

i Tech Management

AUTOMATING PROJECT AND SOFTWARE DEVELOPMENT CONTROL SYSTEMS: A MODEL

By

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ABSTRACT

The processes of project management intersect in many ways. This book provides a model for automating these processes in order to facilitate these intersections to assist those who want to build a software-based project control system. A building block approach is used, wherein the processes are introduced and defined prior to incorporating them in a cohesive, systematic environment. This wholistic approach brings together into one context model and one data model all of the entities and data relationships necessary to accurately incorporate all of the interrelated project management processes in one system. Pointers are provided for managers to automate their processes in a way that is tool-kit independent.

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CHAPTER 1

INTRODUCTION

Predecessors

In the vernacular of project management, predecessors are those tasks that must be completed prior to the current task beginning or ending. Its usage here is to set the stage and give recognition to several key groups and authors upon whose work this study is based and upon whose work this paper is based.

The principal visionary in the field of project management processes for the last decade has been Watts Humphrey. Humphrey, the author of the influential books *Managing the Software Process* and *A Discipline for Software Engineering*, a past member of the Malcom Baldrige National Quality Award Board of Examiners and a veteran of 27 years with International Business Machines (IBM), was also the original architect of the Carnegie Mellon University Software Engineering Institute's (SEI) *Capability Maturity Model*.

Humphrey, like Deming, perceived that some organizations that were successful had addressed the problem of developing large-scale software systems by adopting the concept, taken from the manufacturing community, of a defined and managed process. From this perception came his vision that ultimately was developed into the Capability Maturity Model.

Beginning as the SEI's process maturity questionnaire a decade ago, it initially became taxonomy of the maturity levels without a framework.¹ Today, the framework exists in the *Capability Maturity Model*, one of the best-known products of the SEI. This model has had a significant impact on the software community as evidenced by current international standards efforts on software processes.

Watts Humphrey built upon the pioneering work by Barry Boehm, Software Engineering Economics and Tom DeMarco, Controlling Software Projects, who provided the earlier attempts to apply process engineering to the software development arena. The emphasis of their time was to isolate the process steps and develop empirical models to ascertain probabilities of success, levels of error and quality, and numbers of error free lines of code. The primary differences in approaches of Humphrey and Boehm/DeMarco were that Humphrey concentrates on the processes themselves while Boehm/DeMarco concentrated on the results of processes.

Another leader in the project management field, Dr. Harold Kerzner, applies a systems approach to the processes of planning, scheduling, and controlling projects. Dr. Kerzner, a professor of Systems Management at Baldwin-Wallace college is the author of the internationally acclaimed reference, Project Management: A Systems Approach to Planning, Scheduling and Controlling. Now in its fifth edition, it has become the project manager's bible.

¹ The Capability Maturity Model: Guidelines for Improving the Software Process, Software Engineering Institute, (New York: Addison-Wesley Publishing Company, 1995), p. 5.

Another set of pioneering authors who used the work of Boehm and DeMarco as starting points were Robert B. Grady and Dr. Howard Rubin. These authors took a slightly tangential path to Humphrey's direction however. Robert Grady, the author of Practical Software Metrics for Project Management and Process Improvement, and Dr. Rubin, author of How to Configure Your Measurement Dashboard, provide a framework for process measurement that complements the vision of Humphrey.

Essentially, the vision of Humphrey is to have a controlled set of replicable processes to perform. At the very high end of his model, he introduces the concepts of quantitative measurement. The complementary position of Grady and Rubin is to have sets of controlled monitors for processes. Kerner's position that companies are made up of small operational islands that have cross-functional communication problems that can be ameliorated by a systems approach which allows project management processes to coordinate and integrate across multiple, functional lines is a key concept to be addressed by an automated model for project management processes. This paper will merge these positions in which a model is described for controlled processes that are measurable and able to be monitored as well as systematically applied across all functional entities.

In the early days of project management, projects were of limited scope and complexity. Project Management, as it is known today, has come about due to the increasing scope and complexity of information technology projects. The increased numbers of tasks, as well as the tremendous number of interrelationships, have left the ability of managers to manage the process in the dust. Thus the formalization of processes,

e.g. Capability Maturity Model, was precipitated in order to gain control once again of information technology software development.

Problem Statement

Information Technology projects are difficult, usually bleeding edge, and fail more times, than they succeed. They are complex, usually at the leading edge of technology. Staff and management are often learning the technology as the project unfolds. Staffing is always a mixture of skills and capabilities. Staffing is often a heterogeneous matrix of organizational talent. Management is often under-authorized, under-delegated, and overly responsible, given the former. As an industry, we are spending far too much and reaping far too little.

Statistics from the Standish Group highlight the poor results of our information technology management processes:

- \$250 billion spent annually on software application development
- 31% of all projects are canceled prior to completion
 - \$81 billion wasted
- 53% of all projects overrun original budgets by 189%
 - \$59 billion wasted²

² *LBMS Process White Paper*, (Houston, TX: LBMS Corporation, 1996), p. 2.

Today's information technology project teams require coordinated work of many entities. Complexity and technology has outpaced our abilities to solve problems intuitively. What is required is a more structured approach to information technology process management.³

Other examples of information technology software development catastrophes include an unpublished review of 17 major Department of Defense software contracts that found that the average 28-month schedule was missed by 20 months. In the same review, a four year project took seven years. Not one project was delivered on time.⁴

A recent Government Accounting Office (GAO) report concluded "The understanding of software as a product and of software development as a process is not keeping pace with the growing complexity and software dependence of existing and emerging mission-critical systems."⁵

In information technology projects the criteria for a successful project is generally understood to include meeting the triple constraints *of on-time, under budget, and meeting quality standards (or customer satisfaction.)* Meeting the triple constraint is a challenge for many reasons. One of the primary reasons is the fact that project management is a relatively modern function (in large part brought about by the extremely high numbers of failures.) Project management is characterized by new approaches to management

³ Watts S. Humphrey, Managing the Software Process, (New York: Addison, Wesley, 1990), p. viii.

⁴ The Capability Maturity Model, pp. 3 - 4.

⁵ Mission Critical Systems—Defense Attempting to Address Major Software Changes, General Accounting Office, GAO-IMTEC-93-13, p. 13.

restructuring and adaptation of special management training. Project management therefore has come about more through necessity than through desire.⁶

Project management has had a slow growth attributed to the lack of acceptance of the new management techniques and the “fear of the unknown.” In addition, Project Management has required new paradigms on authority, resources, and methods. Project Management processes have evolved as the need for flexibility has surfaced as a result of no two information technology projects being alike.

The differing aspects of people, technology, locations, schedules, approaches, contract terms and conditions as well as a broad range of other human factors collectively require flexible management approaches to project management. For example, one of the project management approaches has been the establishment of project task forces.

Task force concepts have been effective at marshaling all of the organizational resources into a focused project team. The project task force usually spans organizations and areas of authority and responsibility as well as technology.⁷

With project management has come the new people environments, like the task force model, that provide project managers with integrated responsibility resulting in:

- Single Point of Accountability
- Project direction
- Functional Coordination

⁶ Harold Kerzner, Project Management: A Systems Approach to Planning, Scheduling and Control, (New York: Van Nostrand Reinhold, 1979), pp. 1 - 2.

- Integrated Planning and Control⁸

With the success of the task force concept has also come failure. The organizational management and project management approaches where they intersect will inevitably lead to difficulties due to matrix management. The classical confusion when administrative and functional managers are not one-in-the-same spawns new dynamics in the workplace.

Over the years, behavioral scientists and other students of project management have tried to observe the structure of human interaction and behavior on projects and reach conclusions on relative productivity levels of different behavioral modes. This independent study project has concentrated on those project management processes that are affected by the human side of the project equation and thus will have an effect upon the organizational productivity and quality.

This concentration has consisted of gathering data on project management, project control, project planning, and project metrics. In preparing this report, the acquired data has been filtered through the twenty-eight years of first-hand project management experience derived of information technology projects.

This study thereby focuses on the human side of project control systems, identifying the areas of control, citing leading authorities on the subjects, and holistically bridging the subject by preparing a model for automating project control systems. While this model will be useful for future research and development, it is not intended as a one-size fits all

⁷ Ibid., p. 5.

solution. In fact, this study does not present itself as a solution, but as a framework for automated solutions.

In particular, the emphasis will be on the capturing of data that furthers the use of statistical methods in managing the information technology project. In the past several years, several noted industry experts have attempted to expand the institutionalization of statistical methods in this manner as noted earlier.

One outspoken individual in particular, Dr. Howard Rubin, has been at the forefront of the trend. A software package developed by Dr. Rubin, *RA-Metrics*, was specifically designed to capture application profile data to be used in creating what Dr. Rubin calls a project “Dashboard.”⁹

The “Dashboard” presents a graphical view of project management process indicators from which a project management team or IT department manager determines levels of quality, productivity, and performance relative to pre-identified service level objectives and critical success factors. This is Dr. Rubin’s ultimate metrics weapon in automation of project control systems.

Systems of course are the cornerstone of all information technology projects. Most information systems people are reasonable and astute enough to recognize the human element involved in making planning and scheduling systems do what they’re supposed to do. For the purposes of this study, a broad definition of a system as “an organized or

⁸ Ibid., p. 6.

⁹ Christine B. Tayntor, *Institution an IS Metrics Program: A Case Study, Information Mangement*, (Boston, MA: Auerbach Purblications, 1992), P. 4.

complex whole; an assemblage or combination of things or parts forming a complex or unitary whole” will be used.¹⁰

Full-fledged project control systems then would incorporate project policies, planning and control, administrative policies, and behavioral systems for example. This would suggest that an overall systems approach can be used to transform project decision making into easier tasks. In practice, however, project management is a loosely arranged series of sub-systems that are dependent or interdependent upon each other. An example of this is a planning and control sub-system may stand-alone or be tied to a time and effort sub-system.¹¹

The desire to apply a systems approach to project control has been in evidence for some time. A recent survey investigating the interaction of project characteristics was conducted of the membership of the Project Management Institute. On the whole, the survey revealed a negative response for project management tools such as PERT/CPM. The summary of the survey recommended “judicious and adequate, but not excessive use of planning, control and communications systems.”¹² Disagreeing, others have suggested alternative tools and techniques such as linear programming, heuristic scheduling, resource leveling and the like as tools to help solve project problems.

¹⁰ David I. Cleland and William R. King, Systems Analysis and Project Management, (Tokyo: McGraw-Hill Kogakusha, Ltd., 1975), p 15.

¹¹ Paul C. Dinsmore, Human Factors in Project Management, (New York: American Management Association, 1984), p 4.

¹² James J. O'Brien, Project Management: An Overview, A Decade of Project Management, (Drexel Hill, PA: Project Management Institute, 1981), pp 306 - 309.

This apparent disagreement also prompts this look at project control systems automation. One thing most experts would agree on is the fact that project efficiency demands that a single set of control mechanisms, or an information system, be used throughout the project. It is preferable that this not be a monolithic environment.¹³ The automation of tools for project control is not a panacea, as the problem is really human based. If automation is to succeed in project control systems, then the approach must be contextually based upon human interaction. The human interaction side of project management is an elusive topic and has proven to be hard to measure and subjective. If an automated project control system is to succeed it must have synergistic effects upon human productivity and quality—and it must provide solid empirical data that is in a form that management and staff can use with ease.

The essential ingredient for success for dealing with these unique sets of problems is knowledge with certain characteristics. An information technology project is at the high end of the continuum based upon the qualification of a number of interrelated dimensions of knowledge:

- It is Complex rather than Simple
- It is New as Opposed to Established
- At the Boundaries of development
- Most Often Incomplete rather than Complete
- Progressing rather than Static

¹³ Charles C. Martin, Project Management, (New York: AMACOM, 1976), p178.

- Systemic and not Isolated
- Most Importantly, Contingent upon a Myriad of Interdependent Activities.¹⁴

The implications are that the technology:

- Is Hard to Learn
- Is Not Generally Understood
- Requires Inventive Minds
- Requires Quick Response to Keep Up
- Involves Tremendous Interdependencies Among Staff
- Inherently has a High Degree of Uncertainty
- Produces Unpredictable Results

As a result, managing information technology projects in a hierarchical (traditional fashion) manner leads to the corollary that supervisors should manage sub-ordinates performance and productivity. This raises an interesting management challenge. Due to the complexity and high degree of interdependence among activities, tasks and people, many aspects of employee and group performance are likely to be invisible to the manager.

Additionally, performance becomes immeasurable and in many instances the manager does not have the level of technical currency as the staff being managed.

Ultimately, individual performance becomes secondary in importance to group

¹⁴ Mary Ann Von Glenor & Susan Albers Mohrman, Managing Complexity in High Technology Organizations, (New York: Oxford University Press, 1990), p. 217.

performance. Group performance is singled out because of its central importance in the fast paced world of Information Technology. Because of this shift, a direct impact on staff self-esteem can be seen because of the group's performance regardless of an individual's performance.¹⁵

Another factor, which affects systems development success, is the characterization of projects as a series of transient phenomena. A project is in fact, the transient step function that appears, changes, or adds something, and departs. A project manager is in fact not trying to achieve equilibrium, but disequilibrium. In other words, a project manager is trying to manage a situation that is by definition never in equilibrium.¹⁶

It is because of all of the preceding that the subject of automation of project control systems was chosen as the subject of this paper. The application of the systems theory and a wholistic approach best characterizes the approach described herein. It is the very nature of systems, and the knowledge that most systems have chaos, that prompted this research. This understanding, that systems theory allows chaos to co-exist with harmony, dictated that chaos be fully addressed in this model.

It is a dichotomy, however, that in the information technology management field, the thrust is to create order, improve order, and if chaos cannot be tamed, to ignore it. This does lead to very narrow thinking patterns, and ignores the fact that chaos increases as equilibrium nears.¹⁷

¹⁵ Ibid., p. 223.

¹⁶ Albert Kelly, (ed.), New Dimensions of Project Management, (Boston, MA: D.C. Heath, 1982), p. 7.

¹⁷ John P. Van Gish, Applied General Systems Theory, (New York: Harper & Row, 1974), p. 59.

It is because of chaos (project failures caused by the inability to channel the chaos) that the subject is being addressed. The knowledge that equilibrium is drawing near will allow information technology managers to better understand the nearness of their end goal. The added knowledge that disequilibrium is riding on the coattails of equilibrium should enable technology managers to better prepare for the inevitable. This paper addresses the critical components or subsystems of project control in such a manner, addressing synergistic effects of automation where practical. Lastly, in the conclusion a brief description of difficulties in accepting an automated project control system will be provided, as will recommendations for implementing such an approach.