks may well be scattered across your city, state or continent. The solution is to visit project resources virtually rather than physically, a variation that might be called management by flying around -- except that travel takes place in cyberspace, and you need not leave your office to do it.

Appendix C

Capability Maturity Model (CMM)

To help organizations, the Software Engineering Institute (SEI) has developed the Capability Maturity Model (CMM) that delineates the characteristics of a mature, capable management process. CMM can be used for process improvement, assessments and capability evaluations. Higher Levels of CMM Lead into Risk Reduction, and Productivity and Quality Enlargement as shown in the following figure.

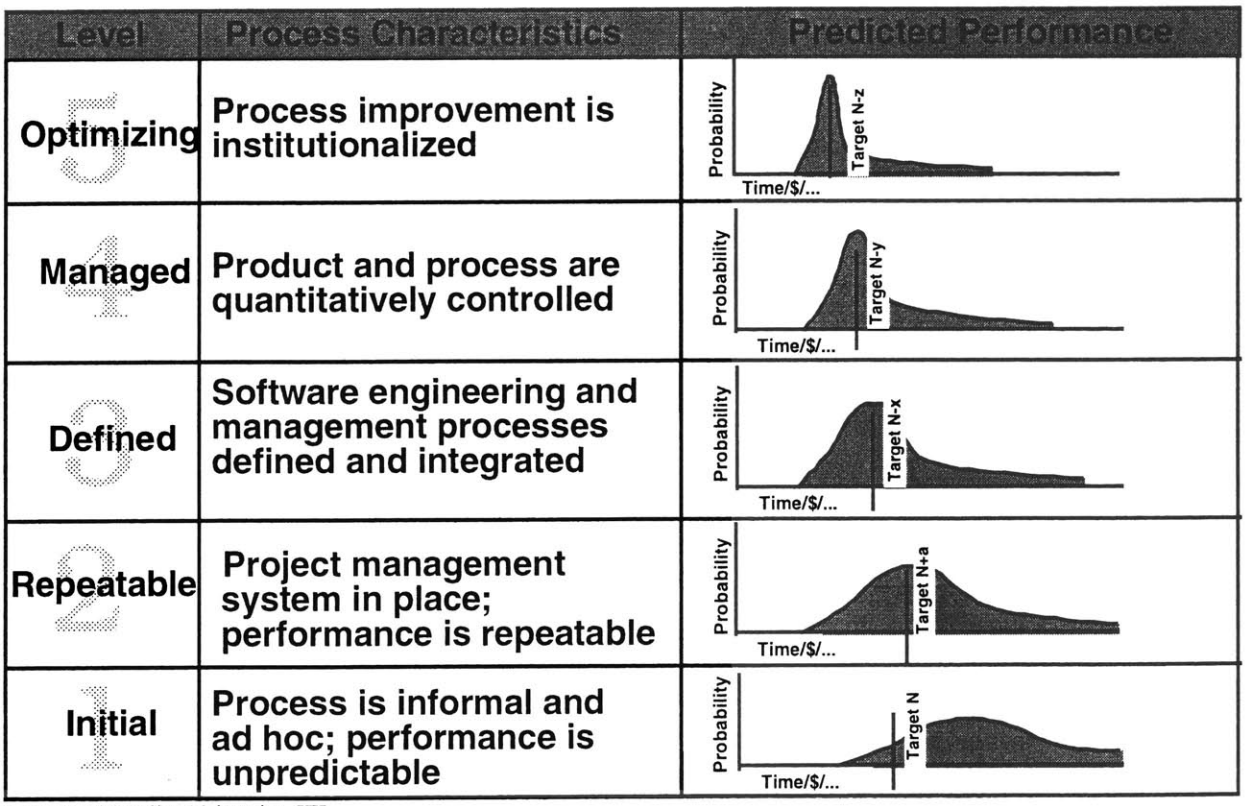
Figure 22CMM maturity levels and respective characteristics

Level	Description	Focus	Key Process Areas in place	Balance
5 Optimizing	Improvement fed back into process	Focus on continuous process improvement	- Process Change Management - Technology Innovation - Defect Prevention	Productivity & Quality
4 Managed	(quantitative) Process measured & controlled	Product and process quality	- Quality Management - Process Metrics & Analysis	
3 Defined	(qualitative) Process defined and institutionalized managed according to process	Engineering process; managing according to processes	- Peer Reviews - Intergroup Coordination - Software Product Engineering - Integrated Software Management - Training Program - Organization Process Definition - Organization Process Focus	
2 Repeatable	(intuitive) Process dependent can repeat previously mastered tasks	Management Process	- Configuration Management - Software Quality Assurance - Software Subcontract Mgt. - Project Tracking & Oversight - Software Project Planning - Requirements Management	Risk
1 Initial	(ad hoc) Unpredictable and poorly controlled	Individual Capabilities		

The maturity of an organization's process helps to predict a project's ability to meet its goals. Projects in Level 1 organizations experience wide variation in achieving cost,

schedule, functionality, and quality targets. As illustrated in the following figure, three improvements in meeting targeted goals are observed as the organization's software process matures. First, as maturity increases, the difference between targeted results and actual results decreases across projects. For instance, if ten projects of the same size were targeted to be delivered on May 1, then the average date of their delivery would move closer to May 1 as the organization matures. Level 1 organizations often miss their originally scheduled delivery dates by a wide margin, whereas Level 5 organizations should be able to meet targeted dates with considerable accuracy. This is because Level 5 organizations use carefully constructed software processes that operate within known parameters. The selection of the target date is based on the extensive historical data they possess about their processes and on their performance in applying it as shown in the following figure.

Figure 23 CMM maturity level with respect to project performance



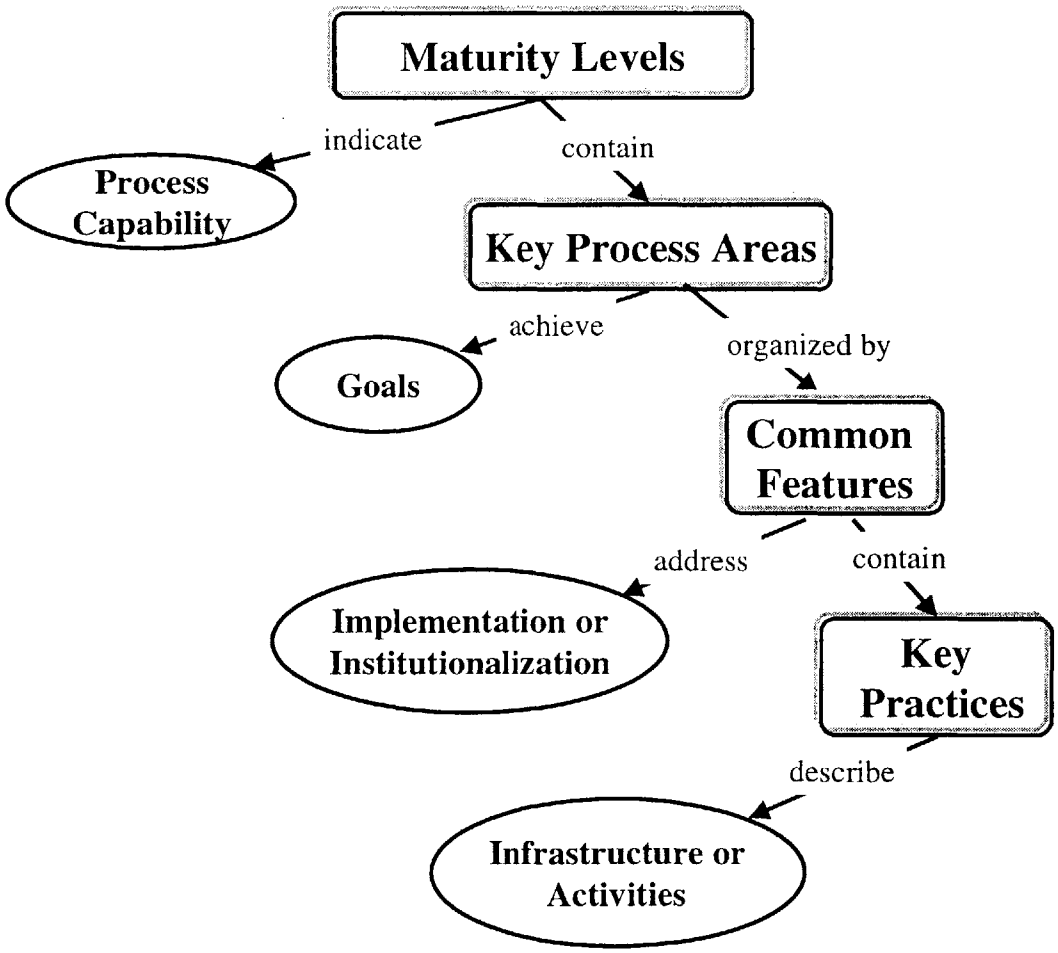
Source: Carnegie Mellon University, SEI

EEFW - Software Process Management

Revision #003

Each maturity level has been decomposed into constituent parts. With the exception of Level 1, the decomposition of each maturity level ranges from abstract summaries of each level down to their operational definition in the key practices, as shown in the following figure. Each maturity level is composed of several key process areas. Each key process area is organized into five sections called common features. The common features specify the key practices that, when collectively addressed, accomplish the goals of the key process area.

Figure 24 The CMM structure



Appendix D

Quality Tool

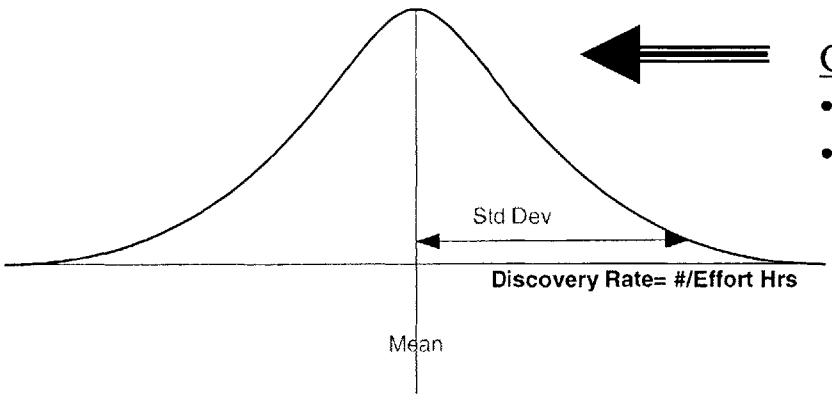
The following quality tool is developed based on an extensive research on the best method to detect risks in the project progress. The mechanism on how this method works is summarized below.

Basic definitions

Data is equivalent to a unit measure divided by a time period, e.g. #/month, day, etc..

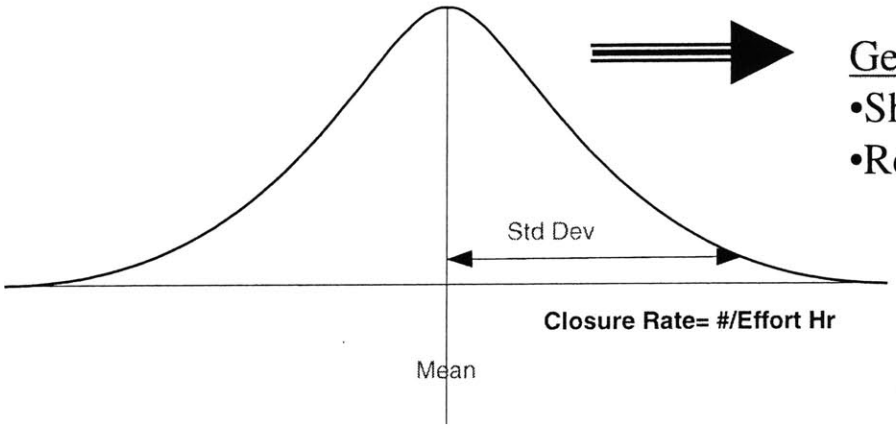
Rate is equivalent to unit measure per effort hours over a defined period of time that the data is generated, e.g. #/(effort hrs)/month, day, etc..

Discovery is also called problem discovery rate. The expectation is the less problem is discovered the more mature the project will be. Therefore, if we assume that the distribution of discovery is a normal curve, as indicated in the following figure, we expect that the target mean shift to the left and variation reduce. The discovery curve is called "Negative Curve" and respective data and rate is defined as followed:



General Purpose
- Shift target mean to left
- Reduce standard deviation

Closure is also called problem resolution rate. The expectation is the fastest a problem is resolved the more mature the project will be. Therefore, if we assume that the distribution of closure is a normal curve, as indicated in the following figure, we expect that the target mean shift to the right and variation reduce. The closure curve is called "Positive Curve" and respective data and rate is defined as followed:



General Purpose
- Shift target mean to right
- Reduce standard deviation

Normalized Discovery/Closure Rate= Normalized Discover/Closure Rate Relative to Mean & Standard Deviation

Examples

Assume the following project data:

AR Status	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99	Jan-00	Feb-00	Mar-00	Apr-00	May-00
Total Open	58	530	593	533	452	405	447	202	297	307	395	299	297
Test Effort	18.6	18.1	13.2	12.9	12.1	15	13.3	12.4	13.8	14.2	17.8	25.3	24.9
Open/test	3.12	29.28	44.92	41.32	37.36	27.00	33.61	16.29	21.52	21.62	22.19	11.82	11.93
Norm Discovery/Dev Effort		2.90	6.39	5.59	4.70	2.39	3.87	0.00	1.17	1.19	1.32	-0.99	-0.97

Total Closed	58	299	428	357	390	347	275	130	221	183	238	242	187	68
Dev Effort	40.4	81.8	44.2	46.9	46.1	56.4	50.1	45.4	53.7	52.1	50.4	46.5	28.3	6.3
Close/Dev	1.44	3.66	9.68	7.61	8.46	6.15	5.49	2.86	4.12	3.51	4.72	5.20	6.61	10.79
Norm Closure/Dev Effort		-2.82	-1.47	-1.93	-1.74	-2.26	-2.41	-2.99	-2.71	-2.85	-2.58	-2.47	-2.16	-1.22

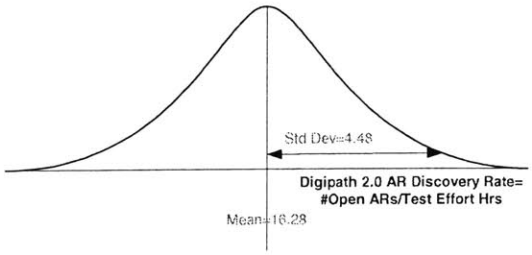
Followed by the following definitions:

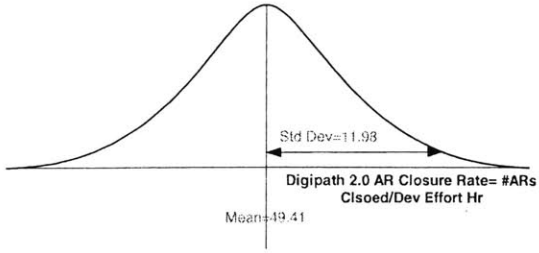
Discovery= Open ARs/month
Discovery Rate=Open ARs/Test Effort Hrs/Month

Closure=Closed ARs/month
Closure Rate=Closed ARs/Dev Effort Hrs/Month

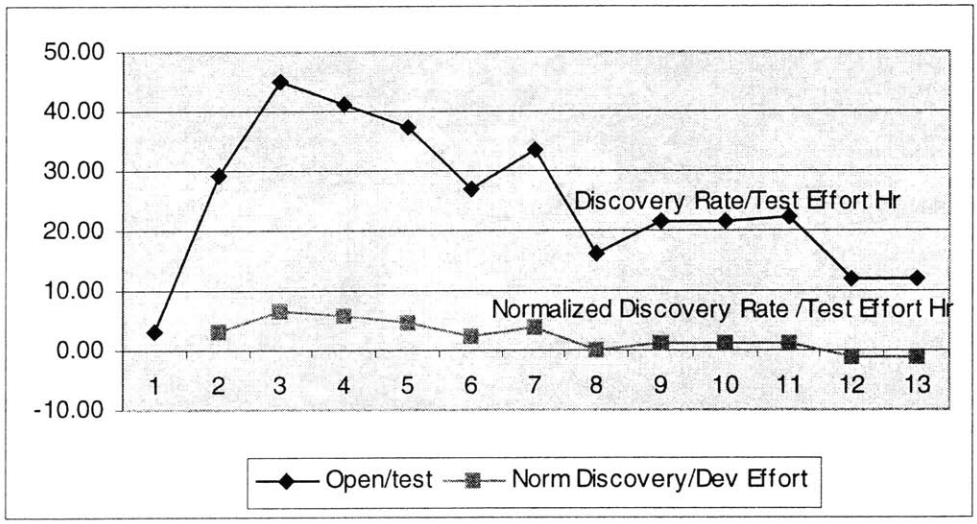
Normalized Discovery/Closure Rate= Normalized Discover/Closure Rate Relative to Mean & Std Deviation

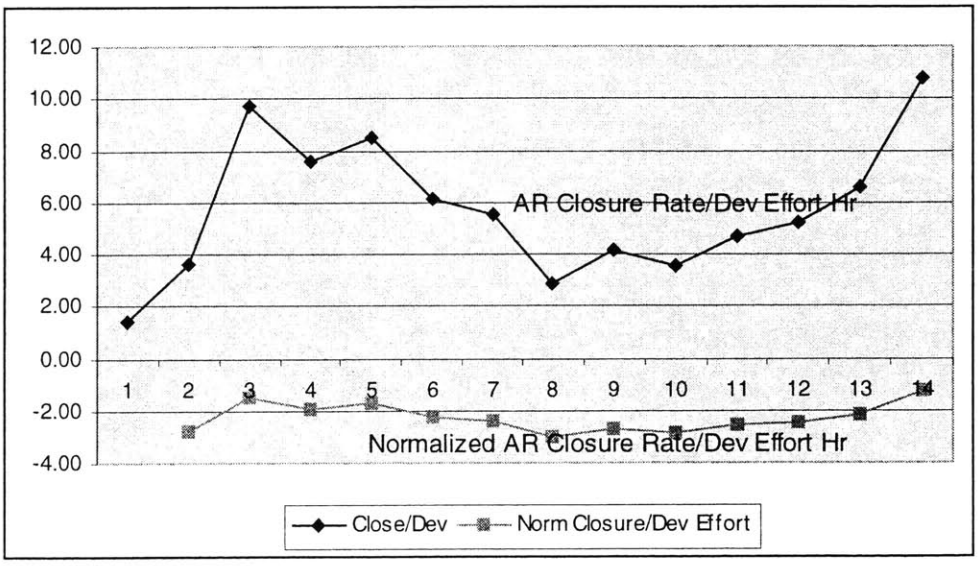
with the following normal distribution:





will produce the following results for project management view:





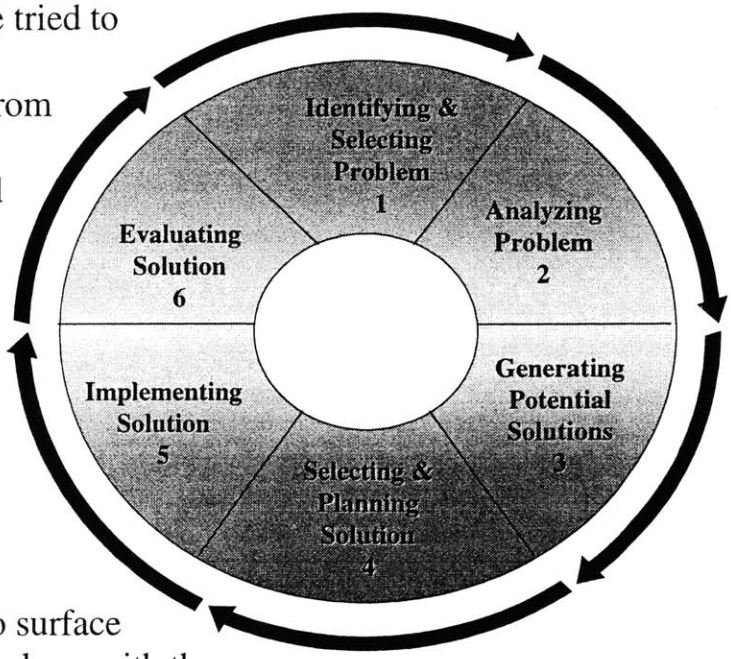
Appendix E

Leadership Through Quality [10](LTQ)

One of the best practices in the industry received Malcolm Baldridge Award, is Xerox Problem Solving Technique (PST) – Leadership Through Quality (LTQ). The following is the 7 distinguished stages of this tool:

Identifiying and Selecting Problem; after much deliberation on what do we want to change? Expansion/divergence of problems for consideration, contraction/convergence on one problem statement, one "desired state" agreed upon, and What's needed to go to the next step; we decided that the following is our problem statement: " Unable to access technical and procedural OSS" , and our desired state: "Develop an Operational Model for our Process Asset Library"

Analyzing Problem, we tried to answer the question on "what's preventing us from reaching the "desired state"? and we identified many potential causes and key causes such as:
Lack of operational model
Lack of boundary
Lack of defined procedures



Generating Potential Solution, we tried brainstorming in order to surface basic constructs or ideas along with the connections between them. The basic steps of this technique are to think about a product and then come up with pictures that convey a basic concept or part of a concept. Then we tried to

[10] Xerox, Problem Solving Technique (PST), Leadership Through Quality Model (LTQ)

answer the question of "how could we make the change?". We developed lots of ideas on how to solve the problem and potential solutions were clarified and compiled to:
Develop an operational model
Define boundaries and responsibilities
Define process and procedure for those boundaries
Selecting and Planning Solution, we decided on the optimum solutions and planned their implementation. We tried to answer the question of "what's the best way to do it?" and expanded the criteria for evaluating potential solutions, and on how to implement and evalutate the selected solution. Then we agreed on the criteria to use for evaluating solutions, implementation and an evaluation plan. At last we defined what was needed to go to the next step as:
A plan for making and montoring the change:
We defined the operational model based on functional teams,,
Their boundaries are the functional team's responsibilities,
and started defininining the standard operating procedure for each functional team.
Also, we will start collecting the organizational concerns and feedback at various forums to monitor the change.
Measurement criteria to evaluate solution effectiveness:
We will build a prioritized list of concerns and feedback and review them priodically.

Implementing a Solution, we have not reached this stage yet, but at this point we will answer the question of "Are we following the plan?" We will agree on the contingency plans if necessary.
Evaluating the Solution, at this stage we will answer the question of "How well did it work?" We will agree on the effectiveness of the solution and continuing problem, if any. Finally we will verify that the problem is solved or address continuing problems.

Appendix F

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