Walden University

COLLEGE OF MANAGEMENT AND TECHNOLOGY

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ABSTRACT

Interactions Among Process Improvement, Business Process, and Information Technology Process Maturities in Corporate Information Technology Organizations

by

Richard E. Biehl

B.A., Binghamton University, 1978
M.S., Walden University, 1999

Dissertation Submitted in Partial Fulfillment
of the Requirements for the Degree of
Doctor of Philosophy
Applied Management & Decision Sciences

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ABSTRACT

Different forms of process maturity within the information technology field were studied in order to develop a model of process maturity interactions, the use of which might help improve the focus and yield of process improvement investments. The study was focused on asking what IT organizations at different levels of process maturity did to improve their processes, and what involved IT professionals thought about these improvement initiatives in their organizations. A grounded theory research design was used involving interviews, discussions, and on-site observation with respondent cohorts drawn from two IT organizations; iterated with analysis using concept mapping of interview transcripts and observation notes, and affinity analysis of resulting concepts and keyword lists. Key variables were identified in the study, the improved interaction of which might help improve the yield and outcomes of efforts aimed at implementing process improvement and information technology maturity improvement, separately or together. The key variables include management's inflexibility toward implementation, levels of forgivingness toward underachievement in the culture, and alignment and appropriateness of the models implemented. Change initiatives that address the interactions defined in this model can result in a better optimized combination of higher quality, lower cost, reduced risk exposure, and positive outcomes for organizations. For the people who work in those organizations, addressing these interactions can lead to lower stress levels, higher job satisfaction, and improved quality of work life.

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DEDICATION

This work is dedicated to my wife, Janet, without whose love and support I cannot imagine having been able to persevere in this effort.

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This project would not have been possible without the support and participation of the many respondents who shared their thoughts, experiences, and workdays with me, as well as the two Chief Information Officers who provided me with their insights and unfettered access to their staff, projects, and work places over the 2-year course of this study. I can't thank them enough.

I would also like to thank the members of my dissertation committee for their involvement and encouragement: Dr. Gary Gemmill (chairperson), Dr. William Steeves, Dr. Ruth Maurer, and Dr. Gwen Hillesheim. An extra thanks to Dr. Hillesheim who originally brought me into Walden University through the ECTI masters program, thus beginning my journey that would result in this project.

I would also like to thank my wife, Janet, for editing my KAM and dissertation manuscripts over these years at Walden. My readers receive a higher quality product because of her help and insights.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1:

INTRODUCTION

Introduction to the Study

The information technology and quality management industries, both of which emerged in the aftermath of World War II, have affected both economic and societal change in profound ways (Juran, 1995). First, the war resulted in the development and eventual commercialization of computers, and gave birth to what would become a global information technology industry. Second, the scale of that war required the development of the means of mass production and the ability to ensure the reliability of the goods produced to support the war effort. Such mass production gave rise to the statistical sciences of quality control, and eventually the management practices of quality assurance. This study explored an area of friction between these two interacting disciplines regarding their general approaches to quality management and process improvement.

In the last 60 years, the software and quality disciplines have followed different paths. The principal path of the quality movement moved to Japan for several decades, being rediscovered by companies in the United States in the 1980s (Walton, 1986). The software industry remained largely in the United States, and improvements in the early decades were based on the growth of capabilities and reduction of costs in computer and peripheral hardware coupled with improvements in knowledge and practice specific to the software engineering disciplines (Wiegers, 1996; Hohmann, 1997).

The general quality movement did not touch the software industry significantly until it began to become popular in American business in the early 1980s. By the late 1980s, the software industry was adopting the general process management framework of the quality management profession, and adapting it to specific uses and models for the software community. This touchpoint brought the two disciplines closer together, while they continued to develop separately (Shulmeyer & McManus, 1998). Software professionals developed and implemented standard process models for the software industry, while quality professionals continued to focus generally on the quality management principles of requirements, defects, verification, validation, and continuous improvement, even when dealing with software domains specifically.

Today, the outcomes experienced by many modern organizations, both successes and failures, are closely tied to the software and quality management practices within those organizations. Quality management principles form the underlying basis for most software improvement models and initiatives, even if individuals specializing in these two professional practices have not typically worked together directly (Horch, 1996). The professionals who practice in the software arena usually have their educational and career roots in the software engineering community, while quality management professionals find their roots in the historical practices of quality control and statistics (Ibrahum & Hirmanpour, 1995).

A history of quality in the software industry centers on a discussion of the ways in which software development is more engineering than art, and that managing processes is central to continuous improvement. A history of quality in the quality management

industry centers on moving beyond its origins in manufacturing quality control to include the broader role of quality or process assurance across an enterprise. These two disciplines have interacted throughout their evolution, and yet the actual process management practices of the quality and software disciplines have stayed distinct, and their practitioners separate (Hohmann, 1997; Horch, 1996).

Statement of the Problem

Organizations dependent on their software and quality management competencies for success lack an objective theory of how these two related domains interact and support each other, and therefore lack an effective model for making business decisions related to investments in these two areas (Siviy & Forrester, 2004). No existing model identifies how general process improvement maturity and domain-specific process maturity within the information technology field drive or inhibit general business process maturity resulting from the use of information technology.

Anecdotal evidence abounds indicating the importance of both disciplines in contributing to organizational success, and common sense based on even limited exposure would seem to indicate that both are essential to many desired organizational outcomes, such as quality, productivity levels, and customer satisfaction (Hohmann, 1997; Horch, 1996, Wall & Pomeroy-Huff, 2005). As a result, organizations devote considerable assets to the practices of both disciplines without a clear understanding of how these investments result in these outcomes, or even whether the synergy of the two is as effective as either would be alone. Without such a model, particular successes or failures are difficult to attribute to particular disciplinary contributions.

Reporting on the results of emerging technology studies at the Software Engineering Institute (SEI) at around the time of the commencement of this study, Siviy and Forrester (2004) suggested a need for the study of Six Sigma in relation to the deployment of models like the SEI Capability Maturity Model. “Our findings in examining the efficacy of combining Six Sigma with other technologies to get more effective transition are so clear that the technical and business case for further work is simple” (p. 36). They then concluded, “We see tremendous potential for Six Sigma to serve as a strategic amplifier for SEI technology transition success” (p. 36). The research problem addressed in this study was whether such an amplification effect was indeed being seen within information technology organizations exhibiting differing degrees of implementation of the Six Sigma and CMM models.

Purpose of the Study

The purpose of this study was to help organizations undertaking process improvement to understand how and why their investments have the effects they do so that they can make better informed choices and improve their organizational outcomes. The study sought to discover interactions among different types of *organizational process maturity*. This construct is defined as the degree to which an organization practices sound and effective processes toward achieving its goals (Project Management Institute, 2003, p. 5). The interactions among the different layers and types being sought in this study included any aspects of one type that might drive or inhibit aspects of other levels or types. Key interactions were those that, if removed from study, would have weakened the predictive power of the individual levels or types of process maturity.

Organizations exhibiting high process maturity have developed and refined their processes to the point that fidelity to those processes virtually assures positive outcomes (Humphrey, 1989; Humphrey 1995). Organizations exhibiting low process maturity lack an effective set of processes for accomplishing effective or successful activity. To the extent that they are successful, it is usually because of the brute force effort, or the exceptional expertise, of individuals within the organization. Low process maturity organizations can be described as succeeding in spite of their processes, while high process maturity organizations can be described as succeeding because of their processes.

This study looked at organizational process maturity by studying information technology organizations. Process maturity can take several forms based on the perspectives taken when studying organizational practices. Common practice and the literature seemed to point to a complex interaction of general process improvement maturity, more discipline-specific process maturity, and overall business process maturity (Daughtrey, 2002). General process improvement maturity deals with the ability of an organization to focus attention on, and work to improve, their own internal processes. Relationships among internal functions and staff are central concerns of the general process improvement discussion, often measured in terms of productivity and quality levels. Overall business process maturity focuses on the outcomes of organizational processes and how they are perceived from outside the organization. Relationships to investors and customers are central discussions from this perspective, with measures including return on investment or assets, and customer satisfaction (Daughtrey, 2002).

Discipline-specific process maturity looks at the process contributions and impacts of some specific disciplinary area. The discipline-specific area in this study was information technology. Fraser, Moultrie, and Gregory (2002) suggested information technology as among a group of discipline-specific domains in which the study of process maturity could assist in improving organizational outcomes. Other areas suggested include: supplier relationships, research and development, product development, innovation, and reliability engineering.

Current common knowledge, based primarily on anecdote and popular business media, would place the construct of domain-specific process maturity as mediating between general process improvement maturity as an independent construct, and general business process maturity as a dependent construct (*Figure 1*).

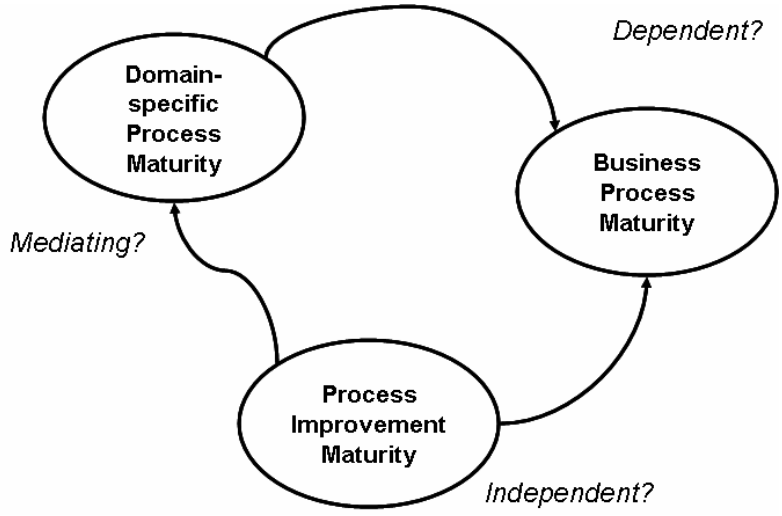

Figure 1. Commonly expected construct interactions (a priori)

Such a simplified model explains little and rarely fits with reality in the workplace. It ignores any role that business maturity might have in determining the actual levels of investment in both general process improvement and domain-specific processes (Kelsey, 1999). It does not allow for repercussions related to how changes to the levels of maturity in any one construct dimension might affect the impact of that dimension, or its effects on others. Kelsey (1999) generalizes these omissions as feedback loops that might often be hidden or go unnoticed in the interactions of these constructs. If feedback turned out to be significant among these constructs, there might be nonlinear interactions that would best be described by complexity theory. The result of these considerations is that the realities of independent, mediating, and dependent factors in this study were expected to be much more complex and dynamic than traditionally assumed.

This study focused on the information technology industry and profession as the domain-specific area of interest. It explored the realities of process maturity in

information technology organizations using a multi-case approach to analyzing a set of information technology organizations, a single-case depth approach to a pair of such organizations, and a review of information and publications across the general process, discipline-specific process, and business process domains. The result is a grounded theory of process maturity in organizations using information technology that allows for the definition of specific propositions related to process maturity and capability to be formulated and explored by subsequent research.

This study can help information technology managers and professionals understand how different outcomes can be expected from organizations at different positions on these three construct dimensions. The available permutations are large, and can help explain the broad diversity of efforts and outcomes actually seen in practice.

Background

Attempts to measure the process maturity of information technology organizations began in the late 1980s with the work of Humphrey (1989). He decomposed the activities in observed organizations into related process areas and then used correlation analysis to assess the relative contribution of each process area to positive organizational outcomes and success. His model became a baseline for others to measure and to begin to improve organizational processes.

During the early years of such measurement in information technology, reports of successful implementations based on Humphrey's process areas far outweighed the few disappointments (Herbsleb, Carleton, Rozum, Siegel, & Zubrow, 1994). Even with the successes early reports raised questions regarding whether activities other than

information technology maturity programs could be contributing to the reported improvements. Herbsleb, et al, reported being unsure of the extent to which other factors were influencing their results.

Goldenson and Herbsleb (1995) studied the relationship between domain-specific process maturity in the information technology industry and the business process maturity enabled through resulting information technology initiatives, two of the three construct dimensions included in this study. Identifying implementation weaknesses in their data, their results included a suggestion that several dimensions or concerns needed to be added to the Capability Maturity Model (CMM) developed by the Software Engineering Institute (SEI) (see Appendix A) to improve its effectiveness in improving certain aspects of the domain-to-business maturity relationship. They discussed the implications of these changes, and the difficulties anticipated in changing the CMM models to include them.

Viewed from another perspective, their list of factors reads like a conventional list of concerns raised in the quality management literature (Horch, 1996). The need to improve levels of management commitment, overcoming disillusionment when change is slow, managing stakeholder expectations, obtaining needed resources for change, assigning clear responsibility and accountability, and culture issues related to change were among their recognized factors (Horch, 1996, Humphrey, 1995). These issues are typically addressed in the general quality improvement literature, and typically are not seen directly in the information technology literature.

From Goldenson and Herbsleb's (1995) CMM-focused study perspective, their recommendations included adding these factors and concerns to the CMM. An alternative, and the basis for this study, was that their results had identified a possible hidden construct that was influencing the relationship they were looking at between the CMM-based domain-specific maturity construct and the business maturity construct. That third construct dimension is the process improvement maturity construct identified and clarified in this study. The interaction effects among the study constructs and this third construct seen in this study help explain their observation that "there may be organizational characteristics that help make some process improvement efforts more likely to succeed than others" (Goldenson & Herbsleb, 1995, p. 23).

Instead of suggesting that a general process improvement framework be added to the information technology maturity model, this study viewed process improvement as a third construct dimension, and sought relationships and interactions among all three. Organizations that exhibit high levels of process improvement maturity, through such programs as Quality Control, Total Quality Management, or Six Sigma, might be more likely to report an ability to implement CMM-based appraisal recommendations, without any need to add such concepts into the CMM directly (Siviy & Forrester, 2004). The implication of enhancing the efficacy of the CMM framework is that organizations will see an increased return from their investments in both information technology, and in process improvements related to information technology.

Public and private sector industries spend billions of dollars each year attempting to improve their performance capability by investing in information technology. Evers

(2003) reported that worldwide software expenditures reached $73.5 billion in 2002 and $76.1 billion in 2003. These investments have been at these levels for years. According to the Congressional Budget Office (1998), domestic expenditures in the United States reached $60.5 billion in 1995, with $13.6 billion spent by the United States federal government alone.

This investment includes hundreds of millions of dollars per year attempting to improve information technology processes in order to improve the quality, and lower the cost, of the information technology resulting from that investment. Phillips (2002) reported a Morgan Stanley estimate that information technology expenditures higher than would be expected if those process improvements were in place, termed *technology overexpenditures*, amounted to $130 billion, including hardware and software, during the 2-year period from mid-2000 to mid-2002.

Likewise, hundreds of millions of dollars per year are spent generally trying to improve organizational process performance, both specifically in the information technology arena, and generally across each enterprise (Baetjer, 1998) (see relationships in *Figure 1).* Actual improvement costs are difficult to document because many organizations do not report their investments in process improvements.

However, many organizations do report improvement benefits, and expenses can be inferred from these benefits. A sampling of reported benefits illustrates the investments being made. Harry and Schroeder (2000) reported four-year savings of $2.2 billion at Motorola from their successful quality improvement initiatives. The Software Engineering Institute (2004) surveyed numerous improvement projects to identify benefit

levels. A single Motorola project was able to save $611,200 in 1997. A project at the U.S. Air Force's Logistics Operations Division in 2002 was able to save $43 million in the first year, with on-going projected savings of $900 million over the remaining life of the F-16 program.

The ratio of costs to benefits in process improvements has been studied extensively. Crosby (1979) placed the ratio between 1:4 and 1:10 depending upon industry, arguing that the information technology industry is complex enough and chaotic enough to receive the higher 1:10 benefits. Schulmeyer and McManus (1999) argued for a 1:7.75 ratio. Using the higher ratio of 1:10 against reported benefits can conservatively estimate expenses that were likely incurred to achieve any reported benefits. With benefits being reported in the tens of millions of dollars for these initiatives, even the more conservative 1:10 ratio would indicate that many millions of dollars are being invested by these organizations in their information technology process improvements.

Beyond the large financial investments, the global economy is now dependent upon the information technology capabilities commonly seen in virtually all products and services. Indeed, the health and safety of individuals is often directly dependent upon these same information technology capabilities (Humphrey, 2006). The defensive capabilities of the U.S. military have become wholly dependent on information technologies. The quality of the software developed and used by individuals, organizations, and governments is now a grave concern (Bott, Coleman, Eaton, & Rowland, 1998). These concerns have grown at the same time that the systems being developed and deployed are get ever larger and more complex (Humphrey, 2006). The

United Nations (2003), noting the growth of such information technology dependence, adopted a call for the creation of a global culture of cybersecurity to deal with vulnerabilities throughout global economies and societies. Increasingly, the CMMI included as part of this study is being used to assess threat and define critical requirements (Software Engineering Institute, 2007).

The threats and vulnerabilities associated with information technology, as well as the competitive pressures on organizations to increase and improve performance, create upward pressure on investment costs associated with these constructs, regardless of return or yield (Software Engineering Institute, 2007). Too little is known about the interaction of these constructs to ensure that current investments, much less future increases in such investment, yield the intended and desired benefits.

Significance

The grounded theory of process maturity interactions resulting from this study can help improve the focus and yield of process maturity investments in companies using information technology. Application of such a theory will result in a better optimized combination of higher quality, lower cost, reduced risk exposure, and higher organizational outcomes (e.g., profit, goodwill, quality of life) across the corporate information technology sector. If organizations can get their processes and quality right, the customers of those organizations will receive better value in products and services, and the employees of those organizations will have more successful and fulfilling careers. If the software industry were more mature, everyone’s attitudes toward information technology might be very different than it typically is today. The cost of software

produced by mature organizations is also typically far lower than that produced by immature organizations (Software Engineering Institute, 2004). Cost, value, trust, safety, and improvements will come about through a sharper shift toward process maturity in the information technology industry.

In addition to avoiding ineffective investments in process improvement, the long-term effect of this theory can be in the increased process capability enabled through subsequent successful organizational change initiatives. Information technology plays a critical role in our modern society, and an increasingly effective information technology industry will enable more successful synergies and outcomes from that sector (Usrey & Dooley, 1996). By redefining the cost-benefit dynamic involved in information technology investments, this study can affect the basis on which corporate CIOs consider choices for technology investment, plan for new systems capabilities and product features, and select staffing options such as outsourcing or cosourcing. Such changes might affect the desired portability of knowledge, providing additional positive opportunities for advancement and career mobility among professional practitioners in the information technology field.

Theoretical Support for the Study

A grounded theory study results in new theory grounded in the data collected within the study (Glaser, 1992). The study's allegiance to outside theories or the literature is secondary, although the theory's fit with existing constructs and data lends support to the grounded theory's applicability and usefulness. In this regard, initial theoretical support for the study came in the form of disciplinary areas that could lend

initial constructs to the study process, and that could have provided integration touchpoints as the theory emerged.

Several subject areas in the management and human relations fields fell into this category, including (a) social and organizational psychology (Shein, 1978), as they pertain to understanding how individuals interact in organizational change settings, and how these organizations serve as social settings for such interactions; (b) role theory (Biddle & Thomas, 1979; Trahair, 1969), as the organizational process changes described in this study caused role shifts for the individuals participating in those changes; (c) motivation theory (Utley, 1995), as individuals participating in process change attempt to understand, interpret, and react to process change around them; (d) systems theory (Lazlo, 1975, Ackoff, 1995), offering relational explanations for characteristics and indicators that emerge from the interviews and content analysis in this study; (e) complexity theory (Çambel, 1993, Dettmer, 1997), as the expected interactions among study constructs grow in diversity and frequency, including feedback loops that might drive nonlinear reactions; (f) knowledge management (Liebowitz, 1999), as increasing process maturity causes further refinement and specialization of the workers involved in process change; and (g) credentialism (Lerman, Reigg, & Salzman, 2001; McCain, 2001), as the exchange-value of certain process milestones periodically overtakes the use-value of the actual process improvement in certain situations. Each of these areas is further explored in chapter 2.

Nature of the Study

This study produced a grounded theory that describes the interactions of the process maturity constructs described above using a grounded theory methodology (Corbin & Strauss, 1990; Glaser, 1978; Glaser 1992; Strauss & Corbin, 1998). Principal data collection techniques were semi-structured interviews with working professionals, extended observation of those professionals in their work places, and review of related literature and professional conference proceedings.

Initial interview participants were selected from a single organization that served as the single-case depth component of this study, a global chemicals company headquartered in the northeastern United States. A second cohort of interview participants was selected from a second organization to serve as a contrasting single-case, an academic medical center in the United States. A third cohort of interview participants was selected opportunistically from several additional information technology organizations identified in the review of conference proceedings. The identification and choice of these participants involved principles of theoretical sampling described by Glaser (1992, p. 101). These diverse participants included information technology individuals from across multiple business sectors and geographies. Their participation served as the multi-case breadth component of this study. Additional professionals were identified opportunistically to serve as key informants, by participating in peer reviews of researcher concept memos and emerging model components throughout the study. Details of this methodological approach are explored in chapter 3.

Assumptions

This study made no particular assumptions about facts that would hold true beyond the scope of inquiry. The data that emerged from the data collection process drove the direction and form of the resulting theory that developed. This placed a great importance on the efficacy of the design and execution of the study as described in chapter 3. The resulting grounded theory exhibits alignment with ideas expressed in related current literature, but such alignment was not assumed as part of the study design.

Scope and Delimitations

The scope and delimitations of a grounded theory study are adjusted throughout the study to follow the conceptual threads emerging from the data. Within such conceptual flexibility, this study focused on issues in the information technology industry, and was not expected to grow beyond that industry. The guiding models for understanding processes in the information technology industry were the capability maturity models (CMMs) of the Software Engineering Institute (SEI). While the study might have developed into process or organizational areas beyond the scope of these models, most issues were expected to be covered within their boundaries.

Owing to convenience and to the dominant location of the industry, most of the participating interview and peer support individuals were expected to be from organizations in the United States. International participants were limited to individuals in both the chemicals company and healthcare organization who worked for those organizations outside the United States. In particular, several participants from India

were added in second wave interviews owing to the common use of the SEI CMM models by the information technology industry in India.

Limitations

A potential limitation to any grounded theory journey is that the destination is not completely known, although a general direction and orientation is typically established at the beginning. The breadth and depth of the grounded theory built by this study was determined by the researcher's theoretical sensitivity (Glaser, 1978) to the issues involved in the emerging constructs, the availability of data sources along lines of inquiry identified, and the sufficiency of those data sources for achieving theoretical saturation (Glaser & Strauss, 1967).

The only firm boundary limiting the theory was the choice of the information technology field as the domain-specific process maturity arena to be studied. The process and quality models available in the information technology field were specific and well-defined. There was no expectation that this study would cross outside of that field. While there was some possibility that the data would allow certain grounded statements to be made about the mediating role of domain-specific models between the general process maturity and general business maturity of an organization, it was not my immediate intent to move in that direction. The general uniqueness and specificity of the information technology arena would seem to preclude such a finding, although its outright exclusion would violate the spirit of grounded theory research.

Definition of Terms

Key concepts in the foundation of this study involved the terminology of process improvement, maturity, and capability, and the interactions of those concepts:

Figure 2. Central terminology of process management.

Process Capability: The level to which a process will satisfy its requirements within a given predicted precision is its process capability (Juran & Godfrey, 1999). For example, one process might consistently complete some activity, usually going 30% over budget. If the requirements for that process are to complete work within 30% of budget, then the process is said to be capable. If the requirements for the process are that it complete work within its budget, then the process would not be considered capable. A capable process is said to be able to predictably fulfill its requirements. It is a measure based on actual performance. Organizations experiencing quality problems are typically dealing with improving their process capability (Omdahl, 1997).

Process Maturity: The level to which a process includes desired or state-of-the-art practices, usually measured against some external standard or benchmark (Weber, Paulk, Wise, & Withey, 1991). In contrast to capability, maturity measures expected process potential, not actual process performance. As a process changes over time, usually by adopting better tools and practices, it is said to be maturing (Humphrey, 1995).

As an example, grounded theory research conducted today, taking guidance from the most recent writings of Strauss and Corbin (1998), exhibits a higher level of process maturity than it did when first proposed by Glaser and Strauss (1967). This is not to say that early attempts were unsuccessful. Rather, the processes under which such research is conducted today are simply more mature than at previous times. Because the process maturity is higher, the process capability of a representative research project today is *expected* to be higher than one in the past.

Process Improvement: Activities that attempt to improve the reliability, effectiveness, or efficiency of a process (Omdahl, 1997). Also, any orientation to quality improvement that focuses on improving process maturity in order to improve process capability (Humphrey, 1995). It operates under the belief that directly attempting to improve process capability can be counterproductive and will be unlikely to result in sustained improvement even if successful in the short term. Improvements in process maturity, even if small, will be sustainable and will likely lead to a cycle of continuous improvement that surpasses any short-term value associated with direct intervention in process capability (Humphrey, 1989, p. 430).

Interactions: Relationships among aspects of concepts that actually result, or can result, in one concept having a set of effects on the other; generally affecting information as a feedback loop between decisions and actions (Forrester, 1994). Modeling these interactions requires identifying aspects and characteristics of the constructs, both temporal and sociocultural that result in relationships that cause the concepts to become a single system. Interactions among the constructs being measured in this study might

include synergistic or supportive relationships, as well as inhibiting or limiting relationships. A systems effect is seen when the interactions become important to understanding the basis and behavior of the underlying concepts. Harvey and Reed (1995) pointed out that such interaction effects in a social system should not be expected to be linear, requiring aspects of systems and chaos theory to build appropriate models.

Study Questions

The overarching initial questions in this study were:

1. What did information technology organizations at different levels of process maturity do to improve their processes, and the products and services produced by those processes?

2. What did information technology professionals think about the process improvement initiatives they were involved in, and the effects such initiatives have on the products and services they produce?

Summary

This chapter has introduced the problem of process maturity interactions among quality management, information technology, and business management dimensional constructs and highlighted the significance of developing a theory that can guide organizational investment in these overlapping areas. It also introduced the wide variety of theoretical areas that would lend constructs and frameworks to the analysis of collected data in search of a grounded theory, as well as defining the scope of this study as it sought such a theory. The initial study questions formed a starting point for

collecting data that could then be analyzed in search of more specific and focused questions. Additional expansive and clarifying questions were added throughout the early phases of the study.

Chapter 2 begins with an overview of the literature that traces the development of quality management principles as they have been applied to the information technology arena over the last few decades, and continues with a selection of other studies that have effectively developed grounded theory in these and related areas. Chapter 3 continues with a description of the grounded theory methodology used in this study with the result and conclusions of the research described in chapters 4 and 5. The method begins in the literature, and quickly moves to the field, through interviews, observations, and review of work products and project content.

CHAPTER 2:

LITERATURE REVIEW

Introduction

This chapter presents a review of the literature that surrounds and theoretically supports the constructs that formed the basis for this study. It begins by describing the origins and history of the process management disciplines within the quality management field before narrowing the perspective to the specific applications and models of process management in the information technology field. It concludes with examples of grounded theory studies that have looked at areas of concern similar to, or related to, the constructs being investigated in this study.

To identify appropriate sources in the literature, a two-pronged approach was used. It began with a systematic approach to keyword searching of the relevant journals and databases; starting with the broad terms of process and quality management, and getting more specific as opportunities presented themselves. In continuing, key studies published by the Software Engineering Institute (SEI) were reviewed looking for results that included the targeted areas of concern in their suggested research sections. Both of these prongs resulted in extensive sources. The search followed many threads, and eventually led back to the same Humphrey, Crosby, or general TQM literature described below. Several key informants at the SEI and American Society for Quality (ASQ) suggested other research going on in the field at the time on related topics, and these studies are also included below.

Quality and Process Management

Quality management has a long and varied history. Most of the early history of quality focuses on product quality, with process quality, or process management, not arising until the middle of the twentieth century (Juran, 1995).

Juran (1995) described various tools and techniques practiced by the ancient Greeks as quality control during the construction of temples and civic structures over a 3,000 year period. He described large government departments devoted to formulating and executing product standards in the Zhou Dynasty in China between 1000-800 B.C. Other examples include early craftsmanship in India, Scandinavian shipbuilding, and ancient Roman architecture. He highlighted the expanding role that guilds played in ensuring quality throughout the Middle Ages and Renaissance, particularly in German industry, the French arms industry, and throughout the Venetian Republic.

Looking at quality movements more recently, Folaron (2003) described early product quality milestones, including Eli Whitney's need for interchangeable parts in 1798 to satisfy a government contract to produce rifles, and Henry Ford's need for close-tolerance parts in 1913 for his new moving assembly lines. These quality initiatives focused on quality control of manufactured products, and heavily emphasized inspection and testing.

Folaron (2003) described the beginning of the shift from product quality to process quality, or process management, as having occurred on May 16, 1924 when Walter Shewhart introduced a new data collection and analysis worksheet into the processes at the Western Electric plant in Hawthorne, Illinois. The worksheet would

become known as a control chart, and would constitute the working core of Statistical Process Control (SPC). Following World War II, this statistical technique was taken to Japan by W. Edwards Deming, a statistician and friend of Shewhart's. Deming's contribution to quality thinking in Japan included what came to be known as his fourteen management principles and seven deadly diseases (Deming, 1982).

The Japanese business and industry adapted and evolved these statistical principles and techniques into what became known as Total Quality Control (TQC), an emphasis on statistical monitoring of processes to predict inherent process weakness and enable an environment of continuous improvement (Ishikawa, 1985). Folaron (2003) described the international oil crisis of 1973 as a turning point in quality management when Japanese automobile companies were able to apply the principles of TQC to the quick design and production of more fuel efficient cars that quickly gained enormous market share in the United States.

The shift toward the process management imperative in the United States can be dated to June 24, 1980 (Dobyns & Crawford-Mason, 1991). The NBC television network aired a one-hour documentary, *If Japan Can … Why Can't We?*, that was credited with waking up managers in the United States to the power of quality management principles, and the threat of economic competition resulting from Japan's mastery of these principles. Overnight, W. Edwards Deming became well known in corporate boardrooms across the American business sector. It was during this same period that Joseph Juran was adding layers of planning and management to the quality literature (Juran, 1989),

and Crosby was redefining quality management in quantitative terms that American management would embrace: zero cost, and zero defects (Crosby, 1979; Crosby, 1996).

Crosby (1979) offered a model for managers to better understand quality as a problem they were responsible for rather than a technical problem that could be delegated. His Quality Management Maturity Grid (Table 1) defined five maturity stages that managers could assess their own organization against. Table 1 is adapted from Crosby (1979/1996).

Table 1

Crosby's Quality Management Maturity Grid

Stage	Maturity	Characterization
1	Uncertainty	We do not know why we have quality problems.
2	Awakening	Must there always be problems with quality?
3	Enlightenment	We identify and solve problems.
4	Wisdom	Problem prevention is routine for us.
5	Certainty	We know why we do not have problems.

For each maturity stage Crosby (1979), described a set of characteristics for organizations at that stage, including (a) the expected level of management understanding and attitudes in evidence, (b) the status of the quality function within the organization, (c) how problems are handled, and (d) the typical cost of quality as a percentage of sales. This last characteristic carried great weight with managers, ranging from a high of 20% for organizations at the first uncertainty stage down to a low of 2.5% for mature organizations that have achieved the certainty stage. By prescribing a set of guidelines for improving organizational process maturity based on which level of the grid an

organization assessed at, Crosby had created a management tool that translated quality and process management into something that was actionable in the boardroom. With such awareness, these managers next needed quality improvement program opportunities designed that would allow improvement against Crosby's model.

Two major new tools became available in 1987. First, the International Standards Organization in Geneva, Switzerland published the first of the comprehensive ISO 9000 quality management standards; and second, the United States Department of Commerce launched the Baldrige National Quality Award program (Juran, 1995). Both programs provided working models that organizational management could use to define and guide their quality management programs. The programs themselves would embody the tools and practices of Total Quality Management (TQM) that was the popular trend during this period. The new international standard and national quality award program gave management a way to think about and promote quality in their organizations without getting into those technical details.

The first company to win a Baldrige award was Motorola (Juran, 1995). Fortunately for everyone else, one of the criteria for winning that award was that winners were required to share their quality and process management practices publicly in order to promote continuous improvement across all organizations (Breyfogle, 2003). The quality system that Motorola shared was a hybrid approach to TQM that emphasized a specific combination of quality tools and statistical approaches that worked to reduce process and product defects to previously unrealizable levels, 3.4 defects per million

opportunities, or Six Sigma. The Six Sigma movement was born, and that movement still dominates the quality management arena today (Breyfogle, 2003).

While much of the literature describing quality program implementation focused attention on the technical aspects of the practices and tools included in the quality program, Wiklund and Wiklund (2002) argued that such descriptions should be expanded to include broader aspects of organizational learning. Beyond the tools, they suggested that a key aspect for understanding how an organization disseminates and supports a set of quality management practices involves the actual structuring of the organization, as well as effective strategies for education and on-going support needed to succeed with an effective implementation. Viewed from an interactivist perspective, they questioned how an organization can implement a process improvement program in such a way that changing attitudes and behaviors of the participants can be properly taken into consideration.

Wiklund and Wiklund (2002) specifically studied the implementation of Six Sigma at The Solectron Corporation. As a fairly technical and numerical discipline, Six Sigma requires the training of experts in the tools in order to support an effective implementation. The techniques are considered too difficult for ready adoption by novice individuals. As a result, organizational learning needs to be built into the program deployment in order to assure that all participants develop and begin using the necessary technical skills demanded of the Six Sigma approach. A central concern of such a learning focus is how to get everyone involved “to overcome mental barriers and use statistical methods in their daily work” (p. 234). They pointed out that when quality

methods fail to be implemented effectively, it is lack of sufficient quality learning that is typically a driving cause.

Ittner and Larcker (1997) looked at the performance outcomes that organizations could attribute to their quality management techniques and found that many organizational investments in quality improvement techniques were not yielding positive business or economic returns. Looking at organizations in multiple countries and industries, they found that too many organizations were adopting the tools and techniques of quality without internalizing or appearing to adopt many of quality management's underlying or background philosophies such as customer orientation or horizontal process organization. Many quality tools were simply being introduced and applied within existing organizational structures and cultures, often failing to achieve any of their intended benefits. They also found that the sequence in which different quality tools were implemented had direct impacts on the efficacy of those tools, particularly in the computer industry. Several tools, most notably Statistical Process Control (SPC), were described as being implemented before the prerequisite process maturity was in place to take advantage of the tools. They argued that their results support a position that companies must first achieve the process capabilities of the earlier simpler tools before moving on to implementing the more advanced and quality tools.

Ittner and Larcker (1997) also looked at the actual collections and sets of tools implemented in the organizations studied. Through a recursive partitioning of their results, they found that more than one combination of tools, or what they refer to as bundles of practices, could be correlated separately with different organizational

outcomes. They suggested that identifying the interactions and relationships among the different practice bundles would be a significant contribution to the quality management literature.

Information Technology

Quality and process improvement in the information technology field centers on a particular set of standard process maturity models known collectively as the Capability Maturity Models (CMMs) from the Software Engineering Institute (SEI) (Software Engineering Institute, 1993). Appendix A provides a background and overview of these models. The cornerstone of the CMMs is a five-level maturity sequence (Table 2) that describes incremental improvement in process maturity as an information technology organization progresses through the stages and process areas within the model, mirroring the five-level management maturity popularized by Crosby (1979) and discussed above. Table 2 is adapted from Weber, Paulk, Wise, & Withey (1991).

Table 2

Levels of IT Process Maturity

Level	Maturity	Characterization
1	Initial	Ad hoc, chaotic, dependent on brute force
2	Repeatable	Basic management controls in place
3	Managed	Processes defined and used for all core activities
4	Improving	Metrics and data define process exceptions
5	Optimizing	Process continually changes in response to metrics

Jung and Goldenson (2002) analyzed the content clauses (the key process areas by maturity level) of the CMM and found a high level of internal consistency when analyzed across all of the organizations that implemented the model during the first decade of use. The validity of the model as a process maturity tool for information technology is widely accepted across the industry. Problems are often encountered during implementation, but none that causes the underlying model to be questioned; problems tend to involve human and cognitive factors, and the difficulty of implementing such high levels of organizational change.

The nuclear power industry is among the few existing software-related industries in which the absolute demand for software quality is paramount. Harauz (1999a, 1999b) described the complex web of national, industrial, and international quality and software engineering standards that have been promulgated in recent years. His focus was on the inadequacies that are revealed when attempting to put together these numerous standards for application within a single software organization. Harauz's perspective was as a software quality engineer for Ontario Hydro, an area where quality management in software engineering is of critical concern in such a highly-regulated industry. It is critical that the software designed to trip a nuclear reactor and shut it down in the event of a problem or disaster be of high quality. Part of demonstrating the quality of software is to be able to demonstrate it. Ontario Hydro, and most other modern software organizations, rely on adherence to national and international standards as the cornerstone of their quality management programs.

Harauz's (1999a) finding was that the suite of available standards, in total, was inadequate for that task of improving quality levels to the extent desired. While applauding the contribution of individual standards efforts in identifying and defining aspects of quality in limited domains, Harauz lamented that the standards could not easily be combined into systemic comprehensive quality guidance. He argued that it takes the intervention of professionals into the equation as mediating agents. Ontario Hydro developed their own hybrid set of requirements in lieu of complete adoption of external standards because they view the weaknesses of the standalone standards as too significant.

The high demand for software quality in the nuclear power makes Harauz's (1999b) observations important in that industry. Outside of that industry, or others with similar concerns for safety and regulation, commercial software organizations often willingly accept weaknesses in their software engineering practices, and in the resulting software, as normal and expected outcomes of their engineering practices. Accepting such weaknesses, most commercial organizations producing software will never make the effort to harmonize and synergize all of the available international standards. As such, they will never see the problems that Harauz has pointed out. As a result, many organizations will over-rely on standards that, in fact, contain unobserved weaknesses and contributions. The SEI Capability Maturity Model highlighted in this research study is one such model that has been widely adopted by industry, and yet is considered in Harauz's analysis to contain considerable weaknesses that can make its adoption risky for some organizations. A disclaimer and limitation, therefore, is appropriate for whenever it

is used in an organization. This study's use of the model is based on its penetration throughout the industry, not upon any particular aspect of its validity.

Relatively few software organizations have ever moved up to the third level of the five-tiered SEI improvement model for software engineering organizations (Software Engineering Institute, 2004). Many in the software industry perceive the SEI's CMM as a complex and highly technical model. Cosgriff (2000) described lessons learned when his organization, the Ogden Air Logistics Center in Utah, was certified as having achieved that highest fifth level of the CMM model. Coupled with the fact that the origins of the model are in the U. S. Department of Defense with its highly structured command and control model, it is not surprising that a U. S. military facility would be among those organizations that reach the model's highest levels of maturity. Cosgriff's observations, though, were that the importance of people, and the meaning they attribute to their work, should be considered the key driver in achieving high levels of process maturity. The major effort in achieving such improvement is to "change people's attitudes" (p. 28) and make the improvement "philosophy inherent in all (their) activities" (p. 30).

Cosgriff's (2000) observations indicated that focusing increasingly on people, meanings, and "common sense" (p. 32) can enable software engineering organizations to improve their process maturity, and that such focus can partly outweigh any bureaucratic or political obstacles that might otherwise inhibit such improvement. The quality improvement literature is plentiful on the need to improve top-down management activities related to process. This study attempted to contrast the structural-functional approach with an interactionist approach based on meanings.

Paulk was one of the original principal architects of the SEI CMM (Weber, Paulk, Wise, & Withey; 1991). Paulk (1999) later addressed many of the misconceptions and myths that have surrounded the CMM since its inception, primarily, that it was written and intended to be used by large software engineering organizations, often conducting projects on behalf of large government agencies. It is true that the CMM was originally developed in response to concerns by the U. S. Department of Defense that software was becoming an increasingly mission-critical component of just about all major defense systems (Software Engineering Institute, 1993). It was also true that most early adopters of the CMM were large and controlled software organizations.

Paulk (1999); however, argued that it was never the intent of the CMM authors to create such a limited and isolated model. “Its fundamental concepts are useful to any size organization in any application domain and for any business context” (p. 21). In an argument that seems to lead directly to a distinction between structural functionalism and symbolic interactionism, Paulk observed that the CMM only truly makes sense if the structure it advises is properly interpreted by employees according to the meanings that each prescriptive component derives for those who will participate in its application. “The team has to discuss at length whether an implementation is adequate” (p. 21).

Paulk’s (1999) call for common sense was a call for interpretation, not a blind adherence to structure. For large organizations, like the early adopters of the CMM, structural admonitions fit well with their own beliefs about their organizations and roles; but for more recent adopters (i.e., the small commercial software houses, the dot-coms), fixed structures as described by the formal language of the CMM are inhibitors because

they contradict the culture and belief systems of the organizations and the individuals in them. Paulk's observations can be extended beyond the CMM because his argument applies equally to other quality and software models beyond the specific CMM he discussed.

The CMM five-tiered process maturity model for the software industry that was used in this study comprises increasingly more mature plateaus of process maturity. Few organizations have achieved certification against the highest level of process maturity in the model (Software Engineering Institute, 2004). Of those, about half are organizations in India (Software Engineering Institute, 2004). Jalote (2001) addressed this fact and attempted to outline factors about the Indian work culture, either general cultural factors or factors that are unique to their software engineering industry that might explain the unusually high success rate of organizations in India when implementing the SEI's CMM. Once identified, these factors might assist other organizations in their respective implementation attempts.

Jalote (2001) identified a number of factors, both in the definition of the software industry in India, and in the general cultural model that might be used to describe such organizations and individuals in India. Jalote's key industry finding was based on the fact that there existed very little software industry demand in India; India's software market is mostly devoted to export. The primary means of export today is through the provision of software engineering services to organizations that have contracted their software needs to these companies in India. India's software market is global, but is clearly dominated

by the United States. From the American side of these relationships, one will hear organizations talk of outsourcing their software engineering or of having sent it off shore.

These contractual links between organizations create an opportunity for the CMM to penetrate organizational thinking since it was originally developed to assist the U.S. government to better manage contract relationships with corporate entities (Software Engineering Institute, 1996). Therefore, it fits well with the need to manage project contracting across the Pacific. The remoteness of the software organizations in India necessitates their exhibiting a high level of process maturity in order to maintain competitiveness in the American contracting market (Jalote, 2001). Another factor supporting the CMM success rate in India has been the fact that the entire software industry in India was born after the CMM was published and available. So the CMM became a building block for the seedling industry, and has had strong penetration ever since (Jalote, 2001).

On the cultural side, Jalote (2001) observed that the India software industry tends to employ professionals with engineering training, while their American counterparts tend to employ individuals with business training and experience. Engineers are likely to gravitate toward defining models and heuristics. Likewise, individuals in Indian organizations tend to be very accepting of frameworks and models developed by reputable and authoritative outsiders. American counterparts tend to resist any model perceived to be imposed from outside, almost regardless of its quality. Also, professionals in India are far more accepting of being measured than their counterparts in American organizations.

Jalote's (2001) observations don't bode well for improving U.S. penetration of the CMM in software organizations. Introducing CMM to United States organizations involves overcoming inertia that simply didn't exist in the fledgling India software industry. Likewise, the reluctance of workers in the United States to readily accept top-down imposition of externally-developed models might be a cultural factor that is extremely difficult to overcome. The existence of CMM high-maturity organizations in America indicates that it is possible, but those organizations that have achieved success using the model tend to be larger organizations with strong contractual obligations. Jalote's study helps explain why the more routine commercial software organizations are very poorly represented on the list of successful CMM software organizations.

Ryan (2000) described the various quality and process-related problems facing the software industry today, with a special emphasis on the importance of improving process practices in the Internet segment of the industry. He described how the Internet software industry was born so quickly, and has grown so rapidly, that software quality practices have failed to keep pace. Jalote (2001) described how the software industry in India was able to adopt significant process quality practices precisely because the industry was born with such practices already existing and in use. The Internet community in the United States did not take advantage of those existing models as the industry was born. Software and process maturity in the Internet community is no better, and Ryan observed that it is often much worse because of the pace of activity, than any other segment of the software industry in the United States today.

Ryan (2000) also observed that fixing this problem will require much more than a structural or functional change. The various change models available in the industry, driven largely by the CMM explored in this study, are often implemented in a purely structural way. Ryan warned that people must be considered a key dimension of any successful implementation, particularly one in which the knowledge is changing so fast that it remains tied to the personal experiences and meanings that participants associated with it, which hints at an interactionist approach. If so, a hybrid of functional and interactionist approaches might work best. Such a hybrid approach was the intent of the exploration intended by this grounded theory study.

Weimer and Munyan (1999) wrote of a need to increase the human element in a software industry where quality and process models usually rely on increasingly complex and sophisticated functional and structural relationships among organizational components that specialize in only parts of each software engineering challenge at hand. Their recipe included many traditional management suggestions for improving the success of organizations in the software industry, but it focused on several particularly non-traditional aspects that are highly reminiscent of the structuralism versus interactionism distinction that was raised by Paulk (1999) and discussed above. Weimer and Munyan initially focused on increasing end-user involvement in all software initiatives. This “helps create user motivation and commitment, and this leads to system success” (p. 25). Increasing involvement in managing the organizational changes often associated with major software-driven implementations also requires individuals to change in ways not implied by the structural definitions of how they function within the

organization. “They must be prepared for the change psychologically and professionally” (p. 25). According to Weimer and Munyan, such change turns them into advocates; enabled by the way they change their own actions through their own interpretation of the meanings of the changes brought about through the software initiatives.

The survey study that Weimer and Munyan (1999) conducted found combinations of structural and human factors as being important for software industry success. They observed that the software industry is typically not known for any emphasis or consideration of human factors, yet human factors ranked highest in priority among their survey respondents from throughout the industry. “Survey respondents may have ranked human element items as most important precisely because they are not included” (p. 27). If so, these human elements would arise in the various interviews to be conducted as part of this study.

Guimaraes and Clevenson (2001) looked at quality determinants for a particular subset of the software engineering industry; namely, the makers of expert system technology. Expert systems technology is unique in the software field in that it attempts to build software solutions that embody the knowledge of its users, rather than simply enabling the processes and policies of those users. Guimaraes and Clevenson described the focal point of such efforts as ‘knowledge engineering,’ and described the difficulties of ensuring that an appropriate level of user knowledge is built into any software solutions. Much of the knowledge engineered into these systems begins as tacit knowledge among the experts who provide domain knowledge to the knowledge engineers.

Of the quality determinants described by Guimaraes and Clevenson (2001), the role and involvement of users and management in providing access to their tacit knowledge, through observation, journaling, and interviews, was among the most important. Lack of such involvement results in software development that is limited to explicit knowledge that usually is very good at handling routine situations, but fails at the slightest exception. The importance of tacit knowledge and perceived meaning is indicative of a shift in these efforts that parallels the structural-to-interactionist shift described above.

Guimaraes and Clevenson's (2001) findings are significant for the improvement of software engineering activities beyond simple expert systems. The role of tacit knowledge and meaning is obvious when engineering rule-based knowledge engines for expert systems. However, if similar tacit knowledge needs to be embedded in all software systems solutions, then Guimaraes and Clevenson's quality determinants will apply to all software initiatives, increasing the role and importance of users in the entire software industry. The on-going shift in process maturity models from software to systems to integrated teams might be tied to the underlying, but still not completely recognized, distinction.

Goldenson and Herbsleb (1995) conducted a comprehensive survey of information technology organizations that had carried out process improvement initiatives looking to identify factors that might be identifiable as driving or inhibiting success. They used the same domain-specific process improvement model, the SEI CMM

(see Appendix A), that was used to operationalize the domain-specific process maturity construct in this study.

While observing that early case studies involving the effectiveness of the SEI CMM for process improvement were almost universally positive, Goldenson and Herbsleb (1995) noted that organizations that were more successful would be far more likely to report their results than organizations that had been unsuccessful. Adding to this self-report bias was the fact that the range and variation of the types of organizations adopting the SEI CMM as their information technology process improvement framework was growing, making the common characteristics of early success reports less meaningful over the growing population. Their broad survey was meant to reframe the debate by collecting a broad array of success and failure indicators from a large diversity of information technology organizations.

While Goldenson and Herbsleb (1995) found a positive correlation between successful implementation of the SEI CMM model and favorable business outcomes (e.g., product quality, customer satisfaction), they did identify problems: many organizations going through the CMM appraisal process reported that the recommendations coming out of those assessments were too ambitious to be effectively implemented with limited resources. Organizations were requesting more guidance regarding how to actually implement many of the recommendations. Their data indicated that organizations expressing such concerns, in fact, encountered difficulties in implementing needed process improvements.

Goldenson and Herbsleb (1995) studied the relationship between domain-specific process maturity in the information technology industry and the business process maturity enabled through resulting information technology initiatives, two of the three construct dimensions that formed the core of this study. Identifying implementation weaknesses in their data, their results included a suggestion that several dimensions or concerns needed to be added to the SEI CMM to improve its effectiveness in improving aspects of the domain-to-business maturity relationship. They discussed the implications of these changes, and the difficulties anticipated in changing the CMM models to include them.

Grounded Theory

Denzin and Lincoln (2000) offered a description of the history of qualitative research in terms of seven phases, or *moments* (p. 12-18). During the traditional period (1900-1950), qualitative researchers wrote objective accounts of their field experiences, still heavily influenced by the positivist science model. The modernist phase (1950-1970) built on the classic traditional works while attempting to formalize the qualitative approach as a distinct set of practices. The ethnographer as participant observer became formalized as distinct from positivist measurer.

Denzin and Lincoln (2000) described the third moment (1970-1986) as a period of blurred genres during which the techniques and disciplines of qualitative study (e.g., symbolic interactionism, constructivism, phenomenology) were reasonably well established, but the qualitative mindset was still struggling to gain a positive reputation in the general science literature. Grounded theory and case study approaches stabilized and

matured during this third moment. The blurring cleared but emerged as a crisis of representation (1986-1990), Denzin and Lincoln's fourth moment. The crisis involved the relativism of different emerging perspectives gaining status among the traditional narrow perspectives. The roles of gender, class, and race became critical concerns in establishing balance among the observer and interpretive qualitative techniques. Qualitative study turned reflective, as the role and perspective of the previously neutral observer needed to be woven into any story being told.

As the interpretive crisis was resolved, Denzin and Lincoln (2000) described the shift into their fifth moment, the postmodern (1990-1995). Increasingly non-traditional voices appeared in qualitative studies, and the role of the researcher continued to shift. Action research and participatory study removed any semblance of the observer as outside or neutral. The sixth and seventh moments; the postexperimental (1995-2000) and future (2000+) are in the transition today.

Locke (2001) positioned grounded theory against the backdrop of Denzin and Lincoln's (2000) moments when she discussed Glaser and Strauss' 1967 book as contributing to the shift from the modernist moment to the blurred genres moment. The realist objective ontology of modernism was giving way to an interpretive paradigm that focused attention on the experiences and perceptions of stakeholders and participants in the fields being studied. Modernism's search for universal objective laws gave way to interpretive discussions of perception and meaning. Social reality, described through symbolic interactionism, required the observational techniques of ethnography to be used to study organizational settings.

A 30 year evolution would bring grounded theory into the heart of the postmodern moment (Lock, 2001, p. 8-9). As a result of this extended history and development, Locke described management studies using grounded theory as being found with combinations of modernist, interpretive, and postmodern perspectives depending upon the developmental stage of the method during any particular study (p. 13).

Charmaz (2000) described the turmoil and controversy surrounding grounded theory in terms of the evolution of the discipline through Denzin and Lincoln's (2000) postmodern to postexperimental moments. Recognizing that such evolution can be represented by a continuum of thought, she juxtaposed the earlier positivist orientations against what she termed a constructivist grounded theory (p. 510). She observed that constructivism actually draws strength from firsthand postmodern accounts, and argued that a constructivist perspective would enhance the use of qualitative techniques generally, and grounded theory specifically, for understanding empirical worldviews.

Locke (2001) saw the constructivist nature of grounded theory when she described the role that the qualitative interview plays in helping participants gain insight into their own beliefs and practices, resulting in an alteration of those beliefs and practices, a form of reflective practice (Schön, 1986). The grounding of the resulting theory in these reflective situations increases the likelihood that the theory will gain ready acceptance among other practitioners, who will also reflectively use the resulting theory to inform and affect practice.

Grounded theory also addresses research gaps between theory and practice precisely because all new theory is explicitly grounded in practice. According to

Partington (2000), where reflective practice allows participant learning to immediately impact practice, the qualitative approaches to theory emergence brings practice tacit knowledge directly into the data collection process in ways relatively unavailable to traditional quantitative research.

Grounding in Texts

Grounded theory research requires the collection and analysis of large amounts of qualitative data, often in the form of texts. Gephart (1993) described an approach to such analysis, based on ethnomethodology, through which individuals participate in sense-making regarding the organizations in which they are engaged in radical change or critical events. The texts under analysis can include naturally occurring archival data from throughout the organization, interview transcripts, and self-generated texts (e.g., field notes, interview memos).

Gephart's (1993) specific study involved a direct engagement with subjects because the organizational event being researched involved public hearings during which individual interviews were not possible, and the hearings could not be tape-recorded. In his case, official transcripts of the proceedings served as his interview text. A less ethnographic model, involving more at-a-distance researcher interviews resulting in session transcripts from tape recordings, can result in a similar base text.

For Gephart (1993), the content analysis of the various texts becomes the central grounding mechanism of a study. He based his analysis on certain methodological assumptions; namely, that texts embed the interpretive knowledge of their creators, and each text ultimately acquires its full meaning through its participation in ongoing text

narratives. It is through the ongoing narrative dialogue that the different collections of archival, interview, and self-generated texts interplay and enhance each other's meanings. He concluded that textual content analysis "can be used to describe and analyze organizational events that unfold over time and leave a substantial archival residue" (p. 1469). Such archival residue is common when researching organization settings and change.

Management Studies Using Grounded Theory

Grounded theory methodologies are used in studying management and organizational problems and issues. Locke (2001) surveyed several such studies, describing patterns in the use of different aspects of the methodology; particularly noting the frequency with which grounded theory was used to analyze and describe situations in which individuals or organizations progress through a series of stages or phases of knowledge or activity (p. 109). She observed that most grounded theory management studies focus attention on process change as a series of phases, with the grounded theory explaining the issues and directives that influence the change from one phase to the next. Grounded theory, therefore, lends itself well to explaining the dynamics of organizational change.

The phased models of organizational change tend to be built on what Locke (2001) referred to as "boxes and arrows" (p. 110). These theories often describe each of the stages of individual or organizational progression (i.e,. the boxes) and the triggering or mediating events that influence shifts from one box to the next (i.e., the arrows). Her description evoked Levin's (1947) view of organizational change. His conceptualization

of change as a field dynamic laid the foundation for the modern organization change models based on phase space and complexity theory.

Lewin (1947) began by pointing out that change can only be discussed as a relative term. A single organizational system might go through extensive periods of stability, or it might go through extensive periods of change, or the periods themselves might vary from one another in length and intensity. A common factor, though, is that each of the change or stable states can only be best understood in contrast to the others. Under circumstances of social change the group entities themselves are undergoing constant change even while the situation for the group as a whole remains stable (Lewin, 1947).

To understand change in organizations, Lewin argued that two issues needed to be distinguished "which [were] generally not sufficiently separated" (p. 199). The first issue deals with any actual change conditions observed. The second issue concerns any resistance to such change. These two issues define a force and counter-force to change. A stable organization is one in which these forces are balanced enough to produce stability. At any given time, an organization can be under only moderate change pressure, or extreme change pressure. If the resistance forces balance that pressure, the organization will remain stable. Therefore, stability offers no evidence for or against the presence of any need for change.

Lewin (1947) defined the development of a model for understanding these opposing forces as the "practical task of social management" (p. 200). To provide a practical tool, he defined the social field as the totality of coexisting entities and

relationships within which an internal structure and external environment can be discussed. The breadth of the field being discussed will vary with the context of analysis. The relative position of an entity in the field determines its ecological setting, and potential for movement within the field. The actual periods of stability and change across the field will depend upon the interaction of forces among the entities in the field. Iansit and Levien (2004) asserted that this concept is used today in defining organizational strategy in modern organizations looking to respond to a collection of modern problems and opportunities.

Locke (2001) cautioned against an exclusive view of phase changes using grounded theory, noting additional uses for grounded theory in management to study more static theoretical models as well. She suggested that researchers “not approach their analytical task with the presumption that they had to generate theoretical elements that could be expressed in boxes and arrows” (p. 110). Grounded theories that model postmodern issues will tend to focus on static theory or expression over phased organizational change.

General Management Problems

Lyles and Mitroff (1980) used a grounded theory study to explore and understand how organizations come to identify and formulate problems in their environment. Their interest included factors at both organizational and individual levels. They found that the personal differences in background among their respondents greatly influenced their results as they included measures of individual differences in their analysis. They also observed that their study was measuring something that their respondent managers did on

a regular basis, but that they spent very little time thinking about or reflecting upon. As a result, they observed that their methodology needed to be able to elicit and draw out details and nuances that would be difficult to predict in advance. These factors combined to justify their emphasis on interviews over questionnaires or surveys in their methodology, noting that semi-structured interviews were deemed to be best for eliciting information from their respondents.

Their resulting grounded theory identified three central dimensions for understanding problem formulation in organizations (a) whether a problem was perceived as internal or external, (b) whether the problem situation was well-defined or ill-defined, and (c) whether the indicators of the problem were formal or informal (Lyles & Mitroff, 1980). Against this model of problem type dimensions, they also mapped problems into a four-quadrant model of themes according to two dimensions: individual versus organizational problems, and social versus political problems. Their theory shows a clear picture of problem formulation without getting into how to solve problems or promote change. This makes Lyles and Mitroff's (1980) theory a good counterexample to Locke's (2001) observation that many management grounded theories result in multiple phase or stage models.

Organizational Change

Coopey, Keegan, and Emler (1997, 1998) used grounded theory to look at the issues in organizational change and innovation. They developed a framework based on structuration theory in which they analyzed the interweaving of the self-identity of individuals with an organizational change process. Their generic structural change model

embodied layers of environmental, systemic, and personal interactive relationships that iterate through a sequence of change from origination, to development, through implementation, to institutionalization. They concluded that within such a framework, individuals define much of their self-identify through contributions to organizational growth and continuity. Also, while developing self-identify, individuals contribute to ongoing change in their organization. The impact of their personal influences can be wide-ranging and unpredictable. Major change initiatives in an organization can "be conceived as having reciprocal effects, through personal agency, on both the organization and the agent's sense of self" (p. 273).

Coopey, Keegan, and Emler (1998) also found that major organizational change was promoted by well-anchored relations among individuals. Individuals gained increased confidence in their self-efficacy by working through change with people with whom they share experiences and one-to-one relationships. Conversely, it is difficult to drive significant change remotely without such anchoring. Social anchoring contributes to a key feedback loop that drives change; where the rhetoric of change drives the cognition of those affected, who through their social interaction affect subsequent change rhetoric. In the absence of such social anchoring, the rhetorical loop on which major change is built is broken, or fails to materialize (Coopey, Keegan, & Emler, 1998). Through this loop the interweaving of organizational change and individual self-identify results in new social systems as well as organizational processes.

Isabella (1990) studied how managers evaluate and interpret ongoing key organizational events using a grounded theory approach. Her focus was less on the

objective reality of change, focusing specifically on how managers perceived change. By looking at large scale organizational changes, she was able to focus on perceptions as they played out over an extended period of time. The changes included in her study were long-term changes that could be described using local milestones for key events, but that would otherwise be described as not being bound by discrete time periods. Such long-term change parallels the change and quality management initiatives of interest in this study.

The change perception theory that resulted from Isabella's (1990) study included four stages of perception: anticipation, confirmation, culmination, and aftermath. Her results identified specific ways in which change participants enact their own reality according to which of these stages they are passing through, and clarified ways in which respondents tend to build their interpretation of events posteriori. As a result, Isabella argued that a history of an organizational change initiative involves more than just an objective timeline of events and actions. It involves understanding the cognitive logic that allows individuals in organizations to understand and adjust to change. The matured cognition becomes a direct outcome of the change that impacts any further change that occurs in the organization. Future change becomes anchored in past cognition, making every change environment and context unique to the players and stakeholders involved.

Gersick (1988) also used a grounded theory methodology to look at group and organizational change. His expectation was that a theory would emerge in which organizations accomplish change through a traditional and gradual series of stages. Instead, he found that organizations can change through alternating patterns of stability

and relative sudden change. He terms these cyclic patterns *punctuated equilibrium* (citing Gould and Eldrige's (1993) use of the term to describe a similar effect in evolutionary biology in the 1970s). Through each iteration of the pattern, group development and change was often more closely associated with the passage of time and pressure of deadlines than with any particular content-specific or objective-focused aspect of the change. This resulted in group change tending to happen at or around major change deadlines, rather than as gradual progressions of change through stages of activity.

Where a traditional model might view such change as theoretically continuous, and perhaps disjointed in practice because of inefficiencies in the change process; Gersick (1988) found that the burst of activity toward change around deadlines was the central component of change, not the exception due to inefficiencies. As such, researchers need to be sensitive to this aspect of group or organizational change, particularly since respondents involved in change initiatives will likely self-report from the traditional continuous viewpoint.

Lee, MacDermid, and Buck (2000) used a grounded theory study to look at organizational change, seeking to better understand how organizations understand and respond to such change. Their resulting theory offers three paradigms of organizational change absorption: accommodation, elaboration, and transformation. Accommodation involves an organization making the most of the situations presented by change, and is the most passive of the three paradigms. Elaboration is more active, with individuals investigating and developing new routines and capabilities in the face of change without

letting go of their status quo. The most active of the three, transformation, involves exploring and accepting routines and activities that completely disrupt the status quo.

As a static, rather than phased or staged, grounded theory, Lee, MacDermid, and Buck's (2000) results can be used in tandem with other staged change models to evaluate and code responses from participants. Their study stopped at a grounding of the three paradigms, leaving for further research the applicability of their three paradigms in the context of staged change initiatives, and the possibility that individuals within organizations will move through these paradigms differently over the lifespan of a multiple-phase change initiative.

Process Management

Zbaracki (1998) used a grounded theory study to analyze possible relationships between rhetoric and reality in the ways organizations selected, adopted, and deployed Total Quality Management (TQM) programs. Using extensive interviews in five different organizational settings, combined with cross-visual displays to identify patterns and synergies across those organizations, he found that the role of rhetoric in such organizational change varied within the lifecycle of institutional change. The lifecycle he described included cycling through three evolutionary stages: variation, selection, and retention.

During the variation stage, the organizations studied reviewed and analyzed different definitions and practices of TQM. At this early stage, the reality of TQM only consists of its rhetoric. Understanding what TQM might mean to the organization, studying successes and failures in other organizations, and discussion possibilities for

deployment all occur within the framework of guru pronouncements, management literature, conference presentations, and expert consultant input. Zbaracki (1998) describes this early rhetoric as defining the TQM reality for the organization preparing to make the selection to move forward with TQM.

During the selection stage, the rhetoric of TQM encourages the reality, but can no longer define it. As new organizational structures are put in place, training programs are built and initiated, and quality improvement teams begin operating, the reality of TQM takes on an objective presence. Management exhortations and team success stories provide supportive and encouraging rhetoric but cannot overcome the on-the-job reality that many individuals across an organization begin to experience. If the program is not well executed, and virtually none are, there will begin to grow within the organization an anti-TQM rhetoric as some individuals find the realities do not match their expectations created by previous rhetoric.

This feedback role of reality eventually defining the rhetoric becomes even more pronounced in Zbaracki's (1998) third retention stage. The experiences and practices of actual TQM teams will affect the ongoing perception and TQM rhetoric across the organization. If the rhetoric is sufficiently negative it can actually kill the TQM program. Typically, for select iterations, management will now input a stronger and renewed positive rhetoric into a return attempt through the entire cycle.

Zbaracki's (1998) grounded theory describes these three evolutionary stages for TQM deployment with two parallel streams for rhetoric and reality, as though each describes a different implementation. The reality includes the technical side of TQM, its

tools, techniques, and practices. The rhetoric includes a broadly ambiguous notion of what TQM will be and do for an organization, often allowing the breadth of such ambiguity to allow almost any successes in the organization to be claimed as having their origins in the TQM program activities, whether or not the technical side of TQM played any real part. As Zbaracki described it, “using TQM may provide an organization with little technical benefit, but the claim to use TQM confers legitimacy on the organization” (p. 603).

Zbaracki (1998) described the rhetorical side of TQM program implementation becoming dominant in the organizations he studied, even overtaking the importance of the technical practices themselves. Individual managers in organizations can feel intense pressure to report successes in their TQM programs in the same terms that were used to justify and implement the programs in the first place. The more resources that are invested in program deployment, the greater the pressure to demonstrate at least rhetorical success. Zbaracki described the reality eventually overtaking the rhetoric because eventually successes need to translate into improved outcomes for the organization in order to maintain the legitimacy of the program.

Information Technology

Orlikowski (1993) studied the deployment and penetration of Computer-Assisted Software Engineering (CASE) tools in information technology organizations using a grounded theory methodology that focused attention on the social and system effects of the emergence and adoption of the technology by information systems developers. CASE tools automate many of the software engineer’s analysis and design activities in order to

provide for seamless transition among development phases, and the automatic production of software source code based on the automated analysis and design.

Orlikowski (1993) found that the success or failure of initiatives implementing these tools in organizations could not be explained sufficiently by looking at the technical merits of the tools themselves or the efforts used to implement them. Understanding the deployment and use of these tools required developing a grounded theory that included the perceptual rationale, or Zbaracki's (1993) rhetorical input, offered by participants. The resulting theory included looking at the organizational conditions that brought about the move toward software engineering automation, the characteristics that drove the adoption of a particular CASE tool, the organizational consequences and outcomes of such adoption; as well as the environmental, organizational, and industry contexts in which these constructs interacted.

Zbaracki's (1993) concluded that a grounded theory approach had been fruitful for her study because it forced her to look at both context and process within the study settings, as well as integrating the actions and statements of key stakeholders, in contrast to many information technology studies that emphasize quantitative variance models in describing differences in technology adoption across a business sector. Her grounded theory points to technology adoption in information technology organizations as a social change process. The technical features of the technologies involved being secondary behind the original selection of the technology to be implemented from among available alternatives. Her theory offers a useful set of facilitating and constraining characteristics that can be used to analyze such change initiatives and settings.

Brown and Jones (1993) used a grounded theory study to look at Zbaracki's (1993) rhetorical side of organizational events and their interpretation by participants. They interviewed participants at a hospital that had been through an extensive period of functional change as a result of a large information technology project that had completely failed to meet its objective of automating key record-keeping and communication capabilities in the hospital. Interviews with project stakeholders resulted in reports that included very divergent views of what had actually happened on the project. Brown and Jones report a chronology of the actual project events that had occurred in an attempt to capture an objective picture of the project, noting that several portions of that chronology were dependent upon some of the narrative reporting. Their chronology was taken as a best possible approximation of what had actually occurred. They then contrasted the narrative reports of participants, and found great disparity along with a few common themes.

Noteworthy among the common elements, and the core of their resulting grounded theory, was that respondents always attributed the causes of project failure as having been beyond their control (Brown & Jones, 1993). In particular, Brown and Jones' (1993) theory groups most narrative responses into two categories; inevitability and conspiracy. Inevitability narratives suggest that events made failure unavoidable, but do not typically assign blame to any particular individual or function. Conspiracy narratives attribute failure to the specific action of other participants. In neither case is the narrator faulted.

Brown and Jones (1993) found that differences among the narratives could be attributed to political interests, with individuals in one department typically focusing on the mistakes and misdeeds of individuals in other departments; or face-saving, with individuals often narrating an involvement and outcome that allows them to maintain self-esteem in spite of the reported failures. Also noteworthy among Brown and Jones' observations was the fact that the narrative distinction they were studying actually repeated itself within the setting of their study. Just as the researchers needed to be careful to differentiate what had actually happened on the project they were studying from the narrative reports of what had happened, the information technology analysts struggled with the same distinctions themselves when interacting with nursing staff in the hospital departments.

Most of the functional specification of the information system, according to Brown and Jones (1993), had been accomplished through input provided by the senior hospital staff. Senior staff in the nursing functions had been too far removed from the operational level on the nursing floor to correctly tell information technologists what the desired system needed to do. Many of these individuals had not served as floor nurses for many years, and so their input tended to emphasize hospital policy over actual floor practice. Floor nursing staff was too busy with their direct duties to properly participate on the project. As a result, the system was built based on what the senior staff felt was needed, regardless of whether it corresponded to reality at the nursing stations. The information technology project team built the failed information system based on what they were told was happening in the practice setting. When that system did not match

what really happened in that setting, the project team had made an error of analysis from which it would never be able to recover. For example, viewing laboratory reports in the system could only be accomplished by doctors using their own passwords. In fact, doctors routinely delegated such work to floor nurses in spite of the fact that it violated hospital policy. Under the new system, nurses could not retrieve lab results, and doctors would not retrieve them; and workaround procedures quickly developed for nurses to contact lab staff directly to obtain lab results outside of the intended system. The resulting process created new delays, errors, and complexity. Too much resource had been put into implementing the system based on the narrative reports to be able to back out and implement reality-based practices. The system was eventually abandoned according to Brown and Jones (1993).

Brown and Jones (1993) cautioned that future researchers should exercise great care when studying and analyzing both successful and unsuccessful change initiatives. Noting the differences between their approximating project chronology and the collection of narrative reports surrounding that chronology, they called for increased use of qualitative techniques in collecting and understanding such complicated cases. Their grounded theory also warns of the dangers of relying exclusively on such narrative descriptions when conducting such studies. Narratives supplied by respondents must be recognized as simplified rationalizations. Their content and meaning represent data in an attempt to understand reality, but are not that reality itself.

Supporting Constructs

A grounded theory study results in new theory grounded in the data collected within the study (Glaser, 1992). The study's allegiance to outside theories or the literature is secondary, although the theory's fit with existing constructs and data lends support to the grounded theory's applicability and usefulness. In this regard, initial theoretical support for this study came in the form of disciplinary areas that might have leant initial constructs to the study process, and that might have provided integration touchpoints as the theory emerged. The following areas in the management and human relations fields fell into this category.

Social and Organizational Psychology

This study looked at individuals in organizational settings. It was concerned with what organizations actually do in their process management practices, and how the individuals in those organizations understand and react to the changes that occur. How these organizations function as social systems, and how individuals see themselves in those systems provided underlying constructs for this study.

Schein's (1978) five types of career anchors provided a useful set of filters for understanding how individuals see themselves in their organizations and helped explain the roles into which they describe themselves evolving over their careers. Each type of career anchor offers a different set of explanations for why individuals might choose different levels of action and participation in the process and technology improvement programs under review.

These constructs were useful for categorizing information that emerged from individual interviews where respondents were asked about their perceptions of organizational process changes occurring around them. Additionally, Schein (1984, 1996) described organizational culture as the context or environment in which careers develop, so interview respondents were expected to describe themselves as having had their career tracks influenced by the change and quality initiatives being discussed.

Role & Motivation Theory

The organizational process changes examined in this study inevitably entailed role shifts for the individuals participating in those changes. Role theory (Biddle & Thomas, 1979; Trahair, 1969) offered constructs and characteristics that appeared in this study as participants described their involvement in change initiatives and how they were impacted by such changes (Ashforth, 2001). Beyond workplace roles, respondents are likely to include comments in these discussions about the effects of change initiatives on their social roles and interactions beyond the workplace (Bettencourt & Sheldon, (2001).

Understanding how individuals react to role changes required using motivational constructs to characterize the way individuals understand, interpret, and react to process change around them. Individuals pursue actions in response to their needs, and the needs experienced by individuals vary widely. Motivation theory provided some structure and predictability to an analysis of motivations by providing a set of framework models for understanding and categorizing motivations expressed by individuals (Hunt & Hill, 1969).

There have also been critiques (Mathes & Edwards, 1978; Neher, 1991) in the literature that have challenged the hierarchy notions of motivations, such as Maslow's (Mathes, 1981) hierarchy where lower level needs must be met before higher level needs emerge. Increasingly, researchers are pointing to the simultaneous interaction of needs at multiple levels (Nordvik, 1996), providing a basis for eliciting indicators and concepts during this study's data collection process as participant contributions were filtered through a variety of motivational constructs. Models in the literature were used to develop propositions as a basis for survey and interview question development, and pattern-matching in the developing of a multi-case analysis.

Utley (1995) found a positive correlation between levels of success of quality improvement initiatives in various engineering organizations and the combined factors of Maslow's (1943) hierarchy of human needs and Herzberg's (1959) two-factor theory of job satisfaction. The organizations most successful in their quality improvement initiatives also had the highest percentage of employees in the upper two tiers of Maslow's hierarchy, and they demonstrated a dominance of Herzberg's motivating over hygienic factors (Herzberg, Mausner, & Snyderman, 1959), particularly if teamwork were added as a motivating factor in Herzberg's model. Utley argued that the emphasis of team structures in organizations has contributed to the emergence of teamwork as a motivating factor under Herzberg's model.

Systems & Complexity Theory

The multiple interactions anticipated among the initial constructs presented in *Figure 1* constitute a system. Systems theory (Bertalanffy, 1956; Laszlo, 1975) became

useful in providing constructs to explain characteristics and indicators that emerged from the interviews and observations conducted in this study. Ackoff (1960) described a system as an interlocking set of components, the collective essence of which is lost if the components are disassembled. He offered a set of three types of systems that might be useful in the context of this study. The first, mechanical, type of system provides function without having any particular purpose of its own; it simply serves some function. The second, organismic, type is typified by an individual organism. As a system, it has purpose and is usually composed of a collection of functional systems. The third system type, societal, is made up of collectives of individual organismic systems and other smaller societal systems. The overall societal system can be said to have a purpose beyond the individual purposes of the individuals that make it up.

Conflict arises (Ackoff, 1995) when contradictions and disconnectedness arise between the purposes of a societal system and the individual purposes of its component members. Organizational change, a form of societal systems change, is likely to disrupt any existing equilibrium between organizational and member purposes. Such disruption is expected to be common in the interview data collected by this study.

The overlapping size and scale of the constructs potentially relevant to this study raised the issue of the effects of complexity. The social systems being analyzed were large and complex, and the constructs of complexity theory (Çambel, 1993; Dettmer, 1997) became useful for examining the role in change of central or theme attractors, as well as systemic emergence and self-organization. Wheatley (1999) and Goldstein (1994) emphasized the self-organizing aspects of social and organizational groups, as well as

emphasizing the need to keep organizational elements as simple as possible to avoid chaotic effects from taking hold during periods of organizational change (Wheatley & Kellner-Rogers, 1996).

Knowledge & Credentialism

Recent years have seen an explosion in the management literature in the area of knowledge management, and the continuing rise of the so-called knowledge economy (Sternberg & Horvath, 1999; Wenger & Snyder, 2000). Whether a fad concept or a long-term systemic change in thinking the literature regarding knowledge management can inform a discussion of shifts in work and learning patterns with respect to the modern workplace (Leibowitz, 1999; Liebowitz & Beckman, 1998; Liebowitz & Wilcox, 1997). Under this view, much of what is being discussed in the process management and process improvement fields might be characterized as knowledge management. Knowledge management provided constructs that were useful when coding data related to learning and change.

The education literature described a shift in recent decades toward the commodification of knowledge: the exchange-value of a credential overtaking the use-value of the education and learning represented by that credential (Dawson, 1987). The arena in which this study occurred is ripe with distinctions where such commodification is occurring (McCain, 2001); from the certification of Six Sigma practitioners as Green Belts and Black Belts, to the certification of an organization as being ISO 9000 compliant, this study required constructs that helped differentiate such certifications as

either demonstrations of new applied knowledge or as commodities for the marketing of services.

Does an organization become ISO compliant because it wants more effective processes, or because it wants to put the ISO logo in its marketing materials? To the extent that this study found low-order motivational factors (at least partially) driving certain change activity in the profession, such activity represented a move toward such commodification (Wonacott, 2000). This contrasted with the knowledge management literature that describes our economy as shifted toward being knowledge-based (Lerman, Riegg, & Salzman, 2001). In the software industry, Issac, Rajendran, and Anantharaman (2004) found that certification to one or more quality standards supported their more effective use, and that credentialism-motivated concerns were secondary to those considerations.

Summary

This chapter has provided an overview of the literature that describes the origins and some history of the quality and software engineering constructs and models that were used as initial constructs in this study, as well as a survey of the use of the grounded theory methodology in answering research questions related to these constructs. Studies that have addressed the issue of quality management maturity or process improvement have consistently found that the human factors of change carry as much weight, if not more, than technical considerations in the efficacy of such improvements. Wiklund and Wiklund (2002) described the need to consider attitudes and expectations when looking at involvement in process change. Jung and Goldenson (2002) emphasized the effects of

human and cognitive factors on organizational change. Echoing this, Cosgriff (2000) described the importance of people and the meanings they give to change in discussing a contrast between a structural-functionalist approach to change, versus an interactionist approach. Paulk (1999), an initial architect of the CMM model used in this study, discussed the interpretation of change by employees and the importance of any changes not contradicting the culture and belief systems of the individuals involved. Ryan (2000) suggested avoiding structural interpretations of quality change, pointing to people as the key dimension in organizational change success.

Beyond organizational culture and cognitive meaning, the literature also suggests that the technical content of process change can best be understood through human study. Guimares and Clevenson (2002) discussed the role of tacit knowledge in process change, describing perceived meaning of procedural techniques as beyond the objective measurement of processes. Understanding real change in such organizations can require looking deeply and beyond the documented history of change. Gephart (1993) described the archival residue that often accompanies such change, but emphasized the importance of extracting shared meaning from the individuals in the organization around such residue. Lyles and Mitroff (1980) suggested interviews as the most effective researcher technique for eliciting the nuances required for effective interpretation of such an archival residue in the documentation.

Several studies emphasized the role of rhetoric in understanding the data likely to be collected from such interviews. Isabella's (1990) discussion of interviews as collecting posteriori interpretations of observed or experienced events points to the need for careful

consideration and coding of data, as well as verification of observations against objective sources where available. Coopey, Keegan, and Emler (1998, 1997) discussed the role of personal agency and social anchoring in interpreting each respondent's observations as part of a continuous rhetorical feedback loop, where the power of rhetoric to influence an individual's understanding or interpretation of what is happening has an influence on the responses they later provide. Brown and Jones (1993) called such influences rationalizations that needed to be taken into account, not to eliminate the rationalizations, but to understand them as part of the data being collected.

The extent to which many grounded theory studies have researched organizational change, many resulting in staged or phase models similar in type and structure to the CMM model that served as the structural focus of this project, is an indication of the viability of such a methodology in this study. The models that have resulted from such studies, including Lee, MacDermid, and Buck's (2000) three-paradigm model or Zbaracki's (1998) three-stage model, provided suggestions for the coding structure that was used in this study during data analysis. Chapter 3 describes the research design for this study based on such a grounded theory approach.

CHAPTER 3:

METHODOLOGY

Introduction

This chapter discusses the methodology that was used to study the interaction among multiple process maturity and capability dimensions in information technology organizations as outlined in chapter 1. It begins with a description of the general grounded theory approach and a description of the research design based on that approach followed by a description of the constructs that were studied and the validity challenges faced.

Industry CIOs make decisions every day about process improvement priorities based on gut feeling and anecdote. When one looks for a formal thought process for making decisions that involve both quality improvement and engineering improvement in information technology, one finds virtually nothing. There is a wealth of data about quality management in information technology, and a great deal of information about the applications of the SEI CMM models to software engineering, but there is very little on their combined contribution. The materials that exist are typically from the business press, and do not include academic studies. There simply isn't a theory in this arena. Too little is known to even establish effective hypotheses for testing. We simply don't know what the synergies are between the process improvement and engineering improvement disciplines.

The questions that need to be asked are broad, yet easy to see; and the population of individuals to be included in such a study is readily available. Grounded theory was

chosen for this study because of the absence of current theory or even hypotheses, and the plentiful availability of observational and interview data for developing a theory grounded in that data. New theory can focus the process on narrower and more specific questions, even on the developing of hypotheses that can be tested using other forms of qualitative or quantitative research.

Grounded Theory

Theory created inductively through a detailed and exclusive analysis of actual field data collected within a study is said to be grounded in that data. Grounded theory research is the formalization of that approach first expounded by Glaser and Strauss (1967) and further developed by them (Corbin & Strauss, 1990; Glaser, 1978; Glaser 1992; Strauss & Corbin, 1998) and others (Day, 1999; Partington, 2000) since then. The level of methodological formalism varies based on the account of grounded theory reviewed, but each variant includes a common emphasis on cycles of qualitative data collection coupled with a continuous data analysis, resulting in propositions that opportunistically drive continuing data collection and analysis.

The conceptual heart of the methodology is the on-going comparison of discovered data against previously collected data (early in the study) and against any emerging theoretical insights or syntheses (later in the study) , the constant comparative method, coupled with the opportunistic use of that data in selecting and driving subsequent rounds of data collection, theoretical sampling. As a continuous cycle, the grounded theory approach needs a criterion for stopping. Glaser and Strauss (1967) invoke the concept of theoretical saturation; the limit of diminishing returns in the data

collection and analysis cycle where new data collected offers little or no productive insight into the continually emerging theory. Saturation is not a simple issue, and occurred in this study at different rates against different constructs and theory elements. In the end, the grounded theory described in this study required some pruning at the margins to remove elements that had not reached adequate completeness for inclusion in the final theory.

Grounded Management Theory

Partington (2000) surveyed issues facing management research and literature and concluded that the field would be aided by more inclusion of inductive theory-building studies that use more empirical data to provide useful, relevant, and up-to-date results. He emphasized cognitive dimensions of many management research problems, and described a need to give more central attention to the conscious thought processes of those involved in making management decisions. With the complexity of cognitive and behavioral studies, the emphasis on statistical significance and quantification can mislead researchers into drawing conclusions about only the narrowest ranges of problems that can be described in such terms. He recommended an increased use of grounded theory research to study fields where data elicitation and analysis are required even to make sense of the problems being addressed, with formal hypotheses and quantitative studies following.

Grounded theory research allows for direct inclusion of the tacit knowledge of managers, and allows that knowledge to build a theory with strong face-validity and attachment to the respondents involved in a study. Such research emphasizes the study of

retrospective accounts through interviews and content analysis. Partington pointed out that such data carries a different ontological status from direct behavioral observation or quantitative data collection. It is the synthesis of these perspectives that gives grounded research its strength. Zbaracki's (1998) contrast and synthesis of the rhetoric and reality of TQM discussed in chapter 2 is an example taken directly from the quality management arena of interest in this study. As a grounded theory study, this research was able to look for any complex interrelationships among manager perceptions and thoughts, and their observable decisions and actions.

Description of the Research Design

The stages of the research design outlined below were adapted directly from Eisenhardt's (2001) analysis of methods originating with the early grounded theory writings of Glaser and Strauss (1967), synthesized with inductive case study methodological additions from Miles and Huberman (1994). The approach can be described as sequential and linear; but, in fact, entailed constant iteration and recycling, with emphasis shifting each cycle from the data toward the emerging theory until sufficient theoretical saturation had been achieved to justify ending the study and documenting the resulting theory.

Getting Started

The study initially explicated set of two simple initial research questions that focused study efforts within the sample frames available. Eisenhardt (2001) argued for minimizing the role of existing theories or hypotheses at the early stages in order to

maintain flexibility in how and where the study begins to collect data, although she acknowledged the possibility that defining certain a priori constructs can provide a better grounding for initial study measures and instruments.

Selecting Cases

It is in selecting cases for study that grounded theory differs heavily from other research methodologies, primarily in the avoidance of randomness in the samples selected. Without existing theory or hypotheses, the conditions for the choice of data sources differ from traditional or quantitative studies. Initial cases in this study were those that offered a direct and broad collection of data surrounding the base constructs defined as core in this study.

Eisenhardt (2001) argued for limiting the range of initial variation in the cases selected in order to sharpen the initial external validity of any emergent relationships. This reduction of variation results in early clarity of data, clarity that might subsequently be lost as ensuing data sources are examined, that drives further opportunistic sampling; or what Glaser and Strauss (1967) defined as theoretical *sampling*, where the focus in selecting additional sources is driven by the emerging data and the projected usefulness of anticipated new data for closing holes or resolving issues in the emerging theory. Glaser (1978) described a researcher with an openness to emerging data issues and opportunities as exhibiting theoretical sensitivity.

Beyond initial sampling, Patton (1987) argued for maximum variation as a central logic of purposeful sampling. Maximizing the diversity of sampling allows central themes and principle effects to emerge. He argued that when similar themes emerge from

a diversity of sources, they are likely to represent core phenomena. By focusing initially on the chemicals company respondents as a single-case exercise, this study gained the initial insights promoted by Eisenhardt. Subsequently expanding the respondent base beyond the chemical company to the healthcare setting, and eventually a broader array of organizational settings, the study built toward Patton's maximized variation.

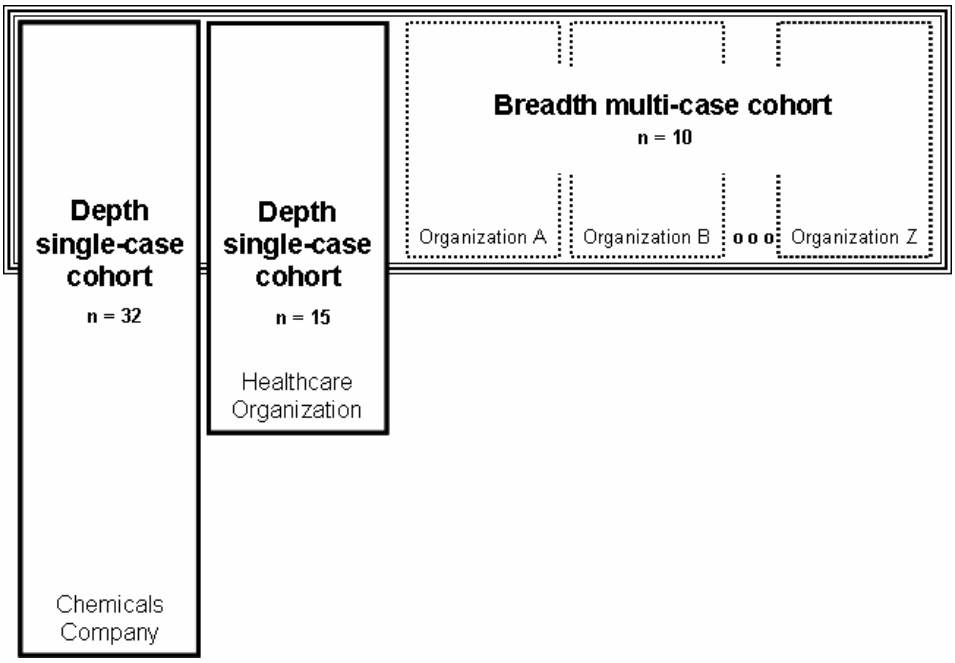

Figure 3. Depth and breadth sampling of IT organizations.

This study included 57 interview respondents, 32 drawn from the chemicals company, 15 from the healthcare setting, and 10 additional respondents for a diversity of industries. Following Eisenhardt's (2001) suggestion to limit the initial diversity of respondents in order to sharpen the focus of the study in identifying initial constructs, activity in this project was limited to just the chemicals company during most of the first year of the study (2005-2006). Twenty of the 32 respondents in the chemicals company

participated in their first interviews during this period, and site observations were limited to locations in this organization. The healthcare setting was added to the study mix during the second year, with its 15 respondent interviews scattered across the calendar along with the remaining 12 chemicals company respondents. Site visits to both organizations continued throughout the second year (2006-2007). The 10 respondents in the tertiary cohort, representing 10 different organizations, were added during the latter half of the second year. Contrasting these organizational perspectives allowed cultural aspects unique to any one organization to be isolated from general constructs that emerged from this study.

Crafting Instruments and Protocols

Triangulation of the evidence collected in a grounded theory study can strengthen both the reliability of the study and the validity of the resulting theory. It is the nature of a grounded theory study to allow the theoretical needs of the study to drive instrumentation, with initial constructs and theoretically supporting literature supplying the initial focus. This study used multiple data collection methods against data combined from multiple sources.

Eisenhardt (2001) argued for including multiple investigators in a study to help ensure the objectivity of such triangulation; something that was not practical in this project. Her alternative was to include a set of key informants who serve in devil's advocate roles as ranging from interview informant to peer reviewer of interim researcher notes and memos. I identified several such participants from among colleagues in the IT

quality management community, including staff at the Software Engineering Institute and the Software Division of the American Society for Quality.

Entering the Field

Beginning the collection of data requires a heavy integration of activity with data analysis activities. This required that the mini-cycle of iterating through data collection and data analysis activities be tight and constant within the larger cycle of the grounded methodology. Particularly in the earliest study phases, field data needed to be immediately readily analyzed so that the data itself would take over as the theoretical underpinning of any instruments or protocols. For this study, this cycle entailed converting interview audio tapes and session notes into transcripts that could be verified by respondents, followed by basic coding of those transcripts to identify key themes and notable or repeated constructs that appeared in each. Interviews were typically converted into keyword lists and concept diagrams within two weeks of each interview session.

The consolidated version of all keyword lists and concept maps from interviews quickly formed a critical mass of materials that validated many of the interview questions being asked, and allowed clearer and more specific questions to emerge. The earlier such critical data mass can be achieved, according to Eisenhardt (2001), the earlier the study can lose its reliance on any a priori constructs used to begin data collection. Once driven by its own data, my further field work could opportunistically take advantage of the flexibility of this approach to pursue emergent themes or unique issues raised in the data. Pursuing such leads based on insights drawn from the literature or a priori constructs would undercut the validity of the grounded theory approach, although the ultimate

alignment between the findings of this study and the relevant literature supports project validity.

While grounded theory is predominantly described as an inductive method, Glaser (1978) described the principles behind theoretical sampling in the field as highly deductive. Conceptual elaboration of data already collected, as well as emerging constructs and relationships, requires an ability to hypothesize the possibilities and probabilities associated with where the data will lead next in order to identify the correct next-case to pursue for further data. The overall inductive process is driven internally by creative deduction, or what Weick (1989) referred to as *disciplined imagination*.

Analyzing Data

Analyzing data involved within-case analysis early in the study as data collection probed for initial grounding constructs and themes. It later evolved toward cross-case analysis as the study progressed. When constructs began to reach theoretical saturation, data analysis shifted from the data collected to elements of the emerging theory. Many of the case analysis techniques used in this study were drawn from Miles and Huberman (1994), including within-case displays to isolate respondents from the same organizations, cross-case displays to compare and contrast respondent texts from multiple organizations, and second level matrix displays to display construct mappings to respondent group texts and themes. For example, analysis of only the data from early chemicals company interviews and observations quickly focused on the central constructs of resources, workload, and accountability, in that order. Analysis of only healthcare-setting data quickly focused on resources, accountability, and value to the institution and

patients, in that order. Cross-checking such data allowed for additional interviews to explore issues of value in the chemicals setting, and issues of workload in the healthcare setting.

Eisenhardt (2001) described the emphasis of the early within-case analysis as focused on gaining an intimate familiarity with each case as a stand-alone entity. While a grounded theory must be grounded in all of the data collected in the study, it must specifically apply to each distinct case. With generalization across multiple cases as the focus of later analysis, the emergent theory must ultimately be applicable to each case presented. The model discussed in chapter 4 includes the constructs of resources, value, accountability, and workload as interacting variables; not necessarily in the specific pattern that would precisely be described by either chemicals or healthcare organizations, but to which their responses and data can readily be mapped.

Seeking patterns and abstractions in the later cross-case analysis required overcoming issues that might have resulted in information processing bias. This was the specific area where Glaser and Strauss (Glaser, 1992) seem to have evolved in slightly different directions after their initial 1967 work. Glaser (1978; 1992) continued to evolve and promote a nearly ad hoc approach to data analysis that remains open to nuances and emergent opportunities. Strauss (Corbin & Strauss, 1990; Strauss & Corbin, 1998) continued to evolve toward making data analysis more systematic and rigorous. There exists some synergy between their two positions that maximizes Glaser's desire for emergent innovation while supplying much of Strauss' rigor and control. Many of the techniques of Miles and Huberman (1994) attempt to bridge this gap, and this study made

use of many of them as the data emerged. Cross-case techniques were used to systematically identify similarities and differences across cases that could inform subsequent data collection. To the extent that such findings could be corroborated from multiple sources, the rigor of their identification became less of an issue. Emerging issues that lacked specificity or clarity were typically turned into observational objectives for site visits, and were included as topics in discussions with managers or the CIOs of both organizations. Data that could not be corroborated might seem weaker and less grounded if the data collection protocol lacked rigor (Eisenhardt, 2001, p. 541).

This study mediated the need to corroborate respondent statements based on the needs of the data being uncovered for analysis. My experience as an information technology data modeling analyst tended to influence my analysis toward Strauss and Corbin's formalized techniques; meaning that an explicit review was required to help assure that Glaser's broader creative elements were not lost in the process. The key informants from outside this study, from the Software Engineering Institute and the American Society for Quality, provided informative input to the analysis of respondent and observational data. The reactions of both CIOs to preliminary finds often resulted in further discussions of the big picture that they believed placed my conversations with staff into context.

Shaping Hypotheses

The continuous shaping of theory and hypotheses was the focus of the constant comparative method. Collected data and emerging analysis were constantly compared to evoke hypotheses that drove continuing data collection and analysis. Eisenhardt (2001)

described the process as a duality between continual refinement and splitting of the study constructs and the building of evidence for, and gaps between, the constructs. As an iterative process, the friction between clarification and gap analysis leads toward theoretical constructs of increasing sharpness and validity. The search for hypotheses and propositions ensured that the data collection and analysis protocols always included questions of *why*, and so ensured a deeper understanding with each iteration.

Enfolding Literature

While grounded theory study typically avoids early comparison of findings with the literature, a comparison of the emerging theory with the literature helped build internal validity of the theoretical constructs. Literature that might have biased the study if introduced too early was used to further validate the constructs and relationships being posited by the grounded theory. Gaps further identified opportunistic data collection areas; while alignment offered opportunities to tie the theory to outside data and findings, enhancing generalization of the theory and its applications. Alignment between this study and the literature is discussed at the end of chapter 4.

Reaching Closure

A grounded theory is never complete, but a grounded theory study must reach some form of closure. The study process ended when only marginal improvements in the emerging theory resulted from further investments in data collection and analysis. Continual collection simply continued to reconfirm data already collected and incorporated into analysis. The last few interviews added no new keywords or constructs

to the study. This point was one of theoretical saturation, and involved subjective judgments that varied across the multiple constructs in the study. The choice to reach closure entailed practical considerations of operating this 2-year project, as well as theoretical issues; although the desire was for the theoretical issues to lead the thought process and determine closure. The study ended because key informants were reporting that the emerging theory was suggesting useful and helpful guidance, and because further data collection was not expanding on the model.

Study Approach

Detailed procedures are an emergent property of a grounded theory study, just as the data and concepts are emergent. The grounded theory model of cycling through data collection and analysis, supplemented by memo writing and review until reasonable theoretical saturation has been achieved, has been described above. Within this cyclic process, specific types of data were accessed as the study drilled deeper into the areas of concern. The richest data came from the one-on-one interviews. To ensure the quality of those interviews, earlier data was used to solidify coding strategies and preliminary constructs.

This research design was highly labor-intensive for the researcher. Key roles for the researcher included (a) identifying the sample of professionals to be included as respondents in the study, (b) soliciting their time and involvement and securing their consent, (c) scheduling, conducting, and transcribing the interviews, (d) analyzing and coding the interview transcripts, (e) synthesizing the coded entries into the cross-referenced and emerging model, and (f) analyzing the model continuously for emerging

holes or patterns that would indicate a need to revise the interview protocol in order to pursue additional or emergent issues. Each interview cycle was accompanied by site visits to observe the chemicals company and healthcare organization settings, interview each CIO, continue discussions with interview respondents, and review and analyze work products and presentation materials. In parallel, the researcher needed to conduct similar activities for the content analysis of the literature and related professional conference proceedings. From the synthesized model, the researcher needed to write up the case notes for the final results chapter, as well as generally complete the dissertation overall.

Literature Review

There was a wealth of literature available dealing with the concepts and issues being explored in this study. Very little of this material presented actual data points that could be used for grounding theory, but all of it could be used to help identify some initial coding attributes and categories for analysis of subsequent data collected.

An advantage to reviewing the literature early was that the material remained static and could not change as a result of the act of reviewing it. Indicators of concepts (Glaser, 1978, p. 62) drawn from the literature can be continuously tested throughout other data collection activities, and can be revisited at any point. I returned to the initial literature several times during the study to review and validate terms being drawn from the interview keyword lists into the construct list for the model.

Archival Data

Archival data was available at the Software Engineering Institute for each of the organizational process assessments that were completed by certified assessors in information technology organizations over the past 10 years. This data provided specific process maturity data about information technology organizations, as well as contact points for potential interview participants. Several dozen profiles of organizations in that data were available as published case studies. Additional archival data was available through the National Institute of Standards and Technology (NIST) for organizations that have been assessed against the criteria of the Baldrige National Quality Award. Winners of the award are obligated by its terms to share data regarding their organizational process improvement and process maturity results with other organizations.

Archival data provided direct visibility into actual practices in organizations, and was used in the data coding process to begin building a conceptual foundation against the indicators and concepts identified in the literature review. This foundation helped clarify the conceptual model, and reduced the risk that the wrong or an incomplete model would form the basis for subsequent interviews. Additionally, the archival data sources that reflect organizational assessments explicitly identified informant candidates from within the assessed organizations that could then be invited to participate in this study as interview subjects.

Personal Interviews

Interviews formed the central core of this study's approach to data collection. Using grounded theory, it was difficult to estimate in advance exactly how many people

would be interviewed, or who exactly they would be; but the general approach can be described. It needed to be kept in mind that the data collected through the personal interview channel represented the subjective reporting of the participants. As such, Isabella's (1990) description of such data as posteriori interpretations was important when placing respondent comments and observations into context. Gersick (1988) observed that self-reports of improvement initiatives tended to describe continuous change that was objectively sporadic or punctuated. Data collected through such interviews required filtering during coding against other archival data or my field observations, without invalidating the such subjective observations as representing the true meaning of events and circumstances to the respondents. Onsite visits and observations in the workplace were used to corroborate statements made by respondents during interviews.

Early study interview participants were drawn from the chemicals company that was selected for initial study concentration. The earliest participants were those who directly worked in or around the company's complex process improvement arena that involved both the SEI Capability Maturity Model and a comprehensive integration of Six Sigma as the underlying process management philosophies. Concentrating on this core group allowed maximum intensity to be focused on early core indicators and concepts. Interview protocols were then adjusted prior to second-round interviews in order to intensify coverage of emerging themes.

As the study progressed, participants from the chemicals company were expanded beyond those directly involved in these programs to include more individuals who were

associated with, or are impacted by, those programs. This latter group included the Chief Information Officer (CIO) and the Vice President for Six Sigma. Using this expanding group helped ensure that the early core indicators and concepts did not become blinders to theoretical sensitivity.

Additional interview participants were identified outside of the chemicals company in order to expand the data and perspectives being reviewed. A second organization, an academic healthcare institution, was selected as an additional concentrated study site that could offer both a cohort of interview respondents and opportunities to go on-site to visit and observe. A third tier of respondents was invited to participate using names drawn from the literature review and archival data analysis described above, and the content review described below. Each interview followed a question script (see Table 3) that varied only in style based on my knowledge of the individual or organization.

Table 3

Initial Round Interview Questions

1. How long have you worked within information technology?
2. How long have you worked within your current IT organization?
3. How would you characterize the size of the IT organization in which you work?
4. What improvement model does your IT organization use to improve processes?
5. What improvement model does your company overall use?
6. How are you impacted by the roll-out or activity of these improvement programs?
7. How effective are these models in actually improving your organization's effectiveness?
8. What does your organization do to measure its processes and quality levels?
9. How might your organization improve the way it rolls out process improvement changes?
10. How do you regard the expectations of what you can deliver in your organization?
11. How successful are your projects from the perspective of your sponsors and customers?
12. Do your customers see the value your organization's efforts to improve your processes?
13. Are the systems and solutions you provide to your customers today better than in the past?
14. Do you attribute some of the improvements to the process improvement initiatives in your organization?
15. Does your organizational culture support the changes driven by your process improvement programs?
16. How would you compare your organization's improvement efforts to other organizations in which you've worked?
17. Are your projects more successful when they directly apply your process improvement techniques?
18. Do your organizational processes hold the organization back from achieving the most that it could achieve?
19. Has your organization's improved process effectiveness reduced your personal workload?
20. Could your organization be just as successful without your process improvement programs?

Interviews were only tape recorded when possible, with the consent of those interviewed, and transcribed before coding analysis. About half of the interviews could not be recorded because of security restrictions at the respondent workplace, in which cases detailed researcher notes were substituted for audiotape recordings. Two of the respondents selected to submit written responses to interview questions because of the weakness of their spoken English. Participants were offered an opportunity to review the transcript of their interview or researcher notes to make corrections or add subsequent comments or thoughts. Each resulting transcript underwent open coding, and was described by a separate researcher memo. As the study progressed, the results of such coding and memo writing were further synthesized into the study's axial coding network and concept cards. Late in the study, these results were synthesized into the study's conditional matrix.

Content Analysis

Although traditionally associated with external data collected in the context of an otherwise quantitative study, Ryan and Bernard (2000) defined content analysis as the attempt to understand qualitative texts through coding and comparison of content. As part of this study, content analysis included both meanings because some of the narratives included interview transcripts and notes generated as part of this study, while other narratives included external materials collected directly for inclusion in this study. In either case, the emergence of a grounded theory depended upon the content analysis of these texts and narratives.

The content of materials identified and collected during the literature review, archival data, and site observations were analyzed using the same procedures as those used to code, memo, and synthesize interview results. These materials included conference proceedings from related professional organizations and example materials offered by interview participants. In particular, access to the chemicals company site resulted in direct access to project meetings, work products, and resulting presentation from over 50 active Six Sigma projects across multiple departments. Access to the healthcare organization allowed for direct observation of six active Six Sigma projects, four of which had improvement scopes that included large information technology components.

There were two major organizations that conduct professional conferences in the area of interest for this study: the American Society for Quality, and the Software Engineering Institute. Both groups conduct annual conferences and publish proceedings. This study analyzed the presentations from each conference in 2005, 2006, and 2007, as well as historical proceedings for 2002, 2003, and 2004. Proceedings prior to 2002 were not electronic, so access to those materials was much more limited.

Data Analysis

The plan for analysis followed the logic in the core literature on grounded theory. It began with basic coding of interview transcripts and notes to identify concepts and attributes that made up the content of those transcripts and notes. This process was non-sequential because of the repeated analysis necessitated by the level of synonyms occurring in the list of characteristics encoded, and the various levels of detail to which

any particular concept was broken out across multiple interviews. I wrote one-to-one memos for each interview transcript, as well as conceptual memos as concepts materialized.

As a theory started emerging, conceptual memo writing overtook the one-to-one approach, and new higher level aggregations and concepts became the target of analysis. What emerged from this process was a conceptual map supported by detailed memos for each of the concepts and relationships in the concept map. The result was a lexicon of concepts, characteristics, and attributes; the values of which could vary for each respondent. The storage of this data involved several large data spreadsheets that evolved over the life of the study.

A review of a particular respondent's input traversed the concept map touching only on those aspects that were relevant to that respondent's interview. A review of a particular concept traversed the map among related concepts and connections to those respondents that contributed toward the emergence and definition of the concept. Themes and patterns across the concept map became the basis for writing up descriptions of findings in the Results chapter. A parallel and analogous process was followed for the archival data and content analysis materials included in the study.

Initial Constructs

The broad initial constructs needed to begin this study were introduced in chapter1 (see *Figure 1*) and are operationalized here using the key terminology also introduced in chapter 1 (see *Figure 2*). While the discussion in chapter 1 introduced some of the terminology of process management out of context, this discussion puts those

terms into the specific context of a process improvement initiative or movement, or the process improvement of process improvement. The use of this process-oriented terminology can be confusing or disorienting precisely because the process being discussed is the process improvement process. It requires applying the three terms described in *Figure 2* to the actual process improvement process used by an organization (see *Figure 4*).

Process improvement maturity. The maturity of an organization's process improvement processes will partially determine the organization's process capability for process improvement. A discussion of the impact that process improvement has on process maturity is a general discussion of terminology, depicted in the upper tier of *Figure 4*.

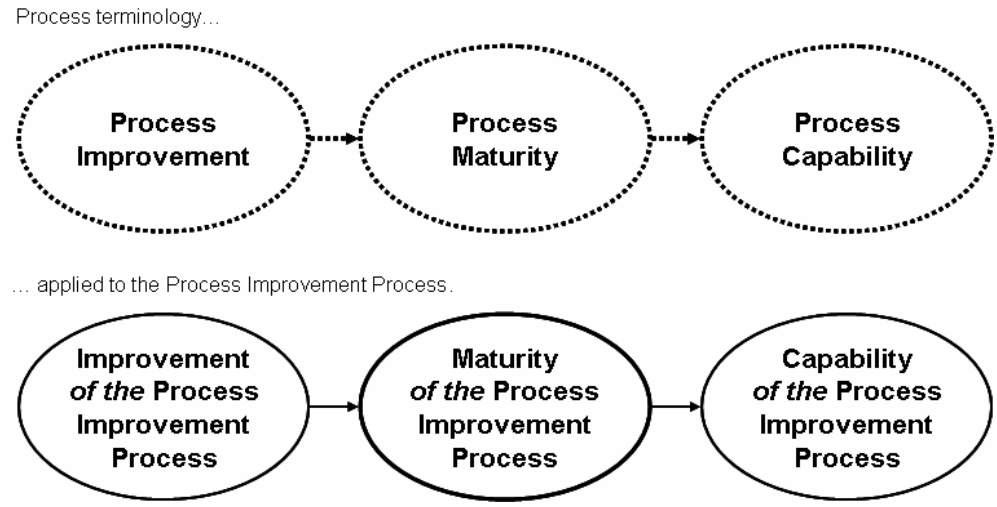

Figure 4. Process terminology applied to the Process Improvement Process.

A discussion of a particular proposition related to a subject domain is a discussion of an application of that terminology to the specific case. For example, a proposition that

attempts to state that “an organizational shift from Total Quality Management (TQM) to Six Sigma is an improvement in the organization’s process improvement maturity” involves a specific case where the process being discussed is the organization’s process improvement process. This example is depicted in the lower tier of *Figure 4*. This proposition asserts that an organization that improves its process improvement processes by implementing Six Sigma will be operating at a higher level of maturity in its process improvement process than previously, implying that the organization’s capability for process improvement will be greater. Measures of this construct are ordinal. The values taken on by the process improvement maturity construct generally represent a continuum from brute-force improvement efforts through early TQM initiatives and into more complex models like Six Sigma, with more recent expansions to include Design for Six Sigma (DFSS).

Domain-specific process maturity. The level of process maturity of a specific disciplinary domain. The domain of interest in this study is information technology. The operational definition of this construct is the Capability Maturity Model multi-level framework developed by the Software Engineering Institute (Weber, Paulk, Wise, & Withey; 1991). Measures of this construct are ordinal, with individual organizations adopting either the set of integers from 1 to 5, or a continuous scale from 1 to 5.

Business process maturity. The maturity of business processes in use throughout an organization is a multi-dimensional construct, and no predefined measures or scales are available a priori. This study identified dimensions that seemed relevant to changes enabled by information technology. Information technology was generally taken to

improve the business process maturity of the business processes in which it is implemented, and such improvements in maturity were notable, even if not quantifiable. Observations of such improvements were developed on an ordinal scale, using one or more scale dimensions depending upon the data that emerged from the analysis.

Categories and examples of dimensions that might have emerged as significant in the grounded theory defined in this study included strategic-tactical planning, product-service lifecycles, change management and reengineering, and engineering-vs.-human relations cultures. I worked to remain open and sensitive to the business impacts attributed to the information technology processes represented in the data collected.

Population & Cases

The focus of this study's grounded theory can be either an organization or an individual, or some combination of organizational and individual aspects. This apparent indecision required the research to look at sampling both organizations and individuals until a grounded perspective emerged. Therefore, the population from which cases and informants were drawn had to be the entire global information technology industry, made up of a wide variety of organizations and the individuals who work in and with them. The key element in identifying cases was gaining visibility into the populations of interest.

Locke (2001) described the issue of access as the most important concern to be addressed by a grounded theory design that is dependent upon theoretical sampling. She suggested maintaining contact with key study stakeholders throughout the time period of the study so that relationships will not have grown stale between intervals of access. In the context of this study, this issue involved access and visibility into the information

technology departments of the two main participating organizations. The chemicals company was selected for study because of its manageable size and scale. A study involving all of its parent corporation would have introduced excessive complexity as well as hidden confounding variables caused by differences among the different divisions across each operating unit and their information technology functions. Focusing on the chemicals company kept the analysis at the same size and scale as other organizations that might have been chosen to participate in this study.

The healthcare organization was selected for participation because it roughly matched the size and scale of the information technology organization within the chemicals company. The healthcare setting offered a contrasting nonprofit service sector perspective to that of the industrial chemicals company, and allowed an exploration of factors that were common or distinct across those diverse settings. In addition, several other companies were included in the sample in order to look for effects within the data caused by unique characteristics of each of the first two organizations or their industry sectors.

The chemicals company and healthcare organization both required repeated and continuous access over the life of the study. To assure continual access to staff, I provided periodic status updates to the Chief Information Officer (CIO) of each organization, typically on a quarterly basis. This continual contact assured continual access and interest from these two important respondent organization. Other respondent participants represented themselves as professionals, not as members of their respective organizations.

Process Management Cases

Sampling organizations and individuals involved in process management maturity required visibility into the related process management practices across the industry. Operationally, the most visible organizations were those who have sought one or more of the various quality awards available in the public and private sectors (e.g., Baldrige National Quality Award in the United States, the Deming Prize in Japan). By applying for such an award, an organization is self-asserting that it is actively engaged in measuring and improving its organizational process management maturity.

Other sources of such organizations and individuals included organizations that have been accredited under one or more quality or process management standards (e.g., ISO 9000, ISO 14000) or who have had individuals presenting the programs of one or more conferences or seminars held by organizations focused in the process management field (e.g., American Society for Quality). Other organizations were written up in the trade literature. All of these information sources were public and were scanned for selective sampling for this study.

Information Technology Cases

Visibility into the domain-specific process maturity of the information technology industry was provided by the standard maturity models of the Software Engineering Institute. Organizations that have conducted assessments against these models were identified by scanning the content of SEI datasets and publications that are either public or available by request for academic study. Additionally, organizations using the models but not being formally assessed were determined through review of the attendee lists of

the various SEI conferences held each year. Finally, the proceedings of the SEI conferences served as a source for data on many of these organizations, and as identifying sources for individual respondent invitations. All of these data sources were public and were used in identifying cases for analysis.

Business Process Cases

Visibility into the improving business practices driven by process and IT maturity is available in the IT trade literature. Numerous trade publications periodically publish lists of top performers in the application of information technology. These organizations served as sample cases for analysis regardless of their maturity levels against this study's other constructs.

Ethical Protections

All participation in this study was voluntary and involved signed consent. No participant in any of the organizations involved was required to participate even though their participation was being suggested by management. Managers in these organizations were not be told who chose to participate or not participate within their organizations.

Questions asked of respondents were largely conceptual and non-personal. Respondents were asked about their reactions to, and feelings about, objective situations in their workplace. The privacy of their responses was assured, and they could ultimately choose not to answer any question, although none of the respondents ever declined to answer any of the question put to them. The types of questions asked were not unusual for internal corporate surveys or questionnaires, and formal IRB approval was obtained

for project invitations letters, consent forms, and interview protocols in the spring of 2005.

In writing up results, individual respondents were not identified. While the study acknowledgements include a general thanks to respondents, that acknowledgement does not name any respondents or their organizations.

Validity Challenges

This study faced four major validity challenges that are characteristic of any grounded theory study (a) a failure to actually build a theory, which would represent a collapse of the grounded theory approach, (b) producing theory that lacks validity, (c) conducting the study in a way not deemed reliable, and (d) building a theory that does not fit the available existing literature and knowledge of the related fields. Additional challenges were more specific to this study: e) disagreements over operational definitions, and f) that the IT industry focus might limit generalization of the resulting theory.

1. Failure to achieve theory. Because the output of a grounded theory study is new theory, failure to produce a deliverable recognizable as theory would invalidate this study. Sutton and Staw (1995) offered a set of five criteria for recognizing when a study has not reached a threshold of offering theory.

First, presenting a “flurry of citations” (p. 373) does not result in theory. References, without any offer of underlying logic or purpose in their inclusion, are not sufficient to build theory. Second, data are not theory. A dataset describes the empirical facts of a case or study but fails to explain why those empirical facts are found.

Therefore, data can ground a theory and yet not suffice to *be* that theory. Third, lists of constructs are not theory, no matter how well they are described. Fourth, diagrams are not theory, although they can support the presentation of complicated aspects of theory; theory explains the diagrams, and provides appropriate rationale behind them. Fifth, hypotheses are not theory. An ability to make predictions from data does not require that any theory intervene between them. Achieving theory necessitates that the underlying logic behind hypotheses can be offered along with the predictions.

Sutton and Staw argued that studies that stop at any of these five rhetorical levels fail to produce theory. Weick (1995) agreed with them, but supplemented their discussion with his own distinction between theory as product, and theorizing as process. He argued that the five characteristics described might be the result of lazy theory building on the part of the researcher, in which case he would also reject the study as non-theory; or as documentation of an interim struggle that the study is still progressing through, in which case he would accept it as weak theory. Seeing theory-ness as a continuum rather than a dichotomy, Weick argued for measuring where a study falls on the five characteristic dimensions before judging the strength or weakness of an offered theory. The onus is on the researcher to articulate the weaknesses of the study and explain why the stopping point was chosen.

This study came to a close because it achieved theoretical saturation: Additional interviews and site observations were not resulting in changes to the emerging model. Making further changes would have required expanding the scope of the study to include additional issues not being addressed by the data collection and analysis processes. Key

informants reviewing interim results were observing that the emerging model was useful and explained organizational details and outcomes that had not been previously explained. For example, the narrowing of the management commitment construct to management resolve was described as accurate and useful. A grounded theory gains credibility to the extent that no contradictions are in view, and potential readers of the theory find it useful (Weick, 1995).

2. Resulting theory lacks validity. As a source of social science theory, grounded theory deals with qualitative issues that cannot be held to strict quantitative definitions of correctness. Qualitative studies run the risk of being perceived as producing much softer results than quantitative studies. A quantitative version of this study – perhaps relying on formal surveys of a broad range of randomly selected organizations – would readily be perceived as more rigorous than this study as designed. However, such a study would fail to look at the range of rich and personal perspectives that was actually studied here. The triangulation of findings obtained through interviews, observations, and content analysis strengthened any conclusions that can be tied across different methods and instruments; making such findings more acceptable to those who might remain skeptical of any one qualitative method.

Parry (1998) argued that the validity of a social theory be defined in terms of the "best approximation" (p. 94) that the theory can make of a social situation or construct under discussion. The point at which a grounded study reaches theoretical saturation inevitably leaves details and additions beyond the theory's grasp. The use of multiple data collection and analysis techniques within this study, as well as the richness of detail

and context explored in the written study and supporting memos, helped assure that any weaknesses in approximation by this theory can be delineated as mistakes versus incompleteness; the former demonstrating incorrectness or lack of validity, and the latter identifying a limitation that points to further study. The detailed constructs in this study's theory should next be studied using some of the more quantitative methods described above in order to further clarify and validate these findings.

3. Inductive study lacks reliability. Qualitative studies generally, and grounded theory studies specifically, can be difficult to repeat. The reliability notion that a second reading of data could reproduce the same result and therefore demonstrate reliability is not useful in a situation where the data emerges from social interactions that cannot possibly be repeated or recreated. A second interview with an informant, even using the exact same instruments, cannot replicate the first interview precisely because it is the second interview; the social context and expectations of the informant and interviewer having been changed by the first interview and the passage of time.

Instead, Parry (1998) argued that reliability of grounded theory studies be associated with the ability to repeatedly apply the resulting theory to novel situations. In this sense, grounded theory establishes its own reliability through the grounding of the theory in the data. Where quantitative studies approach reliability in terms of being confirmed or denied, grounded theory studies cannot be denied; they can only be confirmed or extended. To ensure the possibility of such extension, this study provided context and supporting detail to allow differences in repeated readings to be generalized as extensions of original findings. Interpretive generalization requires a future reader of

this study to be able to merge a theory's broad general statements with the specifics of their application to result in an extended theory and be able to see contextual richness and to articulate the reasons and correlations. Looking at either the chemicals company or healthcare organization alone would have resulted in a different and narrower theory. The industrial setting placed much more emphasis on efficiency of operations and politics of the organization. These issues were almost absent in the healthcare setting, which emphasized a focus on safety and risk not evident in the chemicals company data. Subsequent interviews and observations eventually confirmed that all of these issues are relevant in each setting, but placing them in the theory with the emphasis of any one setting would have over-expanded and over-generalized the findings. Recognizing that this reliability weakness can be present at any point of theoretical saturation, this study approached any broad or sweeping findings or generalizations with skepticism and caution; working to provide the richness of detail needed by subsequent researchers to enable further extensions.

4. Theory lacks a degree of fit with literature. While a grounded theory, by definition and intent, fits the data from which it was developed, it would not necessarily fit with the literature of the supporting fields. Perry (1998) argued that the degree of fit between the literature and the grounded theory offers support for the theory, but that gaps and variations between the theory and literature do not necessarily invalidate the theory. He argued that the theory can be treated as valid, and the grounded study reliable, if the researcher can explain any substantive differences as gaps or differences in the research

situation itself. Such gaps become limitations that can be explored through further research.

5. *Disagreements about what constitutes the constructs being studied.* The researcher had extensive previous experience with the constructs being studied, and therefore could have biased their use within the study design. Therefore, the study literature review and content analysis was used to define detailed operational definitions of each of the constructs based on composite definitions and discussions available among experts in the literature. The addition of key informants to the study as peer reviewers also helped mitigate this risk. This reduced the impact of any argument that my focus was biased by experience and thus broadening the acceptability of the grounded theory.

6. Unable to generalize beyond IT cases. The population from which cases will be drawn in this study was the information technology industry. In this respect, the grounded theory coming out of this study was for this single information technology industry case, and might not be able to be generalized to any other industry or sector. Indeed, the role of grounded theory is to establish grounding in the cases actually studied. Even generalization across the IT industry beyond the cases selected is not assured; only that the theory developed is grounded in the cases actually studied.

Kennedy (1979) has addressed the issue of generalizing from single-case studies, describing aspects of generalizing from disaggregated multi-case studies, particularly when the data collected was qualitative or descriptive. In such situations, specific treatments can be very difficult to define or isolate, and confounding influences and circumstances can make drawing conclusions from case data problematic. “What seems

to be needed before single-case studies will be widely accepted is a set of rules for drawing inferences about the generality of findings for a case study" (p. 663).

When looking at generalizing from single-case studies that have been replicated, Kennedy proposed four criteria for sample attributes that increase the reasonableness of generalizing assertions (a) that there would be a wide range of attributes across the sample cases, (b) that there be many common attributes across the sample cases, (c) that there be few unique attributes in the sample cases, and (d) that the attributes uncovered would be highly relevant to the issues being generalized.

In moving from the replicated single-case study to the non-replicated case study such as this grounded theory, Kennedy acknowledged the limitations to generalization based on the above rules. These limitations do not preclude the analysis necessary to generalize results. The relevant common and unique aspects of each case can be captured. In this current study, I simply was not in a position to generalize because the extent to which each attribute is common or unique cannot be known until this case is juxtaposed against another case by some future reader. The generalizing of this study's grounded theory will be a judgment of the receivers of this information and their determination of the extent to which it applies to their own situation. I can only produce and show information from each case with an eye toward the rules by which that future recipient will evaluate these findings.

Toward that end, Kennedy's four criteria for selecting cases were given weight when choosing from among alternatives during theoretical sampling. However, the desire to promote future generalization could not be allowed to inhibit proper theoretical

sampling, and the commitment in this study was simply to assure that the developed theory was properly grounded in the data and cases studied.

Summary

The initial research questions defined for this study were ripe for being addressed during this project's timeframe. The entire information technology industry was struggling during the two years of this study with the issue of transitioning from the retiring CMM model to the newer CMMI model (see Appendix A). With the newer integrated model representing an increased complexity and demand for effort on the part of information technology organizations, questions were being raised about the efficacy of the historical methods for implementing the SW-CMM. The absence of a validated theory to help explain past failures caused organizations to lack confidence in their ability to commit to, and implement, the newer CMMI. The grounded theory produced by this study can help close that void.

CHAPTER 4:

RESULTS

Introduction

This chapter describes the outcomes achieved as a result of executing the methodology described in chapter 3. Data collection began during the spring of 2005 and concluded in the summer of 2007. The constructs and model described below had largely solidified by late 2006, and the emphasis of activity shifted toward increased analysis and synthesis, and sharing early findings with key informants for validation and critique.

Participating Organizations

Two large organizations were included as primary and secondary cohort sites in this study, each with different histories, styles, issues, and programs. Interview respondents were drawn from these two sites, and site visits were scheduled and conducted throughout the study for data collection and observation.

The primary organization from which the majority of respondents were drawn is a chemicals manufacturing company with global operations and sales, with headquarters in the northeastern United States. The organization has approximately $4 billion in annual sales, and the information technology function within the company includes a staff of just over 100, and multiple outsource-partner relationships that extend its global reach. The company is often cited in the trade press and academic literature for both its quality management program using Six Sigma, and its information technology maturity program using the SEI CMM. The name of the CMM program coordinator within this company has appeared frequently in journal articles and conference proceedings related to the

CMM, including publications and briefings of the Software Engineering Institute (SEI). Likewise, the company's Six Sigma quality program has been often written up in the trade and academic literature. The company appeared to be an emblematic success story for the deployment of both models, and would serve as a rich resource for data collection and analysis.

The secondary organization from which respondents were drawn is an academic medical center in the United States with annual revenues approaching $1 billion. The centralized information technology function within this healthcare setting includes just over 100 people, along with decentralized healthcare systems and informatics staff of another 120 people scattered across the medical center. The head of the quality function within the medical center appears frequently in the healthcare quality management literature, espousing the potential of Six Sigma to improve healthcare outcomes and safety. The medical center was approximately one year into its fledgling Six Sigma program, piloting and running improvement projects that typically included heavy information technology components at the time this study commenced.

The information technology function was not using the SEI CMM model, instead choosing to focus on other basic process improvement opportunities related to project management and contractor management. This program represented the substantive portion of the CMM practice areas at the Level 2 plateau of improvement, and could have been referred to as a CMM Level 2 initiative; but the CIO did not want to associate his activities with the CMM. Instead, he desired to roll-out a simple project management program focused on organizational improvements in key project areas. The organization

appeared to offer a good opportunity to watch Six Sigma unfold in a non-manufacturing environment, allowing the study to explore whether anecdotal reports of Six Sigma applying best in the manufacturing world were accurate (Yilmaz & Chatterjee, 2000). It also offered an opportunity to contrast an information technology organization that had not chosen to pursue a formal CMM program at the same time as it pursued Six Sigma.

Both of the CIOs in the primary chemical company and secondary healthcare institution participated in active and engaged discussions during this study. The chemicals CIO devoted over 100 hours over the 2-year period, and the healthcare CIO devoted approximately 40 hours to the study. The richly-detailed interviews, direct observations, personal discussions, and collection of related project materials for content analysis proved a deep and rich dataset for analysis in this study.

As it turned out, neither the chemicals company nor the healthcare setting played the originally-anticipated roles in this study. The chemicals company that had appeared from the outside to be relatively mature in both its Six Sigma and CMM programs turned out to be internally struggling and faltering with both programs, and the healthcare organization that appeared from the outside to be fledgling in its Six Sigma program, and not yet up-to-date with its CMM-related processes, turned out to be very successful in both endeavors and not to have the internal turmoil expected in a less mature organization. The need to explore and explain these differences set the stage for this study.

Interview Respondents

The study included numerous personal interviews with respondents from the various organizational settings identified for the study. In the case of the concentrated set of respondents in the chemicals company and healthcare institutions, direct observation of work practices and project activities allowed statements made in interviews to actually be confirmed in observed practice. Through such on-site observation, it was possible to verify assertions made by interview respondents, and when verification was difficult, it enabled follow-on interviews to clarify comments that might have been misinterpreted. The level of direct observation was proportional to the penetration of interviews conducted in each organization, resulting in approximately 400 hours of observation in the chemicals company, and approximately 200 hours of observation in the healthcare institution.

A total of 57 information technology professionals participated as interview respondents in this study over the 2-year period of data collection. Of these, 45 continued to participate in on-the-job discussions and observation after their initial formal interviews. Two respondents left their jobs during the period of the study and became unavailable for further follow-up discussions.

Respondents represented a range of experience levels in their specific organizations (mean=8.2 years, median=5 years), and in the information technology industry overall (mean=16 years, median=16 years). Many had differing views from their organizational peers regarding the relative size of their own information technology organization. This illustrated the subjective and interactivist nature of interview

respondent statements: If a relatively objective fact like the size of the organization in which they worked could be interpreted and described so differently, such variation should be expected among all of the interview responses.

Primary Respondents: Chemicals Company

Thirty-two respondents from the primary chemicals company participated in the study, representing 56% of all interview respondents. These respondents had a mean tenure with the company of 10.2 years, and a mean tenure in the information technology industry of 14.6 years. Table 4 provides detailed tenure data for these respondents, as well as how they responded when asked to describe the size of their organization.

Table 4

Primary Organization Respondents (Chemicals Company)

ID	Years in IT	Years in Org.	Org. Size
C01	19	3	Medium-sized
C02	3	8	Small, very lean
C03	21	5	Small
C04	24	15	Adequate
C05	3	3	100-150 people
C06	15	3	Medium
C07	20	6	Dwindling, 4 out of 10
C08	20	3	Large
C09	6	4	Big, diverse
C10	4	4	Confusing, changing
C11	6	6	Medium, extended network
C12	18	29	Small
C13	10	10	Lean
C14	20	18	Large
C15	20	4	Medium to large
C16	17	5	Small
C17	27	24	Large, boundaryless
C18	22	13	Not very big, fairly lean
C19	4.5	4.5	A lot of staff
C20	8	27	Medium
C21	29	8	Large, small locally
C22	30	20	Large, but very different
C23	8	36	Not particularly large
C24	6	1.5	Medium, not like Air Force
C25	5	6	2% of revenue, not too small
C26	8	4	Big
C27	5	5	Certainly not small
C28	21	4	Medium-sized
C29	22	1.5	Medium
C30	16	6.5	Large
C31	13	1	Large
C32	20	10	Large

Secondary Respondents: Healthcare Organization

Fifteen respondents from the secondary healthcare organization participated in the study, representing 26% of all interview respondents. These respondents had a mean tenure with the organization of 6 years, and a mean tenure in the information technology industry of 13.7 years. Table 5 provides detailed tenure data for these respondents, as well as how they responded when asked to describe the size of their organization.

Table 5

Secondary Organization Respondents (Healthcare Institution)

ID	Years in IT	Years in Org.	Org. Size
H01	23	1	Medium
H02	8	8	Large
H03	36	7	Large
H04	4	2	Large
H05	17	1	Large in size, not process
H06	16	1	Smaller than they think
H07	4	0.5	Medium to large
H08	16	12	Pretty big for healthcare
H09	15	0.5	Medium
H10	0.5	2	Smaller than I expected
H11	25	18	Medium-large
H12	16	10	Large
H13	8	12	Larger than it used to be
H14	5	14	Pretty big
H15	12	0.5	Medium

Tertiary Respondents: Assorted Organizations

Ten respondents participated in the study from the tertiary group of assorted organizations, representing 17.5% of all interview respondents. These respondents had a mean tenure in the information technology industry of 23.7 years. Table 6 provides detailed tenure data for these respondents and lists the industries from which they were drawn.

Table 6

Tertiary Organizations Respondents

ID	Years in IT	Industry
G01	14	Chemicals
G02	22	Consulting
G03	26	Academia
G04	21	Scientific Software
G05	25	Telecommunications
G06	18	Aerospace
G07	32	Academia
G08	35	Aerospace
G09	14	Marketing
G10	30	Travel Services

In general, this tertiary group had more experience in information technology than either the chemicals company or healthcare organization participants owing to the selection bias resulting from opportunistically inviting participants into this group who were known to have expertise and that would provide both constructs support as well as a critique of the emerging model.

Interview & Observation Results

As described in the methodology chapter above, the questions included in each respondent interview varied slightly as circumstances and responses warranted. Most variations were subtle, largely driven by my familiarity with either the respondent personally or the respondent's organization. Personal familiarity increased throughout the study as on-going observations within each organization continued in parallel with the continuing interview rounds. The results described below have been organized in line with the basic flow of questions that evolved as the study progressed. Individual respondents might have addressed questions with different wordings, or in different orders, than reported here.

After each interview, I recorded my initial reactions to the discussion in an Interview Log (see Appendix B.1) in order to capture the tone of each interview while still fresh. Audio tapes, when used, were transcribed within a week of each interview (see Appendix B.2), and copies were furnished to respondents for comment or revision. Using transcripts and written notes, I then created a Concept Map (see Appendix B.3) of phrases used and ideas expressed by each respondent; typically within a month of each interview. Through continuous review of these materials, and incorporation of additional notes I gathered during site visits in which I continued discussions with respondents, I developed a Keyword Map (see Appendix B.4) for each respondent in which I began focusing on key words and phrases used by each respondent that were beginning to coalesce as constructs shared across multiple respondents. I used more detailed Response Tracking Matrices (see Appendix B.5) to keep track of which respondents had

contributed to each emerging concept. After many iterations of review and revision, as well as on-going site visits to talk to respondents and observe their work, the mappings became the foundation for the constructs emerging into the model described below (see Appendix B.6). The final outline for this chapter was built from a cross-section of those diagrams and analysis of my observation notebooks (see Appendix B.7).

The following sections provide a description of what respondents said, what I observed, and the constructs in which they formed conceptual groups. I begin with the direct findings of my interviews, and then continue with the emerging model that resulted. The structure of what immediately follows is taken from questions 4 through 20 in Table 3.

4. What improvement model does your IT organization use to improve processes?

Thirty-one of the 32 chemicals company respondents described Six Sigma as their organization's model for improving, and 26 described that model as focusing on process improvement. Only 23 of the chemicals company respondents also noted the CMM as part of their organization's improvement strategy. In fact, one of the respondents expressed no familiarity with the CMM in spite of the fact his organization was over eight years into a CMM rollout.

Respondents from the healthcare institution were less uniform in their responses, but 15 respondents generally cited project management capabilities as their organization's improvement model. One healthcare respondent noted an increasing emphasis on "more project management to get projects across the finish line" (Respondent C30, Line 16) in recent years. Twelve of the healthcare respondents had

recently attended project management training in their organization, and described numerous process and performance impacts and improvements that were being achieved as a result of that training. Seven of the healthcare respondents cited Six Sigma as an emerging improvement program within their organization that was beginning to have an effect on processes, although it had not yet been rolled out to the information technology organization. Among tertiary respondents, a variety of improvement models or standards were mentioned, including ISO 9000, the IT Infrastructure Library (ITIL), Control Objectives for Information and related Technology (COBIT), Sarbanes-Oxley, and Baldrige, along with less frequent mentions of Six Sigma and the CMM.

5. What improvement model does your company use overall?

Most respondents were able to describe their organization's overall approach to improving quality or processes, with 31 of the chemicals company respondents noting Six Sigma, 24 of them noting the CMM, and seven of the healthcare organization respondents noting Project Management. Those who cited Six Sigma as an improvement model within their own information technology organizations also described Six Sigma as the improvement model for their overall company. Twenty-seven of the chemicals company respondents described the overall company Six Sigma program as more mature or more deeply penetrated than the more localized information technology program. Of the seven healthcare organization respondents who noted Six Sigma as an improvement model in their organization, five reported that the overall Six Sigma program across the entire organization was more mature than the component program within their information technology organization. None of the respondents described their Six Sigma

programs in IT as being more mature than the broader Six Sigma program across their entire organization.

In on-site meetings that I attended in the chemicals company, I often observed confusion among participants when issues being discussed involved the domain overlap between Six Sigma and the CMM. Among the study respondents from that organization, 31 had identified Six Sigma as their organization's improvement model. Of the 24 who had identified the CMM as their organization's improvement model, only one did not also identify Six Sigma as their organization's improvement model. Twenty-three of the respondents had identified both Six Sigma and the CMM as their organization improvement model. In meetings that required making project choices that were consistent with only one of these models, I observed team members struggling to clarify which aspects of which model should carry precedence in decision-making.

I did not observe such struggling in the healthcare organization. Project discussions involving change in that setting clearly fell into Six Sigma or project management categories, and the project management perspective was dominant. No information technology project that I observed ever shifted its primary improvement focus from project management to Six Sigma. Discussing the difficulty of getting an IT project selected for inclusion in the Six Sigma program, one respondent commented that his organization didn't have "a way of getting something prioritized into the Six Sigma world" (Healthcare respondent 01, transcript line 69 – H01.69). I observed that when managers discussed identifying Six Sigma project opportunities, those opportunities were often expected to involve an information technology components, but the focus of the

identified projects was never the direct improvement of some information technology organizational capability.

6. How are you impacted by the roll-out or activity of these improvement programs?

Respondents from the chemicals company described two primary impacts, each of which involved different aspects of their information technology process improvement programs. Of the 31 respondents describing Six Sigma process improvement initiatives, 28 of them described a level of anxiety associated with trying to use standardized Six Sigma tools for which they didn't feel adequately trained, and 26 described working on projects for which they didn't see Six Sigma tools being well suited. Regarding CMM-based improvement, 24 respondents described the initiatives as adding to their workload, while adding little value in terms of productivity improvements (22 respondents) or actual quality improvements (16 respondents). Only one respondent specifically commented on quality improvements driven by the CMM program, and she had not identified the CMM as adding to her workload. Among respondents reporting a CMM-driven increase in workload, five reported that their productivity had also improved because of the program.

Of the 15 respondents in the healthcare organization that described improving project management skills and practices as their organization's improvement strategy, 14 described the impact as helpful, although ten expressed reservations with respect to having an adequate level of training, with 5 of these respondents expressing a lack of confidence in applying these new skills. Fourteen of the 15 healthcare respondents looked favorably upon the impact of such improvement initiatives. One manager in the

healthcare organization warned “there’s not adequate attention paid to process change and in many cases it’s not a sustained effort” (H03.27). I observed multiple projects that struggled with early project management learning, particularly in areas that involved coordinating with other departments that were not participating in the project management improvement initiative. During the year that I visited this organization, I observed project management training being rolled out to broader segments of professionals beyond information technology. I observed projects late in this study that were no longer struggling with this issue.

7. How effective are these models in actually improving your organization’s effectiveness?

Twenty-five of the 32 respondents in the chemicals company reported that they did not feel that the overall effectiveness of their organization was being improved by their organizational improvement programs, although 24 respondents were able to describe situations in which the programs had helped. In the healthcare organization, in contrast, none of the 15 respondents described their organization’s program as ineffective, and eleven could describe specific areas of improvement as a result of the program – the use of project chartering folders mentioned by all eleven. One healthcare respondent described the difficulty of formally improving certain IT processes when his customer was not looking to participate in many of the desired changes. The old process rarely required customers to approve documents or specifications, and yet many recent process changes called for such approvals to be in place as part of new process checkpoints. He noted that “when you have an approved version of the document then

you can work with the checkpoint" (H02.39), otherwise work was slowed by disagreements over document content and meaning. Not all customers of IT projects are looking to participate in more robust or formalized IT processes. When they are, "there is a direct correlation between both the project management process and on-time delivery" (H03.86). On-going process change involves contributions and participation from both customers and suppliers in order to be successful.

Of the 31 chemicals company respondents who described Six Sigma as the basis for their overall organization's improvement initiatives, 16 described improved outcomes over time. Fifteen described the particular benefit of vocabulary and technique alignment between staff in the information technology organization and the broader overall company. The shared methods seemed to improve effectiveness directly because of the ability of team members—both information technology staff and business staff—to work using common tools available across all disciplines. Twenty-four of the respondents described the Six Sigma tools as effective as well, with 23 clarifying that some tools were much more effective than others.

Of the 24 respondents involved in CMM-based initiatives, 23 were unable to describe how or where their organizations had been made more effective by the rollout of the CMM. Nineteen respondents described the impact as negative, with 20 reporting increases in workload, 25 describing increased resource demands, and 21 describing the new or changed processes as being both documentation and labor intensive. Thirteen of the respondents described their efforts to avoid having the CMM-based processes applied to their projects, ten reporting that they did so by trying to describe their projects as too

small for the new processes to be applicable. One management respondent described her CMM initiative in negative credentialism terms: “It is a directive from on-high, a certification to be gotten, and then when [assessors] leave the process is not continued” (C30.26].

8. What does your organization do to measure its processes and quality levels?

Only five of the chemicals company respondents described their organization as measuring processes, and four described it as measuring quality. Twenty-five of the chemicals company respondents stated specifically that their organization did *not* measure quality, and 23 stated that their organization did not measure processes. Two of the healthcare organization respondents described their organization as measuring processes at the project level, while nine of them stated that their organization did not measure processes. Eleven stated that there were no quality measurements in place in their organization, but all noted that quality measurement is commonly discussed and practiced in healthcare. They contrasted the absence of quality measurements in their healthcare IT organization with the presence and growth of quality measurements generally in healthcare.

Twelve of the chemicals company respondents mentioned their CMM programs during the discussion of this question, but few could articulate whether or how their management saw their CMM level as a measure of their own processes. When I asked if the CMM maturity level set by management as a goal for the organization should be interpreted as a process measure, 20 respondents suggested that management might consider it so, but that they would not. One respondent commented on the way she had

never seen any quantitative measurement of quality through the Six Sigma program, instead always seeing Six Sigma projects identified and triggered anecdotally: “It’s always been in a reactive-type mode” (C30.49). The only measurement-based controls cited by respondents were project-level controls such as budget or schedule overruns mentioned by twenty-seven of the chemical company respondents, and twenty-two described these controls as ineffective. Only four healthcare respondents specifically cited project-level measurements, although I observed project-level reviews of budget, plans, and schedules for many projects during my on-site visits.

9. How might your organization improve the way it rolls out process improvement changes?

All 57 respondents desired improvements in the way their organizations rolled-out process changes. Twenty-five of the respondents from the chemicals company could not specifically describe the improvements they would like to see, while only four of the healthcare organization respondents could not. One respondent stated, “I’m not sure how I would have done it differently” (C05.65). All ten of the respondents in the tertiary cohort could describe specific ways that they would improve their organizations’ roll-out strategies, and those descriptions covered a wide variety of dimensions. The eleven healthcare respondents who had desired improvements in mind described changes that were specific to their current project management initiative or project management generally. The seven chemicals company respondent able to describe their desired changes focused on ways to improve the training offered in both their Six Sigma and CMM programs.

Twenty-five chemicals company respondents cited a lack of complete and visible management commitment to changes as an inhibitor to improvement, with twelve saying that commitment appeared weakest among middle managers in the organization. Four respondents commented that these middle managers had the ultimate control over whether desired changes were put into practice. While twenty-six respondents stated that overt commitment from the top was not questioned, twenty-two questioned whether the commitment to implement change was serious enough given other resource and demand problems. Respondents who were middle managers and supervisors in the organization all questioned the levels of CIO commitment relative to the level of resources being made available. Respondents among the technical staff questioned the commitment their middle managers, while middle managers questioned the commitment of senior management – specifically in terms of resources.

Among healthcare organization respondents, none questioned the commitment to change of the CIO, although six questioned whether the seriousness of that commitment was sufficient to assure success. Four respondents questioned whether enough resources were being made to the effort, and whether that lack of resources put the CIOs commitment into doubt. None of the healthcare organization respondents expressed concerns about middle-management commitment, compared to the chemicals company respondents. I observed that there were very few organizational levels in the healthcare IT setting, and several layers of management in the chemicals company IT organization.

When specific concerns were expressed, organizational learning was a frequently mention; by 15 chemicals respondents, and nine healthcare respondents. Describing an

inability to absorb all of the information required to master Six Sigma tools and techniques, one respondent suggested that “feeding information to folks in smaller portions and allowing them to be able to grasp onto that and be able to use that to become effective with one piece instead of trying to become effective with the overall whole method” (C03.62).

Another concern expressed by sixteen respondents in the chemicals company IT organization was the idea that the individuals and work-groups who were identifying and driving much of the change within the organization often weren’t part of the groups most impacted by the change. “You don’t see them doing any projects” (C02.59) was a common feeling expressed. These groups were “not affected by what they were coming up with” (C02.60). Three respondents in the chemicals cohort worked in the group being described by these respondents.

10. How do you regard the expectations of what you can deliver in your organization?

Responses to this question varied according to the type of organization in which respondents worked. All thirty-two respondents in the chemicals company felt that the expectations placed on them in the past were reasonable, and twenty-five of those respondents described themselves as overloaded with work. Eight described themselves as struggling to keep up. Twenty-four of the chemicals company respondents who felt overworked declined to describe such overload as an excessive expectation on the part of their organization. Twenty-four respondents reported they felt they should be able to do more than they were doing at the time. Feelings shifted late in the study among the nineteen chemicals company respondents who had been exposed to some form of

downsizing in their organization. In those cases, fifteen reported that the increased productivity expectations resulting from having fewer peers doing similar jobs was changing expectations from their organizational leadership; but only six of these respondents described such changed expectations as unreasonable.

In the healthcare organization, six respondents described leadership expectations as being reasonable. Eleven respondents reported being overloaded with work, with two respondents describing struggling to keep up with that load. Four respondents said that the overload of work did not represent excessive expectations on management's part. Of the 10 respondents that reported a work overload, and 4 more who described the workload as being impossible to achieve, 12 respondents describe management's actual expectations as more being more reasonable, with 5 respondents differentiating management's higher nominal expectations from their lower personally expressed expectations. Thirteen of the healthcare respondents described the organizational culture as adapting to allow actual productivity to be less than demanded by the apparent workload. Two respondents identified this cultural adaptation as an inhibitor to change and improvement. The healthcare CIO described this cultural perception as the biggest impediment to his actually improving organizational productivity and performance.

11. How successful are your projects from the perspective of your sponsors and customers?

Fifty-six respondents (the exception being a healthcare respondent) described their customers as satisfied with the outcomes achieved by their project work, although 51 cited schedule delays as a common problem with customer satisfaction. One

respondent downplayed such schedule delays by pointing out that “they can do a better job today because of the things we’re doing” (C04.196). A respondent who leads a project management group offered a less optimistic assessment, saying “across the board I don’t think we have successful project delivery” (C30.60] while another explained that project staffing usually drives success because it is “an individual or group of individuals that believe in a particular way to deliver a project” (C30.54]. Project success becomes attributable to individual skills rather than to process compliance as indicated in the CMM.

Eighteen respondents from the chemicals company described situations in which they were able to manipulate their processes in order to lower expectations for project outcomes, allowing customers to appear more satisfied against the revised expectations. I observed such manipulation of requirements and project plans in meetings with multiple project teams. The focus of these discussions was usually on finding a way to complete at least some of the project work on-time, and not on overt deception of project customers; but the effect was to redefine project success in terms much more favorable to the project team. Eight respondents acknowledged that customers would typically be much less satisfied if satisfaction had to be measured against original expectations.

12. Do your customers see the value of your organization’s efforts to improve your processes?

Every respondent from both the chemicals and healthcare organizations thought their customers could see value to their process changes, but for different reasons. In the chemicals company, 28 respondents described their customers as seeing value in their Six

Sigma process improvement areas because the customers themselves were involved in Six Sigma changes, with 23 respondents noting a shared perspective and vocabulary that was seen as valuable to the customers. Twenty-five respondents described their customers as recognizing the alignment between their own goals and those of the IT organization. One respondent described a customer's perception of value in terms of improvement efforts being driven "in support of what they're trying to do" (C04.168).

In the healthcare setting, there was no shared improvement initiative; but twelve respondents described their customers as seeing valuing in the actual performance improvements that were being achieved through the IT project management initiative. I observed the new project management procedures as leading to tangible deliverables in project settings that project customers told me had been evident in the past. Even for projects that didn't achieve final improved outcomes, five respondents noted that customers still saw the new project management deliverables as adding value because the they now had visibility into the scale and complexity of projects, thus adjusting their expectations. Eight respondents noted that such controls were not evident in the past.

13. Are the systems and solutions you provide to your customers today better than in the past?

This question was not a differentiator in this study. All 57 respondents described the systems and solutions being created by their information technology organizations as improving relative to comparable past efforts, and all 57 cited ongoing changes to the range of information technologies in use today as contributing to such improvements.

14. Do you attribute some of the improvements to the process improvement initiatives in your organization?

Twelve chemicals company respondents, and five healthcare respondents, declined to directly attribute known improvements to their organizations' improvement initiatives. However, 27 respondents who cited Six Sigma as their improvement approach were able to indirectly describe examples where the use of quality tools had increased effectiveness and improved systems outcomes. Twenty-six of the chemicals company respondents, and twelve of the healthcare respondents, described a general trend toward better and more-sophisticated software systems across the industry as driving most of the system-level improvements over the past decade or more. Interestingly, the CIOs of both the chemicals company and healthcare organization described their internal improvement programs—Six Sigma and project management respectively—as largely enabling their organizations to take advantage of the improvements being seen across the industry. Twelve of the healthcare respondents attributed the improvements more directly to the CIO's general efforts than to the project management initiative specifically. Three of the chemicals company respondents attributed the improvements to the personal initiative of the CIO rather than to the Six Sigma and CMM programs he sponsored.

15. Does your organizational culture support the changes driven by your process improvement programs?

Fifty-six respondents (the exception being in the chemicals company cohort) described culture as having an impact on the efficacy of their organizations' improvement initiatives. The culture in the chemicals company was described by 24

respondents as running contrary to the concepts and techniques of their improvement programs, with 17 respondents seeing a conflict between the cultural requirements of the Six Sigma and CMM initiatives. Describing their organizational culture as based on fire-fighting and individual heroics (15 respondents), coupled with a prevalence of overwork (6 respondents), aggressive schedules (14 respondents), and limited resources (29 respondents), 21 of the chemicals company respondents asserted that the changes proscribed by their formal improvement initiatives stood little chance of actually being carried out, with nine respondents saying that the level of target improvements that were being discussed by management would never be achieved. One respondent commented that in spite of all of the public organizational rhetoric surrounding each process improvement initiative, the culture was ultimately anchored in the "belief that brute-force can still get the job done in a pinch" (C01.201). Only six respondents asserted that their organizational culture was supportive of the desired changes.

Among respondents in the healthcare organization, eleven respondents explicitly described culture as supportive, although several of the problems described above were applicable as well; with seven respondents noting aggressive schedules, and six respondents noting limited resources. Seven healthcare respondents described an alignment between the patient-focused safety culture of the hospital and the improvement goals being discussed in their Six Sigma program, although six respondents acknowledged that the limited penetration of the Six Sigma program had limited their ability to see such alignment in practice. Thirteen respondents described their culture as supportive of the project management tools they were being encouraged to learn and

adapt, with 14 respondents describing the personal involvement of the organization's CIO in initiating and carrying out that particular initiative.

Respondents in both settings, 22 chemicals company respondents, and 10 healthcare respondents, described the culture of their organizations as determining the context in which they would apply the various tools and techniques learned through their improvement initiatives. Twenty-seven respondents stated that their culture was actually detrimental to change adoption, with 25 respondents in the chemicals company, and only two in the healthcare organization, saying that success would have to come in spite of the culture, not supported by it.

16. How would you compare your organization's improvement efforts to other organizations in which you've worked?

Three of the respondents, all from the healthcare organization, were new enough to their careers that they had no experience working in any organization other than the one in which they were currently working. Six respondents had not worked for any other organizations, and so couldn't form an opinion. One chemicals company respondent had been with his current organizations long enough that the issue of process or quality improvement had not been part of the workplace landscape when he had been in a previous organizations. This left 37 respondents who had been with another organization recently enough to form a comparative opinion for this question. Thirty-six of these respondents described the improvement programs in their current organizations as significantly more comprehensive than what they had experienced in their previous

organizations. One healthcare respondent described a more mature and involved quality program at a previous organization.

Twenty-five of the chemicals company respondents described a prolonged history of improvement initiatives in their organization, including previous organizational exposure to quality and process improvement that had been based on basic quality control and TQM approaches, predating their Six Sigma movement. Twenty-three respondents had been exposed to a CMM-based initiative prior to the one currently ongoing in their IT organization, and ten of these respondents reported that their exposure in the current program was more complete and thorough.

Five of the healthcare respondents had previous non-IT experience within the same organization, and commented on changes they observed in the style of improvement programs when they moved into information technology, with improvement more focused in the IT organization than in their previous positions. One observed that “IT is probably ahead of the rest of the organization in terms of institutionalizing this type of rigor” (C05.74).

17. Are your projects more successful when they directly apply your process improvement techniques?

Thirty-one of the chemicals company respondents, and eleven of the healthcare organization respondents, reported that their projects were more successful when they actually applied the techniques from their improvement programs. Twenty-six respondents from the chemicals company emphasized improvements around the shared vocabularies, techniques, and expectations created by their shared Six Sigma perspective.

However, only 17 of these respondents could name an actual improvement outcome that could be tied to one or more of the Six Sigma techniques being used.

Thirteen of the healthcare respondents were able to name specific examples of outcome improvements brought about through the use of the project management disciplines that were being rolled out in their organization, and nine of them expressed confidence that their customers would concur with those examples. One of the healthcare respondents, who was a member of the development team in India, stated that he thought that the project management techniques recently introduced into the organization were helping, but that *inconsistencies* in their use limited the scale of improvement seen.

18. Do your organizational processes hold the organization back from achieving the most that it could achieve?

Answers to this question varied between respondents from the chemicals company and the healthcare setting. Twenty-five of the chemicals company respondents felt that their organizational processes were inhibitors to success, with thirty respondents saying that they would be able to achieve much more if freed from process constraints. Nineteen respondents described themselves as succeeding *in spite of* their organizational processes. In spite of this apparent negativity, nineteen respondents said that they thought their improvement programs could eventually lead to greater efficiencies.

Conversely, 9 respondents in the healthcare setting described their ability to achieve greater outcomes through the direct use of their improved techniques, and 11 respondents described themselves as succeeding because of their organizational processes. Only three respondents described process as an inhibitor in the organization.

Eight chemicals company respondents, and four healthcare respondents, described their change initiatives as being driven by financial factors more than quality factors, and felt more would be achieved around a drive toward quality goals.

19. Has your organization's improved process effectiveness reduced your personal workload?

Thirty of the chemicals company respondents responded that their organization's improvement initiatives had not reduced their personal workloads. Ten of the healthcare respondents reported the same. In the chemicals company, 15 respondents described their workload improving over time, and eleven attributed that improvement to the organization's improvement initiatives. In the healthcare organization, 13 respondents reported their workloads improving (although not reducing), with 10 attributing that improvement to the project management program. Nineteen chemicals company respondents, and twelve healthcare respondents, described productivity improvements even while their workloads remained heavy. While productivity was described as improving, the result was often the "replacing of any of that efficiency with added load" (C01.247).

20. Could your organization be just as successful without your process improvement programs?

Thirty-one of the chemicals company respondents, and all fifteen of the healthcare respondents, said that their organizations would not be as successful without their improvement programs. Sixteen of the chemicals company respondents

acknowledged that not all of the improvements could be attributed to their improvement programs, with one stating that "many changes would have happened anyway" (C03.139). Regardless of the extent to which respondents described problems and concerns related to their improvement programs during discussion of previous questions, every respondent felt that the rollout of such programs had contributed to his or her organization's successes, with 30 chemicals company respondents stating that those successes could not have been achieved without their process initiatives. "I have seen a lot of positive changes in my 15 years" (C04.53), commented one respondent, while another said that improvements "wouldn't have happened without these tools" (C04.160). Among healthcare respondents, 14 stated that the organization wouldn't be as successful as it is without the project management initiative, and the changes made as a result of that program.

Emergent Model

A theory that can begin to explain the divergence of viewpoints expressed about process improvement, information technology, and business process maturity must account for the divergence and complexity of the respondent interviews and field observations collected. In particular, such a theory must be able to explain, if not predict, the major differences that are seen between descriptions in the literature and the actual practices observed in the workplace.

The model that emerges from the data collected in this study supports the use of the three major constructs proposed in chapter 3 above: business process maturity, process improvement maturity, and information technology process maturity. These

constructs appear repeatedly in the data collected, and remain distinct as perspectives that can be discussed and analyzed separately for the organizations involved. The data also include extensive discussions of organizational culture intertwined, yet distinct, from the original three areas, enough so that the grounded theory proposed below would be unable to map observations into relationships among theory components without the inclusion of this fourth major construct. Additionally, social and economic factors play a significant role in carrying out the improvement activities described by this model, requiring the addition of this fifth construct.

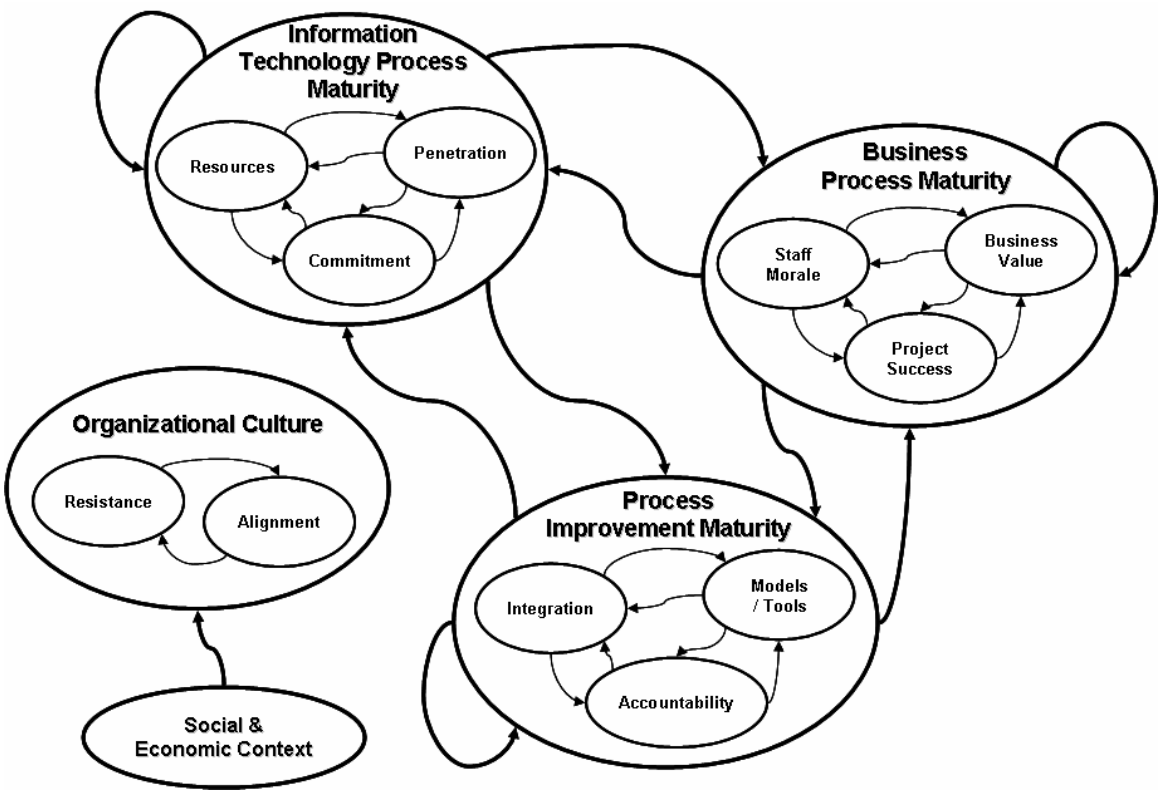

Figure 5. Emergent interactions model.

The full model that emerges from these points is illustrated in *Figure 5*. This model includes interactions among the five major constructs just described, as well as more specific constructs that emerge within each of these major constructs. The broader constructs of social and economic context along with organizational culture should be interpreted as surrounding, or encompassing, the more specific process maturity constructs. Details of each, along with their representative interactions are described in the sections that follow.

Business Process Maturity

Three general categories of improvement or maturity were typically discussed when individuals were asked about the impacts of information technology improvement programs on overall business outcomes: staff morale, project success, and business value. These three constructs form the basis for understanding how business process maturity is enhanced by improvements in information technology maturity and overall process improvement maturity.

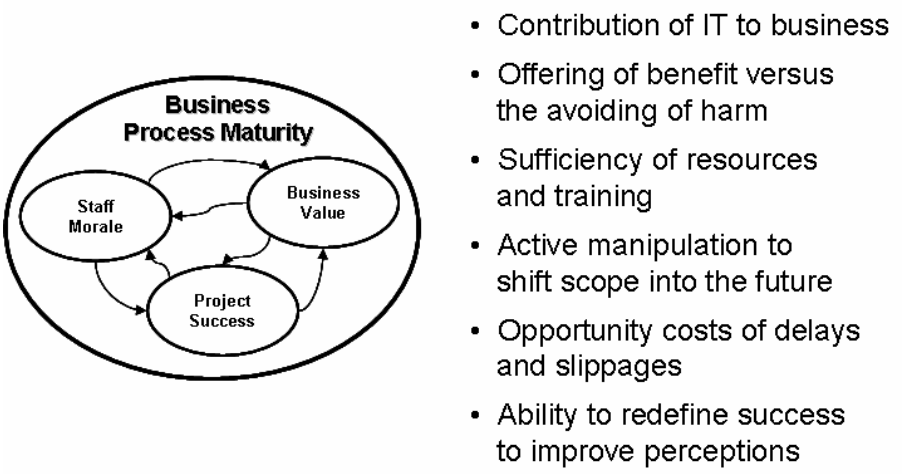

Figure 6. Business process maturity factors

Staff Morale

The staff morale construct includes the feelings and attitudes of individuals within and across the information technology organization, as well as the feelings and attitudes of their customers within their businesses beyond information technology. Staff morale is

typically impacted by efforts to deploy process improvement and maturity models across the organization. That impact is usually negative.

Negative impacts exhibited by respondents in this study ranged from mild antipathy to outright anger at management. These feelings came through in comments to the effect of not having sufficient resources to properly deploy these models, not having adequate training and support to practice the model, or a basic sense of futility at working hard to implement the models under circumstances where the deployments were not perceived as having a high likelihood of success. None of the respondents questioned the potential value of any of the models themselves, particularly the CMMI, among those organizations having exposure to that particular model.

Project Success

The project success construct includes the likelihood that a particular information technology project will be completed on time or budget, and the likelihood that such a project will deliver its targeted functionality and information capability as defined for its scope and consumption of resources. Respondents reported that when serious efforts were made to improve either general process improvement capability or information technology process improvement capability, or both, project success increased.

However, the most commonly mentioned factor for driving project success articulated by respondents was not in the area of helping projects to actually achieve their desired scope, schedule, and budget. Instead, respondents noted that a great deal of their effort as project managers and project team members goes into trying to redefine the definition of project success. In the organizations represented by the respondents in this

study, most projects were seen as highly successful; but this success was typically measured against the expectations for the project roughly at the end of the project. When asked about project outcomes compared to the original expectations of these projects, reports of project success were weakened or reversed. These projects were unsuccessful when measured by their original charters.

Respondent comments indicate that initial perceptions of project success are typically a measure of whether a project provided any value to the business, as well as whether it resulted in harm. Projects that cause harm (e.g., result in regulatory penalties because of schedule delays) cannot be hidden, and it is difficult to see these projects as successful. But if no harm results, respondents were able to describe projects as successful even though they often failed to achieve defined project schedules and scope. While schedules exhibited variability, it was the scope of the project that provided the greatest leverage for managing expectations during a project. Completed projects often had far less scope than they had at the beginning, and often the difference in scope had been pushed into the future as the scope of a follow-on project. Scope was sacrificed to make up for schedule delays, partially explaining the lower variability in project schedule as a factor in assessing success.

The result of this active manipulation of expectations is that project success is subject to much variation as the scope and schedule are continually changed over the life of the project. Preventing harm to the business was the only apparent constraint placed on how much a project could manipulate itself to be able to claim success upon conclusion. One healthcare respondent offered an alternative viewpoint on project scoping and

success when he described “putting together project folders for a number of projects which have not been approved, and that’s not necessarily a failure” (H03.153). He described a project as successful if it didn’t even start wasting resources on the wrong initiatives. “Sometimes they’re not approved for good reasons” (H03.155).

Business Value

The business value construct includes the general perceptions that the results of information technology projects are making significant or notable contributions to the intended requirements areas of the business specifically, and to the goals and objectives of the organization generally. One respondent has “seen a lot of things where we’ve been able to help the business take advantage and do things with new technologies, new functions and features” (C03.144).

Respondents participating in this study unanimously described their projects specifically, and information technology generally, as providing business value to their individual sponsors and to the organization as a whole. That value was partially attributed to the continual and ongoing improvements and evolution to the technologies themselves as time passes, but more value was placed at the project level in the ways that those technologies were being implemented.

Unmeasured in respondent comments were the opportunity costs, in terms of lost business value, of delays and slippages associated with information technology projects. Because projects eventually delivered something from their original project scope, and some benefit was typically associated with what was implemented, positive business value was assured. The fact that the business value should have been larger owing to

reductions in scope during the project, and seen earlier owing to schedule delays in completing the project, remained unstated.

Information Technology Process Maturity

Three general categories of impact were typically discussed when individuals were asked about the impacts of information technology process maturity: resources, commitment, and penetration. These three constructs form the basis for understanding what happens within an information technology organization when such improvement activities are undertaken.

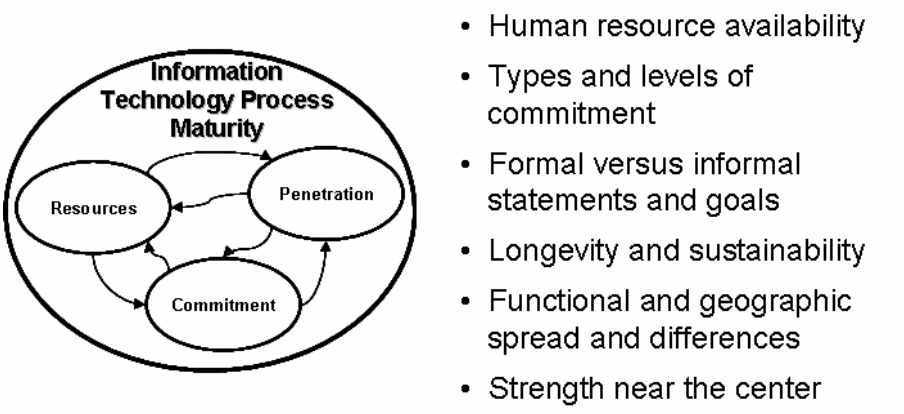

Figure 7. Information technology process maturity factors.

Resources

The resources construct includes all of the people, finances, processes, and technology needed to make change initiatives successful, but overwhelmingly represents human staff resources, whether measured in the availability of people to conduct required efforts, or as funding for the positions that would make those people available.

Resources within the information technology function or organization were the most frequently discussed topic throughout all of the interviews conducted in this study. Of paramount interest among respondents was a concern, usually expressed negatively, that organizations did not have the resources necessary to carry out their defined processes as expected, and that the carrying out of process improvement programs typically exacerbated such problems. At times, respondents expressed concerns about software or equipment resources to carry out their processes, but the overriding concern with the availability of human resources to carry the workload remained universally paramount.

Commitment

The commitment construct includes the demonstration of leadership's intent to charter and carry out desired changes. Such commitment can be formally embodied in budgets, policies, and organizational goals; or informally embodied in the statements and actions of leaders at various levels of the organization.

After resources, the commitment of management and staff to process improvement was discussed most often by respondents. Respondents described differing types and levels of management commitment as driving whether or not staff took such programs seriously, and whether such programs would remain in force long enough, and deeply enough to be effective. One respondent described the management team as "just going through the motions" (C01.218). The commitment of staff was also cited as impacting the efficacy of improvement activities. "People want to do some of these things" (C01.194), stated a respondent, but "they're getting forced to short-cut, and short-

cuts don't work" (C01.201). Another stated that "there are people that believe in the tools" (C02.49) but that "50% do it purely because it's required" (C02.50).

Commitment involves both consistency and communication according to one respondent. Management has to do "a real good job choosing a direction and sticking with it" (C14.33), as well as "making sure that the managers all the way down the levels know that it's a priority" (C14.34).

Penetration

The penetration construct includes the extent to which the entire organization is practicing, or attempting to practice, required changes. Penetration can involve organizational, functional, or geographic perspectives. A change can be said to be fully penetrated throughout an organization if all organizational units are participating across all functions and geographic locations.

Respondents cited varied levels and depths of penetration of process improvement activities into their organizations. None could describe their organizations' process improvement programs as penetrating into all areas of organizational activity, and none described his or her programs as global. Most cited process improvement programs that concentrated on their core activities and functional areas, and tended to describe them as strongest near the organizational center, with less penetration functionally further, or geographically farther, from that center.

The tie between penetration and outcome success was clear in respondents' minds. "The ones that are taking advantage of it" are "delivering better systems for more customers" (C01.212).

Process Improvement Maturity

Three general categories of impact were typically discussed when individuals were asked about the impacts of general process improvement maturity: integration, accountability, and models/tools. These three constructs form the basis for understanding what happens to process maturity within an information technology organization when such improvement activities are undertaken.

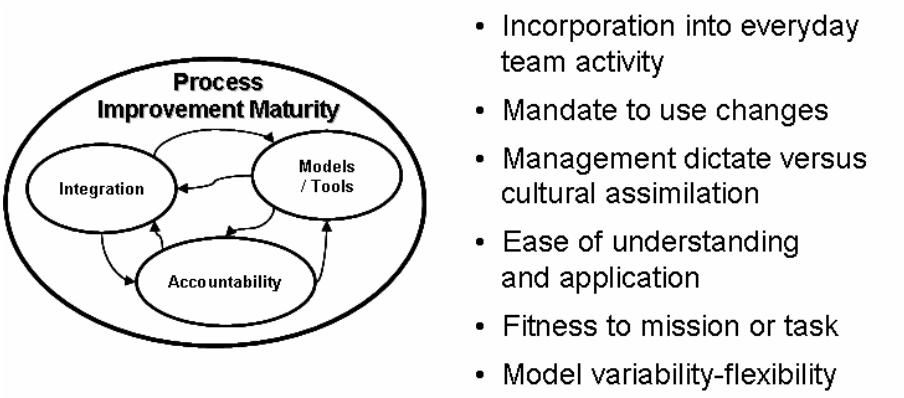

Figure 8. Process improvement maturity factors.

Integration

The integration construct includes the extent to which changes in the organization are made a real part of everyday organizational activity, or are simply made peripheral add-ons to existing organizational processes. To the extent that changes are highly integrated into organizational processes, they become harder and harder to see and measure distinctly over time; individuals participating in highly-integrated change are less likely to identify themselves as participating in change. I directly observed this in the chemicals company: Individuals who systematically practiced Six Sigma techniques on

the job were less likely as interview respondents to describe Six Sigma when asked about improvement initiatives. When asked about this, respondents simply described Six Sigma as “the way we do things around here” (C03.120). These same respondents described the CMM as a more imposing change initiative at the same time that my observation of their practices found CMM-compliance activities to be less natural or systematically practiced by individuals or work groups. Cheng (2007) reported that if quality programs were highly integrated into an organizational business strategy, it didn’t matter as much which quality model was being used because the quality activities became an integral part of the daily operations of the organizations he studied in Taiwan.

Accountability

The accountability construct includes the extent to which individuals and work groups are held accountable to use changed processes and techniques. Accountability can be achieved through formal management dictate and review, or through informal cultural change. If accountability for change is high, individuals throughout the organization will feel obligated to perform according to the changed process routines.

In the chemicals company, respondents described very low levels of accountability for actually practicing Six Sigma techniques, and even lower levels of accountability to practice CMM-based techniques. The slightest burden from the technique was a sufficient excuse to omit or reduce the use of the technique in practice. I observed project teams that avoided using Six Sigma tools in their meetings under circumstances where I knew the participants had been trained in the use of those tolls, and their use would have been highly appropriate to the situation at hand. When asked,

team members commented that they didn't want to start using the tools because they didn't want to commit to maintaining them once used.

Conversely, in the healthcare setting, accountability for using the newly-learned project management techniques was very high. The CIO personally held everyone accountable to actually use the techniques being taught, even if short-term productivity suffered as a result of the learning-curve associated with early post-training use.

Models / Tools

The models/tools construct includes the extent to which the models and tools designed as part of the change initiative are made an explicit part of routine organizational behaviors. Factors that seemed to influence respondents when discussing the possibilities for such inclusion were: the ease with which a technique could be learned and used, and the appropriateness of the model or tool to the mission or task of the user.

Certain Six Sigma tools tended to be more popular among respondents to the extent that they can fit routine activities that need to be done regularly. Tools such as Project Charters, Process Maps, and Failure Mode and Effects Analysis (FMEA) were described by respondents as naturally fitting with their environment, tasks, and work habits; and were much more regularly practiced. Other tools, such as Measurement Plans, Cause & Effect Trees, and Control Plans, were described as being used less because they didn't fit with work habits and routines. When asked, respondents did not see the connection between the lack of use of these tools and their general disappointment with Six Sigma. These latter tools are what epitomize Six Sigma's emphasis on measurement

and control, and differentiate it from previous models such as TQM. By only using tools that seemed to fit their expectations and routines, users were undercutting the Six Sigma program at its core.

Organizational Culture

Across the three core constructs of process improvement, information technology, and business process maturity, organizational culture represented a theme that surfaced throughout any discussion of process maturity and improvement. Judging from respondent answers in the interviews in this study, it is simply impossible to discuss process maturity from any of these perspectives without commenting on the cultural setting of the organization in which the discussion is taking place. “Culture plays a critical role” (C03.148).

Figure 9. Organizational culture factors

Resistance

The resistance construct includes the extent to which individuals in the organization exhibit active or passive resistance to either the content or intent of promoted change. In an organizational culture of low resistance, organizational change should typically be easier than in organizational cultures with high resistance.

Resistance in settings involving deploying one or more of the process maturity models being discussed here largely involves two interacting areas (a) general resistance to change: to being told what to do differently, and (b) specific resistance to changing professional skills: to being told how to do one's job. While all respondents in this study exhibited the former form of general resistance to change, only some exhibited a resistance based on professional knowledge or status, believing that their own professional experience and knowledge should circumvent some of the change being requested.

Another form of resistance coming into play was resistance to change from management, or staff-reactive change. The organizations implementing these process maturity and improvement models were defining goals based on the definition and scale of external models that partially dictated what had to be changed. Once an organization adopts Six Sigma or the CMMI as a change model, the models themselves become barriers to counter-change attempts on the part of resisting professionals. On many occasions, the CIOs of these organizations were put into situations where they couldn't back down, or back off certain issues. These models allow for a certain amount of variation in their implementation, but the majority of the model implications are fixed.

For example, an organization cannot adopt Six Sigma or CMMI and still acquiesce to organizational resistance to collecting metrics. Having chosen the models, organizations are committing themselves to seeing certain changes through.

Seen in this light, implementing process improvement and maturity models in these settings becomes a four-way force-field problem, balancing general change resistance, professional resistance, model variability-flexibility, and sponsoring management commitment. The interplay of these four variables, reminiscent of Lewin's (1947) fields, determines the overall level of organizational resistance to, or acceptance of, these models as they are deployed.

Alignment

The alignment construct includes the extent to which organizational processes, including those undergoing change, are consistent with the goals and objectives of the organization, as well as with the personal goals and objectives of the people working within the organization.

The extent to which the process improvement and maturity models chosen for implementation align well with individual and organizational goals and objectives implementation and deployment runs more smoothly typically leading to better outcomes. The forms of misalignment can be predictive of the types of implementation friction that will be encountered. Individuals affected by a model implementation are particularly interested in two aspects of alignment (a) whether the model fits their own image of their profession and career path (e.g., Is it a good model?), and (b) whether the model fits their organization and targets urgent problems (e.g., Is it the right model?).

The levels and types of resistance encountered during implementation can vary enormously based on the levels of these two different forms of alignment.

Individuals focusing on themselves as professionals tend to be more concerned with model goodness, while individuals focusing on their contributions to their organizations tend to be more concerned with model rightness. I spoke with respondents during site visits who stated that they weren't sure how participating in the organization's improvement initiatives would affect their prospects for getting other jobs; illustrating how identification with one's professional can be stronger than with one's employer. Corrective actions by sponsoring management to emphasize alignment can be counterproductive if the wrong form of alignment is targeted.

Individuals in this study, particularly those in the chemicals company that was implementing both Six Sigma and the CMMI, described Six Sigma in terms of alignment to company problems while sometimes arguing that it was not always an effective quality methodology. Conversely, they described the CMMI as highly IT-industry appropriate, yet not well aligned to the specific resource-based problems their organization was facing. Among the healthcare respondents, the ongoing initiative to implement improved project management practices was viewed as both industry appropriate (i.e., good for their profession) and organizationally needed (i.e., right for their problems).

Social & Economic Context

The social and economic context within which an organization is viewed, including both its culture and diverse approaches to process maturity, become the stage on which all of the competing and interacting constructs and relationships play out. The

CIOs from both the chemicals company and healthcare organization described changes in this construct as being central to many of the changes that have taken place across the information technology sector over the past two decades. Two respondents in managerial roles in the chemicals company expressed similar feelings, noting the difficulty of managing technical professionals who are facing strains in their personal lives outside of work.

Themes discussed by both CIOs included the trends toward workforce and project globalization that results in an effective 24-hour-a-day, 7-day-a-week work schedule. This combines with increases in information technology outsourcing that increases the complexity of team structures and operations. Both the chemicals and healthcare organizations included an outsourced set of project and staff components in India.

Both CIOs also discussed issues related to work-life balance, and this was an especially strong theme for the chemicals company CIO. A counter-theme to work-life balance was the increasing pressure on all staff members to perform well, and to protect their skill sets, in the face of downsizing changes that affect job and team stability. The information technology organization in the chemicals company went through multiple downsizing initiatives during the two years in which they participated. Such downsizing affects how individuals perceive their jobs, and their need to learn and practice new skills.

All of these social and economic factors have an impact on the way that all of the other constructs in this model are perceived, and in how they interact.

Inter-model Relationships

IT-to-Business Process Maturity

There is a strong feedback loop between information technology process improvement maturity and overall business process maturity. Information technology has become central to the products and services of most businesses today, and the ability of a business to implement those critical information technologies is largely determined by the organizations information technology process maturity. Likewise, as business process maturity improves, increased investments in further information technologies, both to maintain business outcomes and grow additional capabilities, are seen.

Respondents reported that they saw direct links between successes in their information technology improvement initiatives and their on-going ability to satisfy business customers through successful projects that enabled improvements in business processes. Respondents also saw a reverse relationship between their ability to use their information technology projects to enhance the outcomes and prospects of the business and the willingness of the business to make investments in improving the maturity and functioning of the information technology function and organization.

A more subtle relationship entailed how respondents viewed the focus of their organizations' information technology process maturity initiatives. Respondents who reported goals for the information technology improvement initiatives in terms of support or improved outcomes for the business also reported higher levels of success and satisfaction with their improvement programs. Respondents who reported goals for their improvement initiatives that were more internally focused on achieving specific certified

maturity levels or internal efficiency outcomes reported lower levels of success and satisfaction. One respondent specifically commented on the “need to understand the business reasons for doing improvement” (G03.40) as a prerequisite to successful information technology improvement.

IT-to-Improvement Process Maturity

The relationship between information technology process maturity and general process improvement maturity is not straight-forward. The IT-engineering and quality management disciplines tend to develop separately even within organizations attempting to improve both. I observed in the chemicals company IT department that I regularly had to talk to two distinct groups of people depending on whether I was looking for information on their Six Sigma or CMM programs. Efforts to improve process maturity through quality programs typically do not make extensive use of IT or software engineering disciplines, and efforts to improve process maturity through IT process improvement rarely focus on the quality-specific perspectives of requirements, defects, verification, or metrics.

To the extent that improving information technology process maturity requires an ability to improve processes generally, one might expect this direct link to be articulated by respondents. The SEI CMM articulates the precise process activities that need to be improved within information technology in order to achieve higher levels of maturity. The model would seem ripe for the identification of IT process improvement projects under the general process improvement initiative. Only the more experienced respondents in the tertiary group articulated this connection. None of the chemicals or

healthcare organization respondents described the CMM as a natural source of Six Sigma projects, and none of the Six Sigma projects I observed at the chemicals company was being used to drive their SEI CMM implementation; the two programs were always discussed distinctly in separate contexts. In the healthcare setting, this relationship was acknowledged by two respondents, but was not observed in practice. In both settings, the Six Sigma program was perceived as targeting business process improvement, not information technology process improvement.

Improvement-to-Business Process Maturity

Process improvement maturity is often described as a driver of business process maturity. The central focus of many process improvement initiatives is the identification and reduction of defects, and process rework driven by those defects. Such process improvements result in decreased costs within the business, and business growth driven by increased customer satisfaction.

Respondents in both organizations who had participated in Six Sigma process improvement projects all reported that the results of those projects included improvements in business processes. No respondent, though, noted that these improvements in business process maturity had any effect on the level of investment or priority placed on their process improvement initiatives. This contrasted with the investments in information technology process maturity that were reported as a result of IT's positive impact on business process maturity. Several respondents noted that when business process improvement was successful, the success could be attributed to better information technology rather than to their organizational Six Sigma program.

When respondents noted a boost in process improvement maturity investment, it was in those cases where a problem or crisis in the business resulted in a need to expand the Six Sigma program into areas not previously covered. Six Sigma was used to diagnose and correct several revenue problems in the healthcare setting, and to remediate and address causes of an industrial accident in the chemicals company.

A few respondents noted that while most business functions within these organizations were using Six Sigma to improve their operational excellence, Six Sigma projects within information technology were generally not addressing the operational excellence of the IT organization itself. Instead, Six Sigma projects within IT were always focused beyond the information technology arena into the business community it served. The few that were largely ignored the parallel CMM initiatives; internally-focused use of the CMM as a tool to predict needed improvement initiatives was not integrated into the Six Sigma project selection process. Despite the commitment to the CMM, I could not find a single Six Sigma project team that was working to implement any component of the CMM in the chemicals IT organization.

Context-to-Culture

While organizational culture is typically described as a central and long-term determinant of how an organization will approach process maturity initiatives, it is ultimately defined and driven by the social and economic context in which the organization operates. Long-term social and economic trends eventually impact an organization’s culture, if the organization is to survive.

The culture of the chemicals company was greatly influenced by the globalization of their projects, and the outsourcing of many of their processes and resources. The healthcare organization was greatly influenced by the outsourcing of IT development resources, and also by changes in the dynamics of the healthcare industry in the United States.

Key Informants

The model presented above was presented and discussed with the CIOs of both the chemicals company and healthcare organization to check on the extent to which the observations and relationships within the model would resonate with these organizational leaders. The chemicals company CIO shared the results of his own recent attempt to apply Six Sigma to his own organization. Among his key input variables were company culture and behaviors, organizational workload, social context, and industry trends. More traditional inputs such as directional policies, strategy and plans, as well as goals and objectives were secondary to those key inputs. He expressed an interest in revising his improvement initiatives in the future to give greater weight to these key input variables.

The healthcare CIO focused his comments on the issues of management resolve and organization resistance, “Organization resolve is always an important part of success. It has to start from the top. Change and improvement require tough decisions. The leadership team needs to be willing to change view, roles, people and goals. It helps if the company is under siege by financial issues, competitors, regulators. It is easier to get people’s attention if they think their company is at risk of going away.” To focus on maintaining support for change, he commented that “rank and file employees should be

targeted with clear communications explaining why the organizations is looking to change, and what their role is." He described change as an emergent group dynamic, not a force-fed program.

I also reviewed the model with several key informants who had not participated directly in the study as respondents, but who had unique perspectives on the study contents. While in agreement with the model, most suggested extensions to include more detail or additional constructs that would have extended well beyond the boundaries established by respondent statements, and so would not have been appropriate for inclusion in a grounded theory model. Some of those comments might warrant further study, while others might present limiting challenges to this model. One informant questioned the applicability of this model to public sector environments where the employer-employee dynamic is very different than the corporate settings I studied. Another informant challenged the complexity of the model ("Keep the bubbles to a minimum.") wondering if managers would have the attention span necessary to assimilate it into action.

Literature Alignment

The model for understanding the interactions for different process maturity dimensions outlined above is grounded in the statements made by respondents and in direct observations that I made while visiting the sites in which these respondents worked. Fidelity to the literature was not a central concern in the development of theory. However, the acceptability and strength of this theory will be perceived in light of its level of alignment with the literature, including the literature cited in chapter 2.

This study confirmed Wiklund and Wiklund's (2002) and Ryan's (2000) findings that in order to study process change in an organization one must go beyond the technical aspects of the quality program to incorporate aspects of organizational learning, particularly with respect to strategies for on-going education and support. Their assertion that in order to understand outcomes one must take into account the changing attitudes and behaviors of participants, closely aligns with my findings. Ittner and Larcker's (1997) challenge that in order to be successful at process change, organizational management must internalize the underlying philosophies of their change initiative was repeatedly articulated by study respondents. Weimer and Munyan's (1999) finding that human factors ranked highest among factors impacting information technology organizational success is consistent with comments made by my respondents that management needed to pay more attention to the impact that these programs was having on the individuals and teams in the organization, and recognize that improvements couldn't be achieved by simply demanding more and more of people.

Jung and Goldenson's (2002) statements to the effect that the SEI CMM is generally accepted as a good model by information technology professionals, while sometimes being challenged as inappropriate in certain organizations, echoed the tone taken by respondents in this study, none of whom ever questioned whether the CMM model was a good model for the profession. The idea that it sometimes wasn't the right model for these organizations was consistent with Jung and Goldenson. My own observation that respondents in the chemicals company thought the CMM was a good model that wasn't necessarily right for their organization matched Goldenson and

Herbsleb's (1995) finding that while individuals in organizations valued the CMM for what it stood for, they often felt the recommendations for implementation that they received from the assessment process were unrealistic for their own organizations. Respondent complaints about having to implement both the CMM and Six Sigma at the same time matched Harauz's (1999a) observation that weaknesses in individual models could easily compound when multiple models are considered simultaneously by an organization. Paulk's (1999) admonition to have teams discuss the meaning of the CMM model in light of how and why it is being implemented in the organization helps explain the weaknesses of the program at the chemicals company where respondents did not indicate any knowledge of why the model was being implemented the way it was, and I observed that management discussions of the implementation tended to focus on the credentialist benefit of CMM compliance over its actual improvement impacts.

My findings regarding geographic differences in CMM implementation differed from Jalote's (2001) when I visited the healthcare organization's information technology development site in India. Jalote reported a strong penetration of the SEI CMM into India software organizations. Respondents from the healthcare organization's IT development site in India did demonstrate very high knowledge of the contents and implications of the SEI CMM, but when I visited the site I did not observe actual work practices that were noticeably different than their less-mature counterparts in the United States. Their knowledge seemed to provide a potential for the CMM to have a major impact, but I did not see that potential materialize. Individuals working at that site who had worked at

other sites in India reported that the level of CMM maturity I observed was typical of an IT organization in that city.

Zbaracki (1998) identified relationships between rhetoric and reality during the deployment of quality programs that closely mapped to issues raised by respondents, and that I observed in organizational settings. In both the chemicals company and healthcare organization, management rhetoric was dominant in initiating and promoting change activity, and was typically followed by bursts of activity and short-term success. When such successes were not sustainable, additional cycles of management rhetoric were needed to sustain the change initiative. Each cycle grew shorter in the chemicals company until the CIO's rhetoric couldn't overcome the poor results actually being achieved, and the overall program faltered. In the meantime, individuals in the organization were claiming success, and, as Zbaracki predicted, were attributing that success to the improvement program. Of the 50 Six Sigma projects I observed in the chemicals company over the 2-year period, only one project ever actually calculated a final sigma score for the process that had been modified, coupled with an F-test against process metrics to show that the improvements achieved were not the result of random effects. This was the only project that could truly claim to have implemented the entire Six Sigma process. All of the others, while attributing any benefits they achieved to the Six Sigma program, actually had not completed the Six Sigma process at all. This is not to say that those projects didn't achieve benefits for the company; only that those benefits were tied to a formal Six Sigma initiative through program rhetoric, not the reality of Six Sigma practice.

Quality management literature generally, and CMM-related process improvement literature in the IT field specifically, does not deal broadly with unsuccessful organizations and failed initiatives. Analogues to the organizations in this study, and the manners in which they were successful or unsuccessful, go unreported in the literature. The chemicals company pursued a complete implementation of both Six Sigma and the CMMI. Their initiative was unsuccessful; and the harder management pushed the staff to comply, the greater the resistance encountered. Much of that resistance was passive, with respondents reporting that they spent considerable time trying to define their own projects to ensure that they would not come within the policy of projects that were required to participate in the improvement initiatives. The respondents who were happiest with the program noted the least pressure from management. The healthcare organization implemented a project management initiative that was much narrower than the initiatives in the chemicals company, and had success in doing so. Respondents did not report a lot of pressure to expand their practices beyond the basic training, and reported both success and satisfaction with the program. Local small-scale successes such as these, as well as large-scale disappointments such as experienced in the chemicals company, remain under-reported in the literature.

CHAPTER 5:

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

Summary

This study looked at the interactions of process improvement maturity, business process maturity, and domain-specific process maturity within the information technology field in order to develop a grounded theory of process maturity interactions that can help improve the focus and yield of process improvement investments, resulting in a better optimized combination of higher quality, lower cost, reduced risk exposure, and positive outcomes for organizations.

Chapter 1 concluded with two overarching questions: (a) what organizations were doing to enhance their process maturity, and (b) what people in those organizations thought about those process maturity efforts. The results described above present a diversity and divergence of viewpoints from respondents. These two organizations were trying to improve all three types of process maturity simultaneously by implementing aspects of industry-accepted models, and each was approaching such implementations with different levels of formality and aggressiveness. The people within each organization were responding to the level of formality and aggressiveness more than to the models themselves, but their reactions created feedback loops that helped determine the effectiveness of the process improvement efforts.

The theory created in this study is that, when implementing process change, less can be more. An organization that focuses its energy on the core essential components of a process change will be more successful than one that tries to carry out more massive

change involving large formal process models or standards. The potential amplification aspects of Six Sigma interacting with the CMM described by Siviy and Forrester (2004) are seen when leadership creates narrower or lower-pressure initiatives, but are not seen when leadership tries to implement the full comprehensive models.

Every interview respondent described his or her organization's quality program as underachieving, and yet universally asserted that the organization could not be achieving its positive results without its quality program. What is it about the deployment of underachieving quality programs that still results is such perceived success? This study found 12 interacting constructs emerged from discussion of this question with the 57 respondents. Those same constructs appeared during analysis of the literature and conference proceedings related to the Six Sigma and CMM models studied, but that content differed markedly with respondent comments and perceptions. Articles in the literature, profiled in chapter 2, tended to focus on larger-scale successful implementation of these models.

Several key findings emerged from this study that help provide insight into the interaction of these constructs and the ways they affect an organization's process improvement maturity, information technology maturity, and business process maturity. Fortunately for the organizations represented by these respondents, every effort to deploy quality models to influence process improvement and information technology process maturities resulted in improved business process maturity. None of the efforts described by respondents or the literature resulted in setbacks for the businesses in which they occurred, but this study found that a great deal of time, money, and effort had been

wasted in these implementations. This study identified variables, the interaction of which, might help improve the yield and outcomes of efforts aimed at implementing process improvement and information technology maturity improvement, separately or together. The key variables include (a) management's inflexibility toward implementation, (b) levels of forgivingness toward underachievement in the culture, and (c) alignment and appropriateness of the models.

Inflexibility Toward Implementation

This study found that management's resolve in insisting that the organization correctly and completely implement targeted models was critical to the viability of successful implementation. Two of the most famous Six Sigma programs in the literature are Jack Welch's program at GE and Larry Bossidy's program at AlliedSignal in the 1990s. Both of these programs have been described as successful, largely owing to the steadfast commitment of these leaders to seeing the programs implemented in their organizations, and refusing to tolerate uncommitted managers (Bossidy & Charan, 2002). Likewise, information technology organizations described in the literature as CMMI success stories are found in the United States defense sector, where compliance with the CMMI is typically mandatory, sometimes to the point of procurement and contract exclusion if certain CMMI-based benchmarks have not been met by these organizations.

Respondents in this study were from a mix of organizations with respect to such resolve. The chemicals company implementation of both Six Sigma and CMMI lacked such resolve from senior management, and respondents reported serious problems in implementation. The CIO in the healthcare organization exhibited great resolve toward

their improvement initiative, and respondents from that organization noted related implementation successes. This suggests that organizations looking to implement any of these models should evaluate whether they have the necessary resolve, either through the strength and personality of some internal leader, or through the external compliance pressure of a major customer or regulator. This study suggests that in the absence of such resolve, much of the formality of many implementation efforts results in wasted effort against implementation details that will not be successfully implemented because of the lack of sustained resolve needed to see them through.

The healthcare organization represented in this study targeted a very narrow range of project management disciplines for improvement, while the chemicals company targeted a much broader CMM-oriented program that included the same project management disciplines as a subset. The healthcare organization's narrower implementation exhibited much greater success than the chemicals company's fuller implementation. Respondents in the chemicals company attributed much of their difficulty with the change process to the large scale and formality of the broad implementation. This suggests that the scale and formality of the broad program was likely a contributor to the differences in outcomes achieved between these two organizations.

If management is willing to accept narrower implementations, much time, cost, and effort can be saved by avoiding such formalities. This study suggests that managers not willing to settle for a narrower implementation should reconsider that approach if they are unwilling to demonstrate the resolve necessary to work to make their

organizations more similar to the success stories in the literature. Those trying to force the broader, more stringent, implementation will cause negative effects for their staff, and not more positive outcomes for their programs.

Forgivingness of the Culture

This study also found that the extent to which an organizational culture was forgiving toward those who underachieved relative to certain goals and implementation expectations was important in determining the level of implementation success against these models. Respondents in the chemicals company, in particular, described the excessive workloads that everyone was assigned, describing the impossibility of ever getting all of that work done. As a result, workers in the culture adopted a level of empowerment, that everyone felt, to decide for oneself what would get done and what would not. Although answerable to management, individuals had a cultural safety net in the fact that everyone in the organization was well aware that everything could not possibly get done. In such an environment, it actually becomes easier to neglect certain aspects of improvement initiatives precisely because the ready-made excuse is built into the culture. The healthcare CIO in this study described this built-in cultural forgiveness as the single biggest inhibitor he had to deal with in trying to drive change and improvement.

Organizations with similar overworked, and therefore forgiving, cultures need to exercise care in designing initiatives to roll-out improvement models such as those studied here. Respondents in this study painted a picture of waste when they described the excessive expectations placed on them by improvement initiatives relative to what's

perceived as actually workable in the environment. A narrower, more focused, implementation might result in the same successes with less cost, effort, and resistance.

Alignment and Appropriateness

This study also found that the level of fit between the models being implemented and the organizational context in which they were being implemented was important when determining the likelihood that such an implementation would be successful. Improvement models that fail tend to do so in two ways (a) the model fails to align with the expectations of stakeholders with respect to its professional or industry alignment with the work environment: it's not a good model, or (b) the model fails to align with the expectations of the organization and its members for the types of problems to be addressed: it's not the right model. A model that is generally good for the profession isn't always a model that seems right for the organization. A model that seems right for the organization might seem contrary to what professionals in the field would see as good. Either way, the model isn't appropriate to the situation in which it is implemented.

When respondents described failures in their Six Sigma implementations, they described problems in applying the model to problem areas that didn't fit those typically described in the literature. Most common in this category were problems that were too small to absorb the overhead of the Six Sigma methodology, or problems to which tentative solutions were already known and for which the exploration and discovery aspects of Six Sigma were considered too cumbersome. In these situations, Six Sigma was not perceived as the right model for the organization. Respondents recognized that their organizations had selected Six Sigma as a good model for process improvement, but

they challenged whether or not it was the right model for actually dealing with the types of problems to which they were typically exposed in the organization. Six Sigma was simply seen as overkill for some organizational problems.

The literature suggests that organizations in non-manufacturing industries struggle to implement improvement programs built on Six Sigma. However, this study did not suggest any industry-specific weaknesses in the Six Sigma model; respondents in both the chemicals and healthcare settings described it as effective, and none of the respondents from the tertiary cohort disagreed. Six Sigma must fit the organization in which it is implemented, but being in a particular type of industry setting did not appear to be part of what such a fit required.

Conversely, no respondent questioned whether the CMMI was a good model for the information technology industry and profession. Respondents who took issue with the model always pointed to organizational fit issues, suggesting that the adoption of the CMMI, while a good model for the industry, generally was not right for their particular organization. Respondents didn't want an alternative to the CMMI, they wanted to know how to effectively implement it. This contrasted with Six Sigma, where respondents wanted an alternative to it.

All of organizations that implemented Six Sigma programs had previously been through a cycle of implementation known generally as Total Quality Management (TQM). Central to the TQM approach was a cyclic improvement cycle known as Plan-Do-Check-Act (PDCA); the DMAIC lifecycle of Six Sigma being a forward-evolution of that approach that adds more systematic measurement and control than found in TQM.

Where respondents reported failed or underachieving Six Sigma programs, they typically described the use of Six Sigma tools in ways that were more consistent with a TQM program than a Six Sigma program. Since the various tools used in these approaches are the often the same, what might have been interpreted as a highly successful TQM program ended up being interpreted as a weak and ineffective Six Sigma program. The success of the implemented model is interpreted in the context of the breadth or narrowness of the entire improvement program.

In the case of the healthcare organization improvement program that was centered on improving project management disciplines, the success of the program might be attributable to the narrowness of the implementation targeted. If the healthcare CIO had tried to achieve benefits by implementing the CMMI model (the first level of which includes many of the project management goals actually implemented) the program would likely have been considered less successful. Even if the exact same improvement gains were achieved, the fact that the program fell short of the entire implementation model would have created a perception of underperformance or failure. When the chemicals company tried to implement the entire CMMI, they actually achieved many of the same project management benefits as the healthcare organization had achieved, but through a much more painful and tumultuous process. In the healthcare organization, their information technology process maturity gains were considered a major success, while the same gains in the chemicals company were considered the minimal that could be recovered from a failed program.

These findings suggest that many of the gains achieved in major improvement programs might be equally attainable without the overhead and formality of the integrated introduction of specific and rigid improvement programs. In the absence of management resolve, a fit to cultural expectation, and appropriate models, the results that are achieved are gained from the narrower and less formal subset of the actual models that will fit the resolve, culture, and environment actually found. If so, the same benefits might be achieved by simply implementing the narrower subset in a less formal way.

Social Impact

There are thousands of corporate information technology organizations attempting to improve their process maturities using combinations of the improvement models described and reviewed in this study (Software Engineering Institute, 2004). New models, and hybrids of existing models, appear each year. To the extent that these organizations are modeling their implementations on the success stories described in the literature, and the marketing materials of the consulting industry that supports this movement, this study found that they are likely to be wasting much of their implementation resource trying to reach for a level of penetration and integration that simply won't be successfully achieved. But this study also found they are likely to have success in helping their businesses improve their use of information technology to achieve better business process maturity. This study suggests that much of that gain can still be achieved with scaled-back expectations for what can be implemented, lowering cost and speeding up implementation at the same time.

There are hundreds of thousands of information technology professionals working in organizations implementing these models. Respondents in this study described the many ways they are impacted by their organizations' attempts to implement the formally-structured improvement programs around them. These impacts, all negative, include: increasingly demanding workloads, performance stress and anxiety, fear of job disruption or loss, workplace hostility, and reduced productivity. Amazing to me was that these same respondents were the ones who reported that their organizations were benefiting greatly from these programs. A strategy of implementing a narrower or less formal version of some of these models is likely to achieve the same benefits, without the negative effects and turmoil encountered in this study.

Conclusions and Recommendations

Information technology organizations looking to implement multiple models, like the CMMI, Six Sigma, and project management programs described in this study, should consider their interactions and possible contradictions when planning and implementing such combinations of models. Implementing only one of these models, usually deferring the others to some future point, is simply a special case of trying to implement all of them simultaneously or with some time lapse among them. Managers and change agents intending to implement these models should consider this theory's constructs and variables identified in the prior chapter. This theory's constructs describe an implementation strategy that looks to optimize existing expected benefits against a lower implementation profile and footprint.

The model that emerged in this study indicates several key questions that management should ask before undertaking the investment and complexity of a process maturity program, either aimed at process improvement maturity or information technology process maturity:

1. Does management have the resolve necessary to enforce the complete implementation of the target program, or can the implementation be tailored to implement only the critical program components needed for success and is there sufficient resolve to see it through?

2. Does the organizational culture provide sufficient accountability to ensure that individuals will perform expected actions and make required changes without being able to hide behind a shield of cultural forgiveness for incomplete goal attainment?

3. Are the improvement models being targeted consistent with how the individuals throughout the organization see themselves as professionals, and will those individuals see this implementation as the right thing to do?

4. Do the models to be implemented make demands on the organization that are consistent with the way the organization is structured to function and behave, and do they solve the actual problems actually experienced and on which time is spent?

All respondents in this study with management responsibilities—particularly the two CIOs—found that these questions, asked soon enough, could have redirected their implementation efforts, avoided a lot of waste, and allowed for faster and easier attainment of the benefits they eventually achieved.

Limitations of Study

The organizations represented in this study were selected opportunistically, not randomly. Likewise, individual respondents self-selected from widely distributed invitations within these organizations. As a result, these findings cannot be generalized to any other organizations or industries. While the model described here is not universal, it is grounded in the statements, comments, and experiences of the respondents who participated. It is supported by direct observation of these respondents in their places of work. Readers who see themselves or their organizations in the comments of these respondents might benefit from adopting and using this model for process maturity intervention.

Suggestions for Further Research

This study suggests that much can be learned about the implementation of process maturity programs by studying less-successful implementations, or implementations that appear successful but have struggled to maintain themselves. More research is needed into organizations and programs that fit these criteria, although getting organizations to report or share negative results is challenging.

There are numerous process improvement models and methodologies across the information technology sector beyond those investigated in this study. Research that looks at these models might confirm or deny the findings presented here, particularly if it is found that narrower or less formal implementation strategies for any of these models are counterproductive.

Process improvement models and methodologies have only a twenty-year history, making them young among management models. They are old enough to provide a basis for study across industries and disciplines, and yet young enough to benefit from the insights of continued research. Over the life of this study, both Six Sigma and CMMI have been evolving. Many organizations practicing Six Sigma have moved on to implementations of Design for Six Sigma or Lean Six Sigma, both representing natural extensions of the basic approach. Some organizations implementing the CMMI have expanded their programs to include Information Technology Infrastructure Library, a model that overlaps and complements the CMMI but not in a way that it can serve as a replacement. As organizations jump among models trying to improve their outcomes, we need to understand what makes some implementations successful while others languish. When current models are deemed unsatisfactory, it is all too easy to move on to the next model. It is much harder to stand fast and figure out why the current models don't always work. In that light, perhaps the most effective process model of all was the original TQM.

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APPENDIX A:

SEI Capability Maturity Models

Introduction

The way that individuals in the information technology (IT) industry think about process maturity and capability is a central organizing element of this study. The dominant model in the industry, and the one used to operationalize the IT constructs in this study, is the Capability Maturity Model Integrated (CMMI) of the Software Engineering Institute (SEI). While many in the information technology field are aware of the CMMI model, and can articulate its many objectives and components, few can describe the model in detail or assess specific implications of the model for their own professional practice. Outside of the profession, there is little reason why anyone would be familiar with it, even in its broad outlines. This appendix offers some background and explanation of the CMMI model and concepts in support of the use of the model as an organizing theme for many of this study's constructs.

Software Engineering

For most of the history of the software engineering profession, the role of creating and implementing software systems for organizations was viewed as an organizational function. Humphrey (1989) described the maturing of an organization's software management processes over time; emphasizing the almost interchangeability of individual software engineers through an emphasis on organizational standards and management reviews. This model attributed the quality of any resulting software systems

to the structure and control of the centralized and usually hierarchical organization models that managed these resources. With computer resources in most organizations dominated by large centralized mainframe computers, the parallel centralized structure for the software engineering function seemed natural to many.

With the advent and explosion of personal computer technologies in the 1980s, the computer and information resources managed by these centralized hierarchies became decentralized. Frictions ensued between the centrally managed software engineers and their widely-distributed user and computer environments. Humphrey (1995) described the pendulum swing within the industry from centralized hierarchical organizations toward independent autonomous individual software engineers. These engineers still worked for hierarchical organizations, but their work and status came to be managed at the individual level. Quality became the responsibility of individual engineers and tools and techniques were developed for these purposes.

By the 1990s, particularly with the advent of the Internet in the mid-90s, computer resources became increasingly interconnected and interdependent; and the software being engineered for these environments was growing more and more complex. Humphrey (1999) described the rise of team and virtual thinking associated with organizational models in information technology. Making individuals the focal-point of quality methods ignored too many realities of how software systems were developed and implemented. Large teams of multi-disciplined professionals became the dominant model for information technology groups.

The history of information technology began with large centralized hierarchies of technology, shifted toward autonomous individual personal computers, and evolved into the wide and complex networks that exist today. The original hierarchical network of workstations all connected to an individual central mainframe gave way to the web of interconnected computers where no central owner or controller existed.

In a manner consistent with a modern structural-functionalist perspective, the software engineering organizations have tried to keep pace with this evolution of technology by adopting organizational styles that mimic the technologies being implemented. Large centralized information technology organizations gave way to webs of dynamic, virtual, self-organizing teams that operate autonomously throughout their parent organizations.

Industry Standards

As these organizational structures have tried to keep pace with this evolution, the industry has also tried to keep pace with the technology by developing and imposing standards that enforce stable views of how technologies should be developed and used.

More than 250 software engineering standards have been developed by more than 50 international, national, professional, and industry standards organizations in the last two decades. (Harauz, 1999a, p. 51) A key player in the technical standards arena has been the IEEE Software Engineering Standards Committee that develops and promulgates a large variety of technical standards that cover the majority of knowledge domains of interest to the professional software engineer. (Moore, 1998)

In addition to the many technical engineering standards that have been promulgated, the same period has seen the definition and growth of general quality standards that greatly effect the economies and industries that set the context for a large portion of the software engineering community. Quality management in the United States has been dominated for the last twenty years by the Baldrige National Quality Award, an industry-focused quality management model design to be used to increase the general quality capability of American companies. (National Institute of Standards and Technology, 2001)

Also during this same period, the international quality management arena has been dominated by the ISO 9000 series quality management standards that define a quality management system against which organizations in many industries can measure themselves and be audited for compliance. (American National Standards Institute, 1991) Within the broader ISO 9000 movement, international standard ISO 9000-3 offers specific implementation guidance for adapting the most comprehensive of the ISO 9000 standards - ISO 9001 – to the software industry. (American National Standards Institute, 1994)

There have been efforts to harmonize, or reconcile, these multiple levels of standards and models. I explored how to reconcile the Baldrige model with some of the technical standards for data engineering. (Biehl, 1993) Radice (1995) developed detailed guidelines for using the ISO 9000 series quality standards in the software industry. All three levels were integrated into a single working model by Tingey (1997).

Origins of the SEI

In the mid-1980s, the U. S. Department of Defense contracted with Carnegie Mellon University to create and operate the Software Engineering Institute (SEI) in response to a recognized need to improve the process and product quality of defense contractors and services. Throughout the 1990s, the SEI worked to develop a series of models that would mediate between the specific and technical software engineering standards that were emerging and the higher-level and broader quality management models.

The earliest SEI work explored the order in which technical disciplines should be improved to optimize the behaviors of the overall management structure in information technology. Weber, Paulk, Wise, and Withey (1991) had learned that the order in which individual engineering and management processes were improved was a key determinant of long-term success. They defined a series of capability maturity levels through which an information technology function must develop to eventually be able to achieve some of the organizational qualities called for in the broader general quality models. Their justification for building a model that included five plateaus was built on the *Quality Management Process Maturity Grid* that had been pioneered by Crosby (1979).

Evolution of the CMMs

Within this backdrop of technical and management standards, the Capability Maturity Models (CMMs) developed by the Software Engineering Institute have become the key focus of software engineering improvement practice among software engineering and information technology organizations worldwide. The three primary CMMs were

developed starting in 1989 (Table 7) have grown from an initial focus exclusively on software to a very broad systemic model that incorporates hardware and communication technical disciplines along with the human factors associated with changes in the modern team and virtual workplaces.

Table 7

SEI Capability Maturity Models

CMM	Scope
Software	Definition, creation, and implementation of software systems.
Systems Engineering	Definition, creation, and implementation of engineering systems; including hardware, software, communications, and other related components.
Integrated Process Management	Definition, creation, and implementation of engineered human-machine systems with emphasis on integration of human factor and psychosocial process factors into system characteristics.

As these models were developed, they met with increased resistance and difficulty while being deployed throughout the industry. Organizations that struggled to implement the simpler narrower models, rarely moved on to adopting wider and broader models.

Capability Maturity Model for Software

The initial CMM from the SEI was the *Capability Maturity Model for Software* (Software Engineering Institute; 1993). It defined a five-layered maturity model that

could be used by any information technology or software engineering organization to define and improve their process maturity through an extensive and long-term improvement program that would bring the organization up through the five levels sequentially. Each level defined specific activities, known as Key Practice Areas (KPAs), that needed to be improved in order to move to the next level. Transitioning from level to level could take between 13 and 25 months per level, necessitating a multi-year commitment to using the model (Wall, McHale, & Pomeroy-Huff, 2005). The model was an important step in helping the software engineering community to know which of the hundreds of available technical and management standards should be attacked first, and which could be deferred until a more appropriate time as defined by the five levels of the SW-CMM.

Use of the SW-CMM to improve practices generally results in quality and productivity improvement. McConnell (1999) reported that organizations making the necessary investments saw productivity improvements of 35% per year, and project schedule improvements of 19%. Quality also improved when viewed through the 39% reduction in reported defects for systems already completed. Use of the CMM proved useful to certain organizations that had what it took to make such an implementation. Exactly what those factors were remained elusive to software practitioners.

Early adopters of the SW-CMM found that its use improved their overall software development process capability as reported in the literature, but that, as the organization improved its software practices, other arenas in the software and information technology area remained problematic. There remained a need for a broader improvement model that

encompassed more than just the software development aspects of systems creation and implementation.

Systems Engineering Capability Maturity Model

The broader aspects needed in an improvement model involved aspects of information technology systems creation that went beyond software. In all but the most trivial information systems, the interaction of the software with its surrounding environment of hardware, data, and communications produces more complexity and quality problems than any particular aspect of the software itself. The SW-CMM maximized an organizations ability to implement software, but left these broader issues unaddressed.

In response, the SEI and a consortium of industry representatives who had made the greatest strides in implementing the SW-CMM, developed and published the *Systems Engineering Capability Maturity Model* (SE-CMM] (Software Engineering Institute; 1996). It added activities to the software maturity model that enhanced organizational capabilities related to vendor and hardware management, problem identification and monitoring, and additional factors related to integration and management of complex system components and subsystems.

The SE-CMM altered the architecture of CMMs as it had been during the development and subsequent enhancement of the SW-CMM. Where the SW-CMM arranged key activities into five different levels that needed to be implemented in the correct order to achieve each level of process maturity and capability, the SE-CMM changed to a continuous model where all activities applied to all five capability levels. In

the continuous model, all activities were relevant at all times, but different specific activities were identified as more or less important at each of the five levels. The difference between the original *staged* architecture and the emerging *continuous* architecture was highly conceptual and created problems in implementation and adaptation among many organizations trying to use both SW-CMM and SE-CMM models.

Integrated Product Development CMM

As the expanded systems model began to be used by those organizations with enough software maturity to take advantage of its added features, additional new omissions became apparent. The systems engineering activities included in the SE-CMM were those highly technical disciplines carried out by engineers on projects. Still omitted were other less-technical disciplines that were involved in any real-world product or system development. These disciplines included marketing, sales, customer service and support, and a host of management and financial specialties. The development of the *Integrated Product Development Capability Maturity Model* (IPD-CMM] (Software Engineering Institute, 1998) worked to address these omissions by adding the disciplines encountered in managing multi-disciplinary teams and cross-functional projects to the technical engineering disciplines already defined in previous CMMs. The IPD-CMM was built using the same continuous architecture that had been introduced in the SE-CMM.

By the late 1990s, the evolution of CMMs within the Software Engineering Institute and the broader software engineering marketplace looked complete. There now existed CMMs for the narrow view of software only, the medium view that added

systems thinking to software, and the broadest view that included people as cross-functional contributors to the development of software and systems.

Final CMM Integration

By the middle and late 1990s there were many organizations achieving various levels of success with each of the initial three major CMMs. A growing problem was that, while the three models were mutually supportive and had much overlapping content, they remained as three distinct models. Software engineering organizations that hoped to improve all of their software, systems, and people processes needed to adopt and use all three models at the same time. There existed no unified model that could be used to implement all of the necessary key practices. The problem of multiple models was made worse by the architectural differences between the staged SW-CMM model and the continuous SE-CMM and IPD-CMM models.

At the end of the 1990s, the SEI announced a new Integrated Capability Maturity Model (CMMI) that would combine all of the features of the three previous models into a single working improvement model. It was developed as both a Staged CMMI (Software Engineering Institute, 1999a) and Continuous CMMI (Software Engineering Institute, 1999b). *Figure 10* illustrates the evolution and flow of these various CMMs.

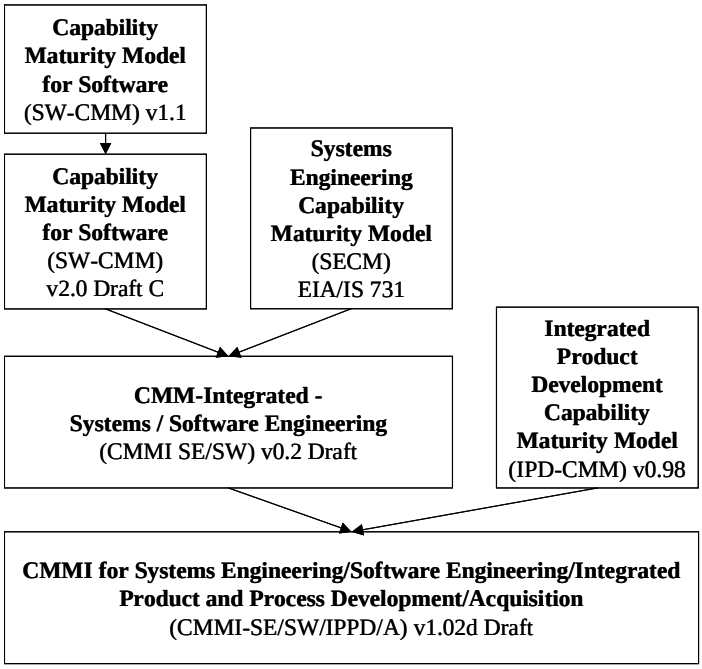


Figure 10. Evolution of the integrated-CMM

While organizations have been reporting success using the newer CMMI model (Gibson, Goldenson, & Kost, 2006, p. 93), the overall model ran into significant market resistance after its introduction in 1999, particularly from organizations that were struggling for years to implement the first three models and resisted the requirement that they rebuild their improvement programs around the new integrated model. Resistance was so fierce that the implementation, originally scheduled for 2000, was delayed several years. Many IT organizations still have not made the transition to the new integrated model.

Each of the Capability Maturity Models ran into trouble being implemented. When viewed from a structural-functionalist paradigm, each had offered increasingly complete and comprehensive coverage of all of the key processes necessary to build and

run a successful software engineering environment. And yet, they have not been readily accepted and used by the industry. This study was designed to explore and understand the reasons why; reasons that required an integration of traditional functionalist perspectives with the human-side, or interpretive perspective, on systems and information technology organizations.

APPENDIX B:

STUDY ARTIFACTS

B.1 - Sample Interview Log

B.2 - Sample Interview Transcript

B.3 - Sample Interview Concept Map

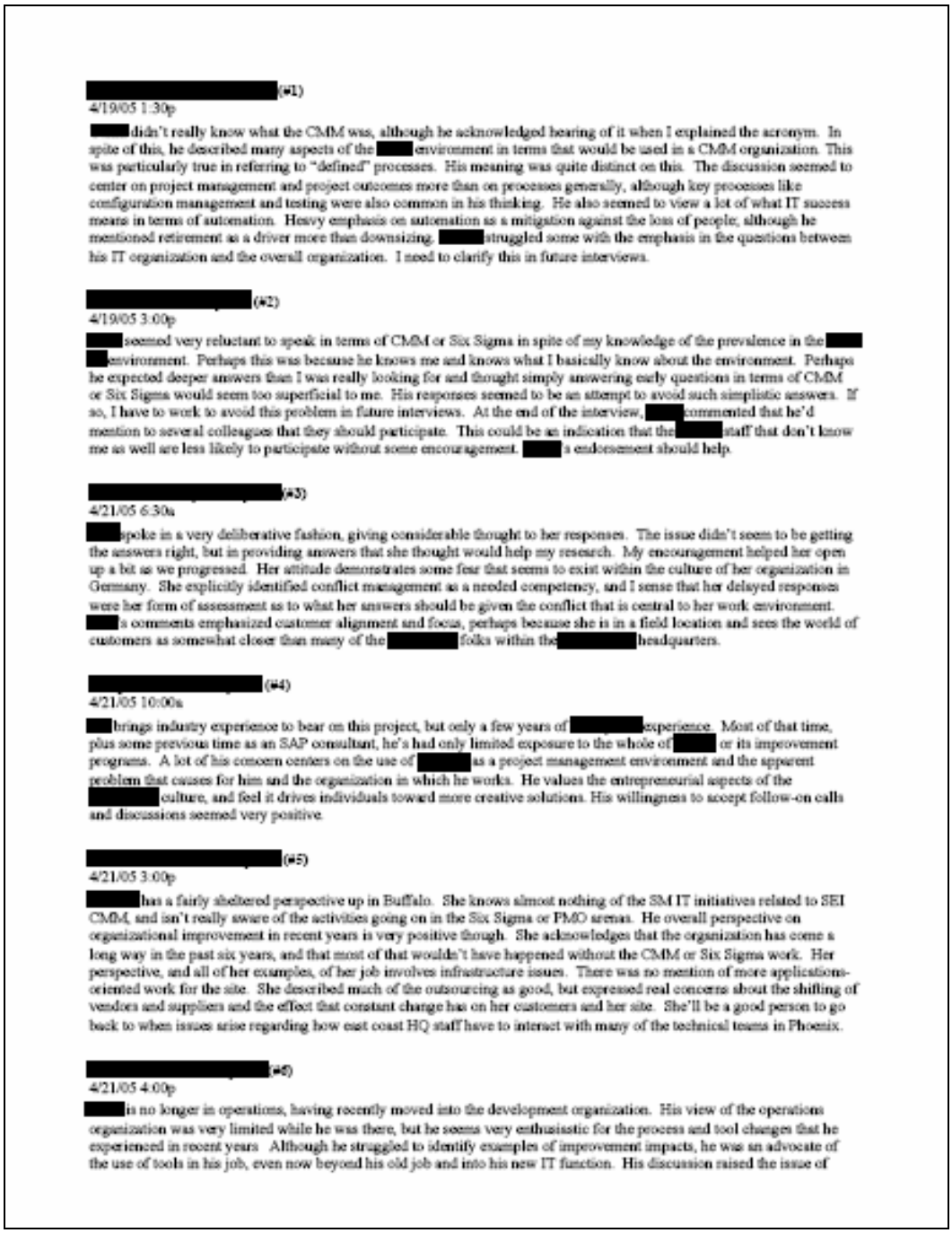
B.4 – Sample Interview Keyword Map

B.5 – Sample Response Tracking Matrix

B.6 - Model Affinity Groupings (Final)

B.7 – Results Description Flow (Final)

B.1 – Sample Interview Log



[redacted] (#1)
4/19/05 1:30p

[redacted] didn't really know what the CMM was, although he acknowledged hearing of it when I explained the acronym. In spite of this, he described many aspects of the [redacted] environment in terms that would be used in a CMM organization. This was particularly true in referring to "defined" processes. His meaning was quite distinct on this. The discussion seemed to center on project management and project outcomes more than on processes generally, although key processes like configuration management and testing were also common in his thinking. He also seemed to view a lot of what IT success means in terms of automation. Heavy emphasis on automation as a mitigation against the loss of people, although he mentioned retirement as a driver more than downsizing. [redacted] struggled some with the emphasis in the questions between his IT organization and the overall organization. I need to clarify this in future interviews.

[redacted] (#2)
4/19/05 3:00p

[redacted] seemed very reluctant to speak in terms of CMM or Six Sigma in spite of my knowledge of the prevalence in the [redacted] environment. Perhaps this was because he knows me and knows what I basically know about the environment. Perhaps he expected deeper answers than I was really looking for and thought simply answering early questions in terms of CMM or Six Sigma would seem too superficial to me. His responses seemed to be an attempt to avoid such simplistic answers. If so, I have to work to avoid this problem in future interviews. At the end of the interview, [redacted] commented that he'd mention to several colleagues that they should participate. This could be an indication that the [redacted] staff that don't know me as well are less likely to participate without some encouragement. [redacted]'s endorsement should help.

[redacted] (#3)
4/21/05 6:30a

[redacted] spoke in a very deliberative fashion, giving considerable thought to her responses. The issue didn't seem to be getting the answers right, but in providing answers that she thought would help my research. My encouragement helped her open up a bit as we progressed. Her attitude demonstrates some fear that seems to exist within the culture of her organization in Germany. She explicitly identified conflict management as a needed competency, and I sense that her delayed responses were her form of assessment as to what her answers should be given the conflict that is central to her work environment. [redacted]'s comments emphasized customer alignment and focus, perhaps because she is in a field location and sees the world of customers as somewhat closer than many of the [redacted] folks within the [redacted] headquarters.

[redacted] (#4)
4/21/05 10:00a

[redacted] brings industry experience to bear on this project, but only a few years of [redacted] experience. Most of that time, plus some previous time as an SAP consultant, he's had only limited exposure to the whole of [redacted] or its improvement programs. A lot of his concern centers on the use of [redacted] as a project management environment and the apparent problem that causes for him and the organization in which he works. He values the entrepreneurial aspects of the [redacted] culture, and feel it drives individuals toward more creative solutions. His willingness to accept follow-on calls and discussions seemed very positive.

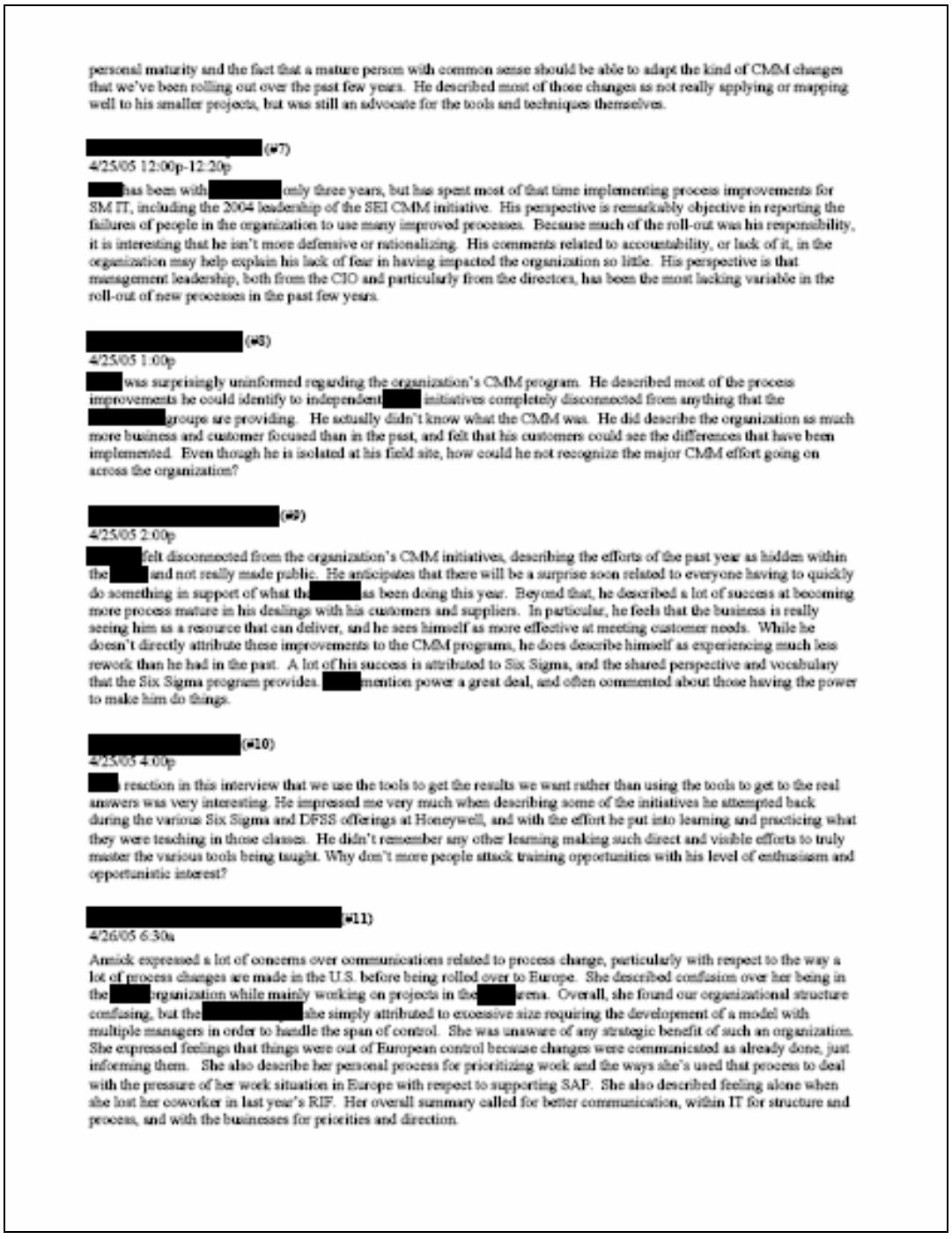
[redacted] (#5)
4/21/05 3:00p

[redacted] has a fairly sheltered perspective up in Buffalo. She knows almost nothing of the SM IT initiatives related to SEI CMM, and isn't really aware of the activities going on in the Six Sigma or PMO arenas. He overall perspective on organizational improvement in recent years is very positive though. She acknowledges that the organization has come a long way in the past six years, and that most of that wouldn't have happened without the CMM or Six Sigma work. Her perspective, and all of her examples, of her job involves infrastructure issues. There was no mention of more applications-oriented work for the site. She described much of the outsourcing as good, but expressed real concerns about the shifting of vendors and suppliers and the effect that constant change has on her customers and her site. She'll be a good person to go back to when issues arise regarding how east coast HQ staff have to interact with many of the technical teams in Phoenix.

[redacted] (#6)
4/21/05 4:00p

[redacted] is no longer in operations, having recently moved into the development organization. His view of the operations organization was very limited while he was there, but he seems very enthusiastic for the process and tool changes that he experienced in recent years. Although he struggled to identify examples of improvement impacts, he was an advocate of the use of tools in his job, even now beyond his old job and into his new IT function. His discussion raised the issue of

B.1 – Sample Interview Log



personal maturity and the fact that a mature person with common sense should be able to adapt the kind of CMM changes that we've been rolling out over the past few years. He described most of those changes as not really applying or mapping well to his smaller projects, but was still an advocate for the tools and techniques themselves.

[redacted] (#7)
4/25/05 12:00p-12:20p

[redacted] has been with [redacted] only three years, but has spent most of that time implementing process improvements for SM IT, including the 2004 leadership of the SEI CMM initiative. His perspective is remarkably objective in reporting the failures of people in the organization to use many improved processes. Because much of the roll-out was his responsibility, it is interesting that he isn't more defensive or rationalizing. His comments related to accountability, or lack of it, in the organization may help explain his lack of fear in having impacted the organization so little. His perspective is that management leadership, both from the CIO and particularly from the directors, has been the most lacking variable in the roll-out of new processes in the past few years.

[redacted] (#8)
4/25/05 1:00p

[redacted] was surprisingly uninformed regarding the organization's CMM program. He described most of the process improvements he could identify to independent [redacted] initiatives completely disconnected from anything that the [redacted] groups are providing. He actually didn't know what the CMM was. He did describe the organization as much more business and customer focused than in the past, and felt that his customers could see the differences that have been implemented. Even though he is isolated at his field site, how could he not recognize the major CMM effort going on across the organization?

[redacted] (#9)
4/25/05 2:00p

[redacted] felt disconnected from the organization's CMM initiatives, describing the efforts of the past year as hidden within the [redacted] and not really made public. He anticipates that there will be a surprise soon related to everyone having to quickly do something in support of what the [redacted] has been doing this year. Beyond that, he described a lot of success at becoming more process mature in his dealings with his customers and suppliers. In particular, he feels that the business is really seeing him as a resource that can deliver, and he sees himself as more effective at meeting customer needs. While he doesn't directly attribute these improvements to the CMM programs, he does describe himself as experiencing much less rework than he had in the past. A lot of his success is attributed to Six Sigma, and the shared perspective and vocabulary that the Six Sigma program provides. [redacted] mention power a great deal, and often commented about those having the power to make him do things.

[redacted] (#10)
4/25/05 4:00p

[redacted] reaction in this interview that we use the tools to get the results we want rather than using the tools to get to the real answers was very interesting. He impressed me very much when describing some of the initiatives he attempted back during the various Six Sigma and DFSS offerings at Honeywell, and with the effort he put into learning and practicing what they were teaching in those classes. He didn't remember any other learning making such direct and visible efforts to truly master the various tools being taught. Why don't more people attack training opportunities with his level of enthusiasm and opportunistic interest?

[redacted] (#11)
4/26/05 6:30a

Annick expressed a lot of concerns over communications related to process change, particularly with respect to the way a lot of process changes are made in the U.S. before being rolled over to Europe. She described confusion over her being in the [redacted] organization while mainly working on projects in the [redacted] arena. Overall, she found our organizational structure confusing, but the [redacted] she simply attributed to excessive size requiring the development of a model with multiple managers in order to handle the span of control. She was unaware of any strategic benefit of such an organization. She expressed feelings that things were out of European control because changes were communicated as already done, just informing them. She also describe her personal process for prioritizing work and the ways she's used that process to deal with the pressure of her work situation in Europe with respect to supporting SAP. She also described feeling alone when she lost her coworker in last year's RIF. Her overall summary called for better communication, within IT for structure and process, and with the businesses for priorities and direction.

B.2 - Sample Interview Transcript

Researcher: Right. So how effective do you think these models have been at actually improving your effectiveness?

Respondent: Um. They've been effective where we've seen the adoption. I still think we don't have the adoption happening all over the place. And, you know, I have some theories on that that I thin we can talk about later.

Researcher: And when that question asked about effectives, what comes to mind for you? Is it a matter of cost or productivity or do you feel you're actually building and delivering better systems?

Respondent: You know, definitely the cost is always a component, but I like to think we are delivering better systems because we're getting the requirements better. We're getting a lot data better to begin with.

Researcher: Right. Now, in what ways does the organization measure processes and quality levels?

Respondent: I think, you know, something we're doing now, a lot of it is the scorecarding process on all the projects… which has been started last year and been formalized more this year and it's tied right into our [redacted] tool. So, to me this is one of the key ways that we're tracking the key changes that we're making.

Researcher: Right. And how might the organization improve the way it rolls-out some of the process changes that are going on? <pause> You mentioned before that the way things are adopted is the key…

Respondent: I think the hardest, Rick, is the resourcing. In other words, this should not be interpreted as, 'we've improved the processes by this much so we have more resources to expend' you know, less resources required. I think that sometimes the false, you know, area that we get into with this stuff.

Researcher: Right. That sort of leads to the next question… How do you regard the expectations for what you can deliver in the organization?

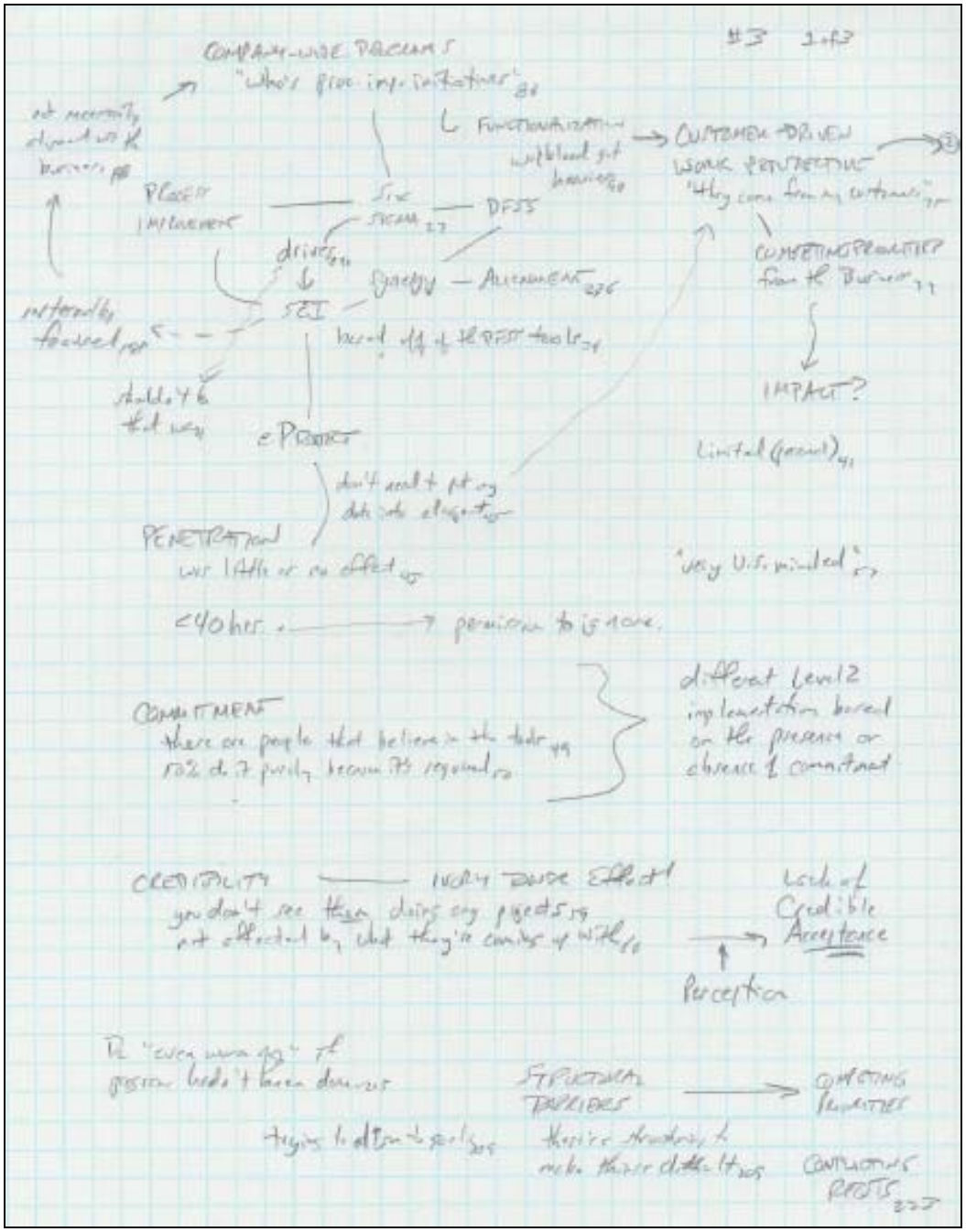
B.1 - Sample Interview Transcript (cont.)

75	Respondent:	Um. <pause> I'm just trying to think…. <pause> I mean I think there… it's
76		hard to answer. I think we do some things to accommodate how much we're
77		looking to get out of everybody in terms of flexibility and different things that
78		we can do.
79	Researcher:	Right.
80	Respondent:	So, in that sense it is good. But, you know, it still feels that we're back to a
81		resource type of constraint in my book.
82	Researcher:	I see. So how do those expectations change over time?
83	Respondent:	How have they changed, or how do they change?
84	Researcher:	Both.
85	Respondent:	Both. Um. <pause> I think we're, you know, I'm going to use the scorecarding
86		tat we're trying to do, and I think we're heading on the right path to really
87		address this resourcing. I see the beginnings of what I see as addressing that
88		area.
89	Researcher:	Okay.
90	Respondent:	I don't think we had the right tools to be able to look at it before.
91	Researcher:	How successful are your projects from the perspective of your sponsors and
92		customers?
93	Respondent:	I like to think they are successful. We don't get negative feedback. Do I thin
94		there's still room for improvement? Absolutely.
95	Researcher:	I see.
96	Respondent:	I thin we're delivering adequately a to, meet the expectations; but we could do
97		better.
98	Researcher:	To what extent do you think that better processes would impact the way you
99		feel better about your workload?
100	Respondent:	Let's see… I think they would, it would help us if these processes were, you
101		know, definitely throughout the entire chain. So, you know, in other words, it
102		wasn't at the project execution level.

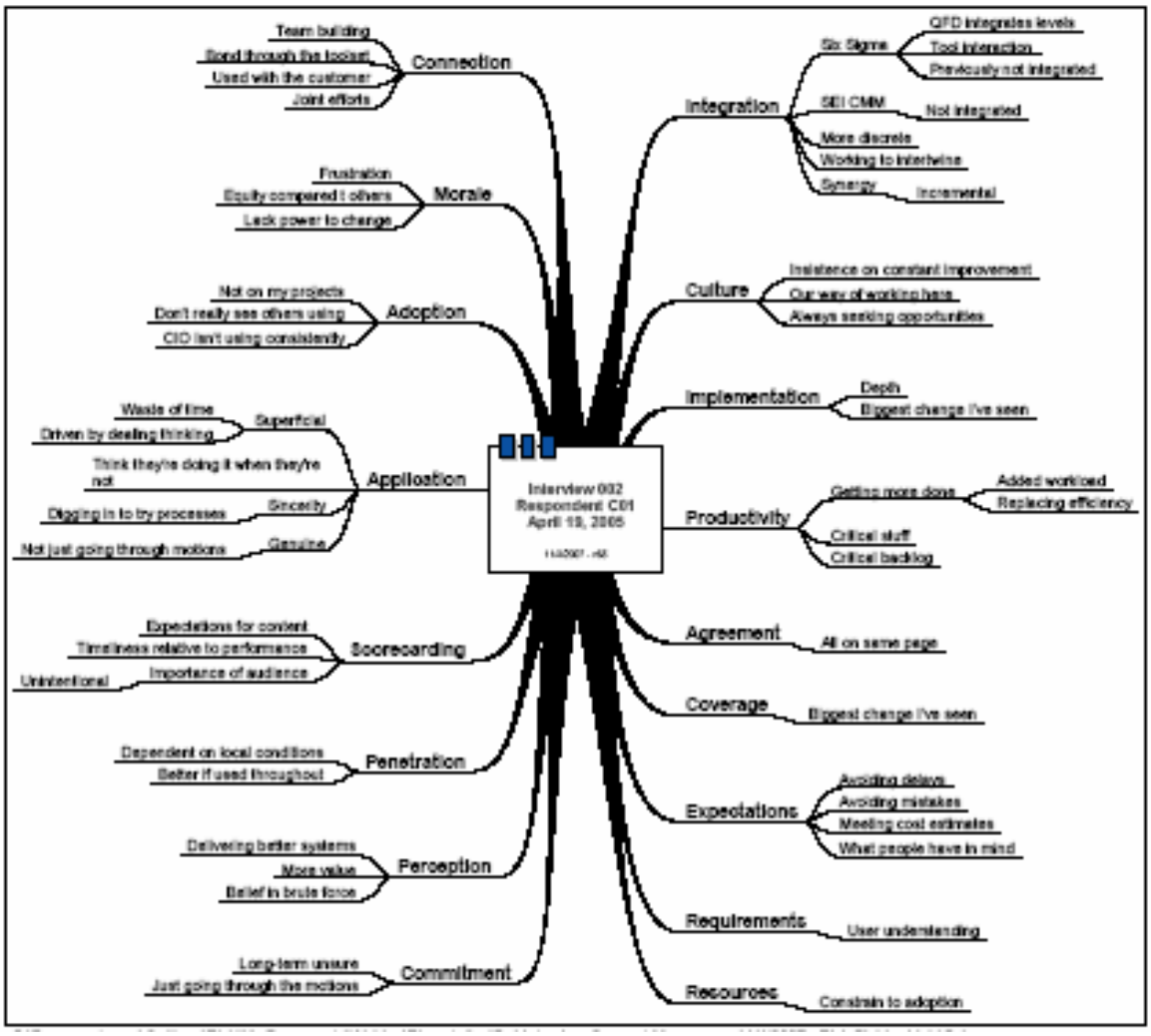
B.1 - Sample Interview Transcript (cont.)

103	Researcher:	Yep.
104	Respondent:	So, sometimes I feel we get up to a point and there's a disconnect.
105	Researcher:	Right.
106	Respondent:	Or, we're reinventing the wheel trying to get data that's already there. So, that
107		would be an improvement.
108	Researcher:	To what extent have these programs made this a better workplace to work?
109	Respondent:	I think we have a sense of pride that everybody shares in what we have achieved
110		so far. So, I think from that perspective it's generated a positive feeling.
111	Researcher:	Good. And to what extent do your customers see your organizational efforts to
112		improve your process? Are the improvements visible?
113	Respondent:	I think there are visible. But, somehow, at least in IT, we're still tied to, at least
114		when we get to the execution phase, to how we performing with our vendors.
115		So, I think sometimes that, … that negativity carries over into our space a little
116		bit as well.
117	Researcher:	I see. You mentioned pride before. To what extent do we take pride in our
118		processes today as we work on some of these projects?
119	Respondent:	I think, you know, I know most of the project manager sthat I've worked with,
120		they've definitely got pride in the fact that we're doing this because we're also
121		getting called upon by other organizations to give our advice.
122	Researcher:	Uh huh.
123	Researcher:	That corroborates that definitely there's a sense of pride there.
124	Researcher:	So there's a general feeling that they wouldn't be asking for our advice if they
125		weren't seeing value in what we were doing.
126	Respondent:	Exactly. Yep.
127	Researcher:	So to what extent would you say that the systems and solutions that we're giving
128		our customers are better today than they were in the past?

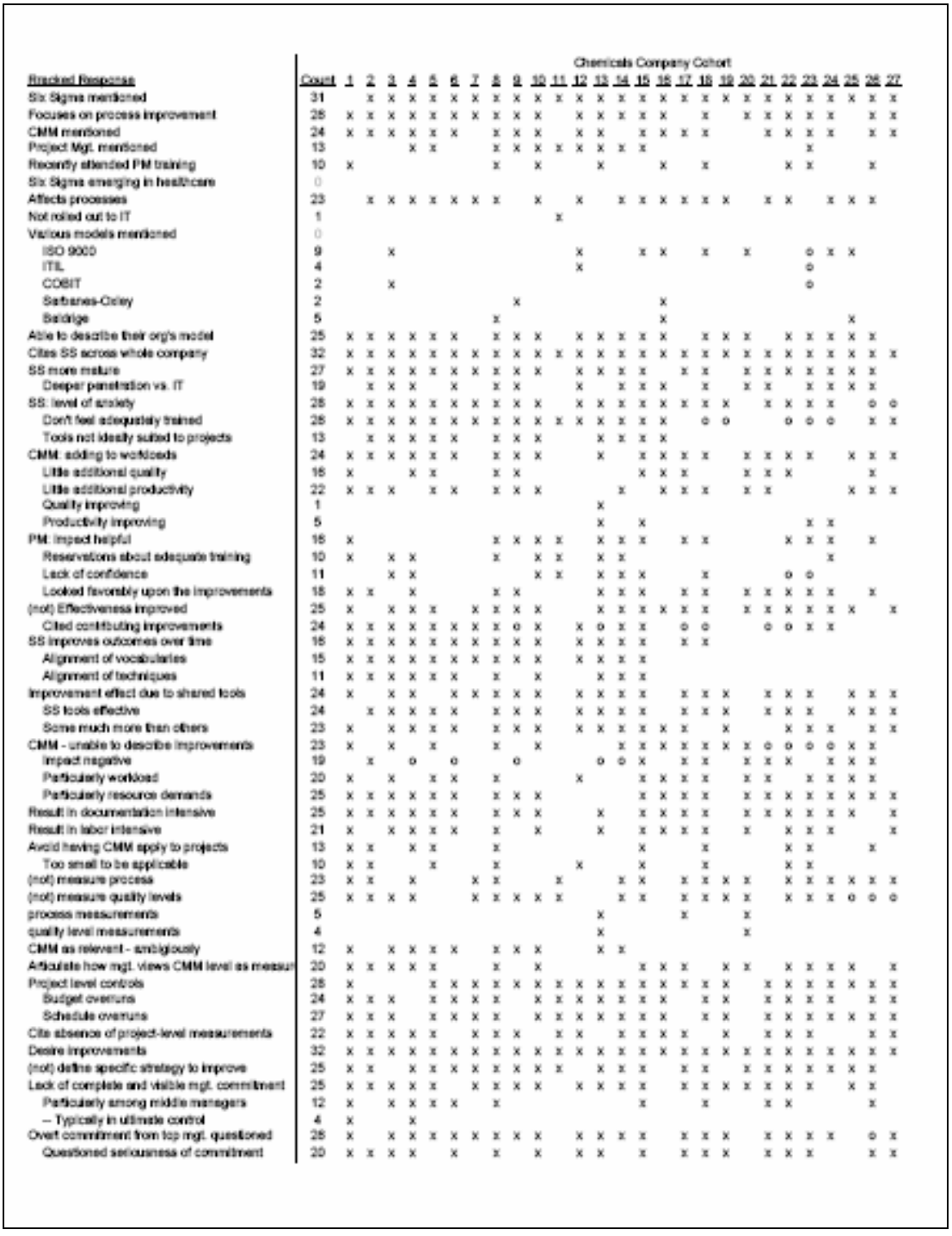
B.3 - Sample Interview Concept Map



B.4 – Sample Interview Keyword Map

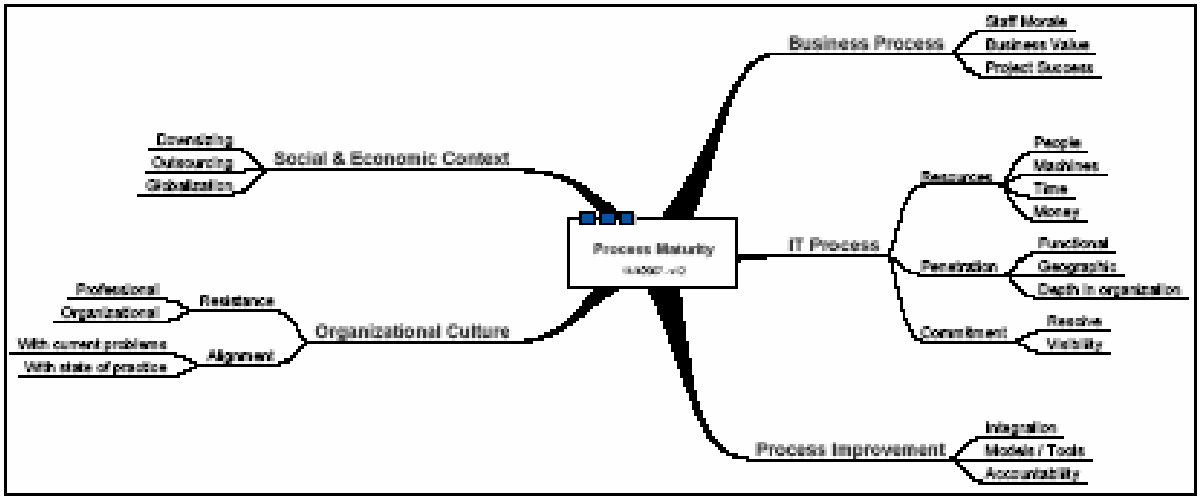


B.5 – Sample Response Tracking Matrix

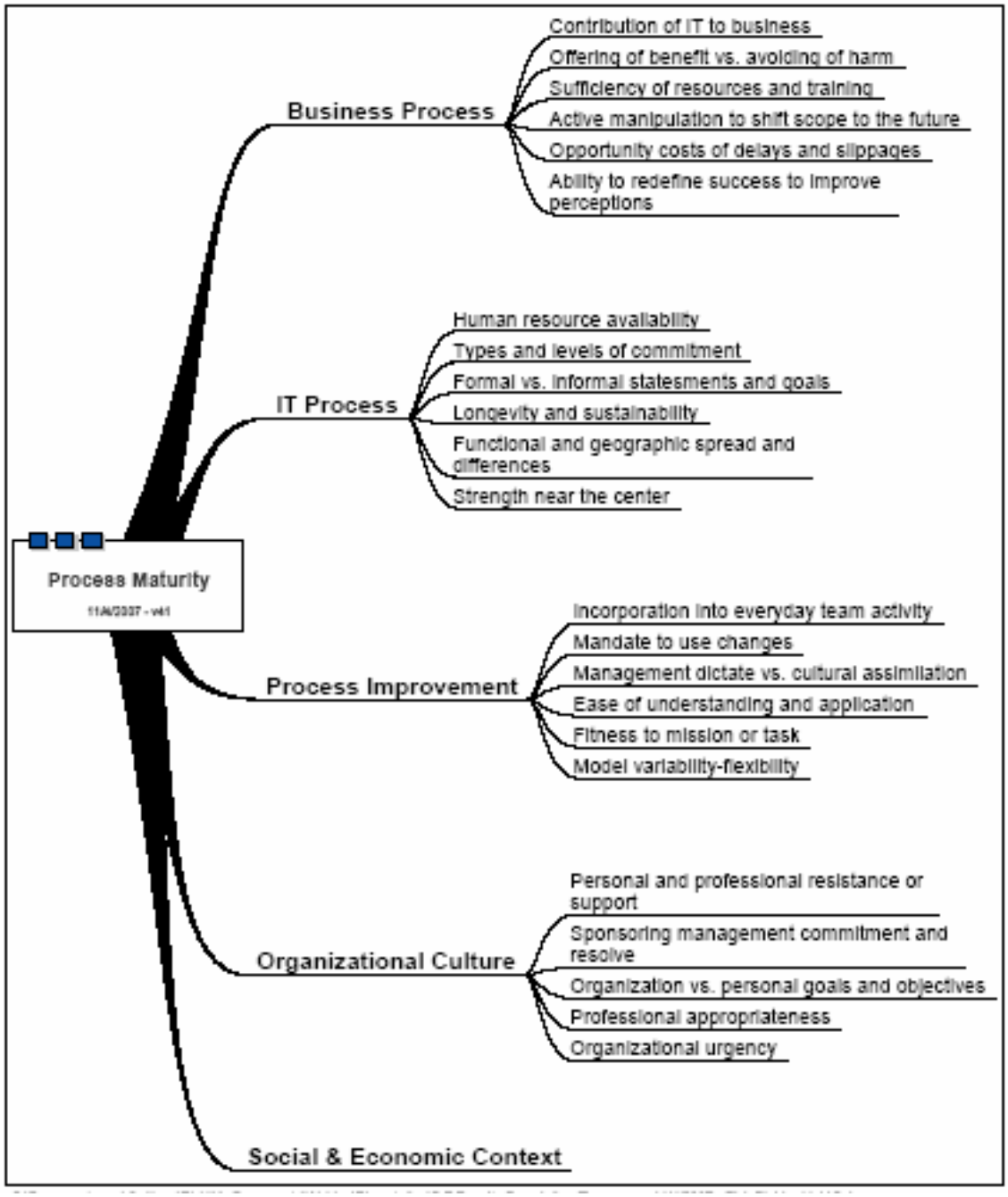


		Chemicals Company Cohort																								
Bracket Response	Count	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Six Sigma mentioned	31		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Focuses on process improvement	28	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x		x	x	x	x	x		x	x
CMM mentioned	24	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	x		x	x	x	x	x		x	x
Project Mgt. mentioned	13				x	x			x	x	x	x	x	x	x	x								x					
Recently attended PM training	10	x							x		x			x			x		x				x	x			x	
Six Sigma emerging in healthcare	0																											
Affects processes	23		x	x	x	x	x	x	x		x		x		x	x	x	x	x	x		x	x		x	x	x	
Not rolled out to IT	1											x																
Various models mentioned	0																											
ISO 9000	9			x									x			x	x		x		x			o	x	x		
ITIL	4												x											o				
COBIT	2			x																				o				
Sarbanes-Oxley	2									x							x											
Baldrige	5								x								x									x		
Able to describe their org's model	25	x	x	x	x	x	x		x	x	x		x	x	x	x	x		x	x	x		x	x	x	x	x	
Cites SS across whole company	32	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
SS more mature	27	x	x	x	x	x	x	x	x	x	x		x	x	x	x		x	x		x	x	x	x	x	x	x	
Deeper penetration vs. IT	19		x	x	x		x		x	x			x		x	x	x		x		x	x		x	x	x	x	
SS: level of anxiety	28	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x		x	x	x	x		o	o
Don't feel adequately trained	28	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		o	o			o	o	o		x	x
Tools not ideally suited to projects	13		x	x	x	x	x		x	x	x			x	x	x	x											
CMM: adding to workloads	24	x	x	x	x	x	x		x	x	x			x		x	x	x	x		x	x	x	x		x	x	x
Little additional quality	16	x			x	x			x	x						x	x	x			x	x	x				x	
Little additional productivity	22	x	x	x		x	x		x	x	x				x		x	x	x		x	x				x	x	x
Quality improving	1													x														
Productivity improving	5													x		x								x	x			
PM: impact helpful	16	x							x	x	x	x		x	x	x		x	x				x	x	x		x	
Reservations about adequate training	10	x		x	x				x		x	x		x	x										x			
Lack of confidence	11			x	x						x	x		x	x	x			x				o	o				
Looked favorably upon the improvements	18	x	x		x				x	x				x	x	x		x	x		x	x	x	x	x		x	
(not) Effectiveness improved	25	x		x	x	x		x	x	x	x			x	x	x	x	x	x		x	x	x	x	x	x		x
Cited contributing improvements	24	x	x	x	x	x	x	x	x	o	x		x	o	x	x		o	o			o	o	x	x			
SS improves outcomes over time	18	x	x	x	x	x	x	x	x	x	x		x	x	x	x		x	x									
Alignment of vocabularies	15	x	x	x	x	x	x	x	x	x	x		x	x	x	x												
Alignment of techniques	11	x	x	x	x	x	x		x		x			x	x	x												
Improvement effect due to shared tools	24	x		x	x		x	x	x	x	x		x	x	x	x		x	x	x		x	x	x		x	x	x
SS tools effective	24		x	x	x	x	x		x	x	x		x	x	x	x		x	x	x		x	x	x		x	x	x
Some much more than others	23	x		x	x	x	x		x	x	x		x	x	x	x	x	x		x			x	x	x		x	x
CMM - unable to describe improvements	23	x		x		x			x		x				x	x	x	x	x	x	x	o	o	o	o	x	x	
Impact negative	19		x		o		o			o				o	o	x		x	x		x	x	x		x	x		
Particularly workload	20	x		x		x	x		x				x			x	x	x	x		x	x		x	x	x	x	
Particularly resource demands	25	x	x	x	x	x	x		x	x	x					x	x	x	x		x	x	x	x	x	x	x	x
Result in documentation intensive	25	x	x	x	x	x	x		x	x	x			x		x	x	x	x		x	x	x	x	x	x		x
Result in labor intensive	21	x		x	x	x	x		x		x			x		x	x	x	x		x		x	x	x			x
Avoid having CMM apply to projects	13	x	x		x	x			x							x			x				x	x			x	
Too small to be applicable	10	x	x			x			x				x			x			x				x	x				
(not) measure process	23	x	x		x			x	x			x			x	x		x	x	x	x		x	x	x	x	x	x
(not) measure quality levels	25	x	x	x	x			x	x	x	x	x			x	x		x	x	x	x		x	x	x	o	o	o
process measurements	5													x				x			x							
quality level measurements	4													x							x							
CMM as relevant - ambiguously	12	x		x	x	x	x		x	x	x			x	x													
Articulate how mgt. views CMM level as measur	20	x	x	x	x	x			x		x					x	x	x		x	x		x	x	x	x		x
Project level controls	28	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x
Budget overruns	24	x	x	x		x	x	x	x		x	x	x	x	x	x	x		x			x	x	x	x		x	x
Schedule overruns	27	x	x	x		x	x	x	x		x	x	x	x	x	x	x		x	x		x	x	x	x	x	x	x
Cite absence of project-level measurements	22	x	x	x	x	x		x	x	x		x	x		x	x	x	x		x		x	x	x			x	x
Desire improvements	32	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
(not) define specific strategy to improve	25	x	x		x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	x	x	x		
Lack of complete and visible mgt. commitment	25	x	x	x	x	x		x	x	x	x		x	x	x	x		x	x	x	x	x	x	x		x	x	
Particularly among middle managers	12	x		x	x	x	x		x							x			x			x	x				x	
-- Typically in ultimate control	4	x			x																							
Overt commitment from top mgt. questioned	28	x		x	x	x	x	x	x	x	x		x	x	x	x		x	x	x		x	x	x	x		o	x
Questioned seriousness of commitment	20	x	x	x	x		x		x		x		x	x		x		x	x	x		x	x	x			x	x

B.6 – Model Affinity Groupings (Final)



B.7 – Results Description Flow (Final)



CURRICULUM VITAE

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Education

1999	M.S. in Education Walden University Minneapolis, Minnesota
1978	B.A. in Philosophy Binghamton University Binghamton, New York

Certifications

CSSBB	Certified Six Sigma Black Belt American Society for Quality
CSQE	Certified Software Quality Engineer American Society for Quality

Publications

Six Sigma for Software, *IEEE Software* (p68-70), IEEE Computer Society, March/April 2004.

Practical Guidelines for Supertype and Subtype Modeling, in *High-Performance Web Databases, Design, Development, and Deployment*. Best Practices Series 2001 (p. 319-331), Auerbach, New York, 2001.

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Journal of the Quality Assurance Institute, Quarterly, Editorial Board - Book Review Editor (1988-1994)

Recent Presentations

Data Quality Measurements in a Hospital Data Warehouse. ASQ International Conference on Software Quality (ICSQ07). Denver, CO, USA. October 16, 2007

Internal Certification Issues in Corporate Settings. National Organization for Competency Assurance (NOCA). NOCA Academy. May 31, 2007.

Getting People to Use Quality Tools. ASQ World Conference on Quality Improvement. Orlando, FL, USA. May 2, 2007.

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Six Sigma for Software. 14th Annual QAI International IT Quality Conference. Orlando, Florida, USA. March 23, 2005.

Six Sigma Project Types: Implications for Project Managers. PMI Central Florida Chapter Monthly Meeting. Orlando, Florida, USA. February 1, 2005.

Optimizing Quality Goals by Differentiating Six Sigma Project Types. ASQ Section 1509 Orlando Monthly Meeting. Orlando, Florida, USA. January 27, 2005.

CMMI: Adapting to SEI's new Integrated CMM. 10th Annual QAI International IT Quality Conference. Orlando, Florida, USA. April 25, 2001.

Quality-Based Requirements Definition. 10th Annual QAI International IT Quality Conference. Orlando, Florida, USA. April 24, 2001.

Software Quality Assurance and Planning for Teacher and Classroom. 8th International Conference of the Society for Information Technology and Teacher Education, Association for the Advancement of Computing in Education. Orlando, Florida, USA. April 4, 1997.

Professional Affiliations

American Society for Quality (ASQ), Milwaukee, WI
Strategic Planning Chairperson, Software Division, 1997-1999
Associate Editor, Software Quality Professional, 1997-2000

Health Information and Management Systems Society (HIMSS), Chicago, IL
Enterprise Integration Task Force
IHE Special Interest Group

Software Engineering Institute (SEI), Pittsburgh, PA
Invited Participant - High Maturity Practices Workshop, November 1999
Invited Participant - CMM v2.0 Requirements Workshop, February 1995
Review Committee - Software Engineering Capability Maturity Model v1.0

Quality Assurance Institute (QAI), Orlando, FL
Director of Education and Certification (1992-1995)

Project Management Institute (PMI), Newtown Square, PA
Software Special Interest Group

IEEE Computer Society, New York, NY
Software Engineering Standards Subcommittee

Computer Professionals for Social Responsibility (CPSR), Palo Alto, CA