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The Journey to IS Organizational Maturity: A Case Study of a CMM Level 3 IS Organization

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ABSTRACT

This paper describes how a 500 person information systems (IS) organization within the Bluejay Company (a pseudonym) used the Software Engineering Institute's (SEI) Capability Maturity Model (CMM) as a foundation to develop IS organizational maturity. "Maturity" within a corporate IS organization is analyzed and four factors involved in the maturation process are identified. These factors are software engineering techniques, coordination, shared language, and culture change. The result of this analysis is the IS Organizational Maturity Model (ISOMM). This case study indicates that becoming a mature IS organization is not a short-term event. IS organizational maturity requires a long term commitment to change and an ongoing willingness on the part of management to avoid rewarding fire-fighting behavior and to enforce documentation and process. This research is sponsored by The Boeing Company

1. INTRODUCTION

The efficient and effective accomplishment of the information systems (IS) function will be one of the key determinants of corporate success in the 21st century. Despite the continued emergence of new technologies, or perhaps because of it, the practice of IS as a discipline remains immature when compared to other engineering disciplines (Grady, 1997; Jones, 1997). This paper will explore how an IS organization within the Bluejay Company used the Software Engineering Institute's (SEI) Capability Maturity Model (CMM) as a foundation to develop IS organizational maturity. We then analyze what "maturity" means within a corporate IS organization and the factors involved in the maturation process. The result of this analysis is the IS Organizational Maturity Model (ISOMM).

2. IS ORGANIZATION MATURITY

Three distinguishing signs of maturity, as a child grows from infancy to adolescence, are knowledge, discipline, and behavioral norms (Kompanichenko, 1994; Hall et al, 1998). These characteristics have also been cited as ways that IS organizations can reach "maturity" (Sanders and Curran 1994; Humphrey 1995) and improve productivity. IS organizations operating in an ad hoc fashion occasionally experience successful completion of projects, but are not able to repeat these successes (Grady, 1997). Two factors of IS maturity that have been identified are process discipline and coordination between software developers and users (Sanders & Curran, 1994). In response to this need, the Software Engineering Institute at Carnegie Mellon University, developed the Capability Maturity Model to facilitate the assessment of maturity levels for software development projects and organizations (Humphrey,1995; Caputo, 1998). While the CMM addresses the process and coordination factors of IS maturity through improved software engineering techniques, it does not specifically define IS organizational maturity. According to the CMM, the term *maturity* implies a potential for growth in capability and indicates both the richness of an organization's software process and the consistency with which it is applied in projects throughout the organization (Paulk et. al 1993). Table 1 shows the five levels of CMM software process maturity.

Grady (1997) defines the goal of a mature IS organization as building stronger and more competitive organizations through continuous improvement, and the application of sound process management practices. The consequences of process immaturity are fragile processes that can fail at any time. When these failures

Table 1: The SEI/CMM Maturity Levels

1) Initial: The software process is characterized as ad hoc, and occasionally even chaotic. Few processes are defined, and success depends on individual effort.
2) Repeatable: Basic project management processes are established to track cost, schedule, and functionality. The necessary process discipline is in place to repeat earlier successes on projects with similar applications.
3) Defined: The software process for both management and engineering activities is documented, standardized, and integrated into a standard software process for the organization. All projects use an approved, tailored version of the organization's standard software process for developing and maintaining software.
4) Managed: Detailed measures of the software process and product quality are collected. Both the software process and products are quantitatively understood and controlled.
5) Optimizing: Continuous process improvement is enabled by quantitative feedback from the process and from piloting innovative ideas and technologies.

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occur, the IS organization falls back to reactive, fire fighting mechanisms, reinforcing the lack of organizational maturity (Grady 1997).

While the CMM provides a measurement framework for maturity from the software process standpoint, it does not address *how* this maturity is achieved. Attaining IS organizational maturity requires significant cultural change on the part of IS managers, analysts, and customers. This case study follows one IS organization through its journey from being a CMM Level 1 organization to being a CMM Level 3 organization. We investigate how this organization attained a higher level of IS organizational maturity, and derive a model based on these insights.

3. RESEARCH METHOD

For this paper, we use a single case study to support the development of the new theory. Case study methodology is appropriate since we are developing theory and the observations and key participants are inextricably interwoven with the context (Benbasat et al, 1987). Lee (1989) instructs researchers to follow the natural science model, while addressing the unique problems associated with case studies. Table 2 describes these problems and how they are addressed in this study.

The research team has studied the research site over three years, performing longitudinal data collection. The single sample case study also includes personal observations and semi-structured interviews (March et al, 1991).

3.1 •The Case Description

This paper describes the experience of a CMM Level 3 IS organization within a large manufacturing firm, Bluejay, Inc. The IS organization studied performs all software activities for a geographical division of Bluejay, and has approximately 500 full time IS professionals. The ratio of development to maintenance activities in this organization is about 20:80. Central data management and networking operations are not a part of the group studied. This organization was formally assessed at CMM Level 3 in the fall of 1997.

Table 2: Single Case Methodology Problems Addressed

Lee	This Study
1. Making Controlled Observations:	
Case studies use "natural controls".	We observed the same organization at CMM Level 1and at Level 3. Compari son is between organizationally induced treatment results (SEI/CMM initiative, introduction of SDMM) of the same organization.
2. Making Controlled Deductions:	
Deduced verbal predictions and logical arguments to identify the superior theory.	Our verbal prediction is that IS organizational maturity goes beyond software engineering techniques, additionally requiring culture change, shared language, and coordination.
3. Allowing for Replicability:	
Lee suggests that independent investigators can use stated theories from case studies to test a new set of observations, thereby leading to an independent set of predictions. Then, the researcher would base his/her deductions on independent verbal propositions.	Independent researchers are encouraged to replicate this study in the manner identified by Lee. The proposed ISOMM can be further studied by quantitative empirical studies.
4. Allowing for Generalizability:	
Lee identifies the theories resulting from a single case study as new and untested until they are confirmed by exposure to a variety of situations. This does not invalidate the theories; it simply renders them ungeneralizable.	Since this study is also based on a single case, our resulting theory will be subject to the same constraints.

3.2 Data Collection and Analysis

Data collection began when Bluejay was a CMM Level 1 organization four years ago. At that time, a baseline survey was taken of software engineering practices, coordination, and IS group performance. During the three years of transition from a Level 1 organization to a Level 3 organization, the researchers met regularly with managers and analysts from the organization, and with members of the Software Engineering Process Group (SEPG). In addition, the researchers attended software process innovation network (SPIN) meetings in the organization and regular SEPG managers meetings. After the group was assessed at CMM Level 3, analysts, users, IS managers, and members of the SEPG were formally interviewed. All of the individuals interviewed had participated in the assessment within their individual projects and voluntarily participated in this study.

Notes were taken during every research observation that enabled a broad picture of the organization's transition from CMM Level 1 to Level 3 to emerge. These notes were compared to the transcripts of the interviews, and items that appeared unclear or discrepant were discussed with members of the Bluejay IS organization. An analysis was made to determine themes that arose from the observations and interviews. From these themes, the initial case analysis was written. In particular, the research looked for factors of IS organizational maturity that were not captured in the CMM. In summary, the research method used could be broadly classified under an interpretive epistemology (Jarvenpaa and Leidner 1997; Orlikowski and Baroudi 1991; Walsham 1993) using a single case study.

4. THE BLUEJAY CASE STUDY

4.1 Bluejay's Plan to Become a Mature IS Organization

One of the first steps toward IS organizational maturity in the Woodson organization was to form a SEPG, and choose a SEPG manager. The SEPG then began integrating a software development and maintenance methodology (SDMM) that the organization was beginning to implement with the CMM Level 2 and Level 3 key process areas (KPAs). The SEPG realized that both of these efforts required a high initial time investment by IS project teams, and the more seamless the process, the greater the potential acceptance would be. The SEPG also had the corporate chief software engineer regularly come to the organization to educate IS personnel on both the value of software engineering practices, and the corporate benefits of a mature IS organization. These sessions were followed by additional classes and

seminars led by the SEPG. The SEPG acted as internal consultants to the project teams, assisting them with documentation and processes, and performing pre-assessment checks. The SEPG group kept a high level of awareness for the SEI/CMM initiative throughout the organization, giving a great deal of publicity and recognition to project teams who were progressing well.

The Woodson organization reached CMM Level 2 in the summer of 1996 and Level 3 in the fall of 1997. While the CMM was the measurement tool used to gauge success and organizational maturity in Woodson, there were several key elements in creating this organizational transition. The first of these elements was the software engineering practices prescribed by the CMM. The second element was strong coordination across the organization that went beyond the logistical coordination described in the CMM. The third element was a shared language, which in the Bluejay case, took the form of a SDMM. The final factor was the culture change that had to take place in the organization between Level 1 and Level 3. These elements are described in the following sections.

4.2 Software Engineering Practices

Software engineering is viewed as a means to introduce discipline through measurement and analysis of software development/maintenance processes in order to improve the predictability and productivity of future projects (Buckley 1989, Fox & Frakes 1997).

The SEI/CMM framework is the approach the Bluejay IS organization took to develop a disciplined software engineering focus. As outlined in the CMM, software development projects and organizations evolve from an initial or chaotic state (Level 1) focused on the individual successes of heroes and gurus, towards a more mature state distinguished by repeatable processes (Level 2) emphasizing the achievements of project teams. Level 3 changes the unit of focus to the organization, requiring more pervasive adoption of standards and cooperation. The Bluejay IS transition from CMM Level 1 to Level 3 took approximately three years. The assessment of this growth in software process maturity was verified and registered by the SEI. A level 3 certification indicates that the organization is following the KPAs found in Table 3.

Software engineering through the CMM provided the goals and measures necessary to improve Bluejay's software processes. The CMM also provided guidance toward two of the other factors of IS organizational maturity, coordination and the creation of a group of change agents, the Software Engineering Process Group (SEPG). However, the CMM did not provide specific directions on *how* to achieve maturity, it simply told Bluejay what the goal looked like and how it should be measured.

Table 3: CMM Level 2 and Level 3 KPAs

Level 2	Level 3
Requirements Management	Organizational Process Focus
Software Project Planning	Organizational Process Definition
Software Project Tracking and Oversight	Training
Software Subcontract Management	Integrated Software Management
Software Quality Assurance	Product Engineering
Software Configuration Management	Intergroup Coordination
	Peer Reviews

Table 4: Determinants of Coordination

Communication	Malone and Crowston, 1991; Kraut and Streeter, 1995; Gorton, 1996; DeSanctis and Jackson, 1995
Mutual Influence	Nelson and Cooprider, 1996; Lipnack and Stamps, 1997

4.3 Coordination

Intergroup Coordination is one of the Level 3 KPAs of the CMM. During our observation of the Bluejay IS organization, and in subsequent interviews, we found that the coordination required to achieve IS organizational maturity goes beyond the logistical coordination described in the CMM. One analyst emphasized communication and shared understanding,

> I would advise them to open the communication lines farther for both ends of the party to get together, even though one may be ahead of the other in understanding levels. They need to show each other what the other needs to have.

Mutual influence was also mentioned as another important element in the coordination of work.

> I think (being Level 3) trickled up and has gotten me more respect. And with that respect has come some influence. I can get things done without justifying them nearly as much.

Malone and Crowston (1991) define coordination as the act of working together and as the art of managing dependencies between activities. The need for coordination (Malone and Crowston, 1991; Lipnack and Stamp 1997) and coordination mechanisms (DeSanctis and Jackson 1994) in IS has been verified in several studies (Table 4).

Communication is key to coordination as a necessary means of transferring critical project information. Another aspect of coordination is influence (Lipnack and Stamp 1997). Two-way, mutual influence between group members is necessary for successful coordination (Nelson and Cooprider 1996).

4.4 Shared Language

Bluejay's Woodson IS organization introduced a software development and maintenance methodology (SDMM) as the roadmap for organizational process control. This SDMM provided a shared language and the documentation templates for the organization's processes. A shared language is important to organizational maturity because there must be a common understanding across the organization to insure process repeatability (Malone and Crowston 1991, Nelson and Cooprider 1996). When individuals are confident that their messages are being understood accurately, they are more likely to cooperate and to demonstrate less defensive behavior when interacting. The researchers discovered the importance of this methodology when they asked analysts about CMM Level 3 KPAs and the analysts answered in the language of the SDMM, which in this case consists of a series of numbered deliverable documents. All of the analysts interviewed were unable to separate the benefits of using the methodology from the benefits of the CMM Level 2 and 3 KPAs. Some of the analysts put it this way,

> The SDMM had a big role in reaching Levels 2 and 3, no doubt about it. It's like, we're all going to be doing SQA (software quality assurance) plans or SQA things and we're ninety projects, sixty different versions of the same thing. The SDMM gives you templates to look at relating them, which is what the SEPG group

did, and it really made SEI/CMM a whole lot easier.

One of the consistently mentioned drawbacks to IS organizational maturity was the initial time it takes to document processes. However, the SDMM provided the framework to do this, and also allowed for a high degree of process and template reuse.

4.5 Culture Change

Fundamental changes in group behavior and expectations of team members naturally lead to changes in culture (Smith, 1998; Tunstall, 1983; and Baker, 1980). In the absence of culture change, strategic initiatives will probably fail or even become counterproductive (Allaire & Firsirotu, 1985).

Markus and Benjamin (1996) found that the influence of change agents greatly impacts the degree of adoption and level of resistance an organization demonstrates toward IS change. In this case study, we identified five elements that contributed to the culture change at Bluejay. These elements were:

1. Top management support
2. Visionary
3. Cheerleader
4. Change agents
5. Individual buy-in

First, top management support was essential. For change to occur, top management must recognize the need for organizational change and set strategic goals (McGuire and Randall 1998). In the Bluejay case, top management support was provided verbally by the senior IS executive in the organization, and by the inclusion of reaching CMM level 3 into individual performance plans. One analyst said;

> In our initial year or two of getting going, we had the verbal support from Executive X. But, we still didn't have it really catching on. But then he put it into everyone's performance measurement and forced it to trickle down. That was the year that there was an incredible acceptance for it.

Second, a visionary was needed to point the organization in the right direction. This role was performed by the corporate chief software engineer. Members of the SEPG described the visionary in this way,

> He did a good job of saying here's where we're going. And the fact that he's not from this site, that he's corporate, adds a level of integrity to it. When someone else, an expert from the outside comes in and tells them (the analysts) something, they tend to believe it a little more.

From both our observations and the interviews, it became clear that this organizational transition would not have happened without a "cheerleader". A cheerleader both clarifies the benefits of change to the organization and acts as an advocate for the change initiative by championing a specific course of action (Markus & Benjamin, 1996). In the Bluejay IS organization, the cheerleading came from the individual who was SEPG manager for the first two years of the transition.

> The SEPG manger was obviously one of the big catalysts in getting things going. He wasn't the manager that started things out here, but I think he helped generate a lot of the enthusiasm out there.

Markus & Benjamin (1996) identified the need for a change agent group that facilitates change by giving direction and being expert resources to clients. In the Bluejay organization, the active, and official, facilitation group was the SEPG. The SEPG was responsible for modifying, training, coaching, and facilitating the change implementation plan. The SEPG group was able to interpret and create a plan of action for the projects to follow and to develop organizational consistency. One analyst summarized the SEPG role as follows:

> They showed us the road map of what we needed to go do. They produce the plans, the training, the whatever it is you need that will lead you down the path, and it's just basically a matter of you following through.

The final component of culture change was individual analyst buy-in. Without this, we believe the Bluejay IS organization would not have matured. While there were, initially, large pockets of resistance, the majority of the analysts now prefer working in a more mature organization.

The change in the Bluejay IS organization was also seen by its customers.

> We don't have near the problems we used to have. The systems run more smoothly. Any extra support we need is there quicker. Our problems are solved much faster. We were waiting months before. Now we're waiting just minutes and they come back with answers for us. The coordination is much better.

5. A MODEL OF IS ORGANIZATIONAL MATURITY

This study identified four primary factors of organizational maturity: software engineering, coordination, shared language, and culture change. It was the interaction of these factors that allowed the Bluejay Woodson IS organization to achieve CMM Level 3 and improve performance. The SEI/CMM framework prescribed the software engineering activities that needed to consistently occur across the organization to improve process repeatability. Institutionalizing these practices required a high level of coordination. This coordination was not just logistical, but involved increased levels of communication and mutual influence among analysts, managers, and users. The use of a SDMM aided coordination by providing a common language and set of documentation that captured and disseminated processes. The move to software engineering practices, higher levels of coordination, and a shared language would not have happened without the actions of organizational change agents. The contribution of this case study is to demonstrate how all four of these factors contribute to a model of IS organizational maturity (ISOMM) (Figure 1).

The ISOMM proposes a four factor model of IS organizational maturity based on the Bluejay experience. This model can now be tested, both qualitatively and quantitatively, for generalizability to other organizations.

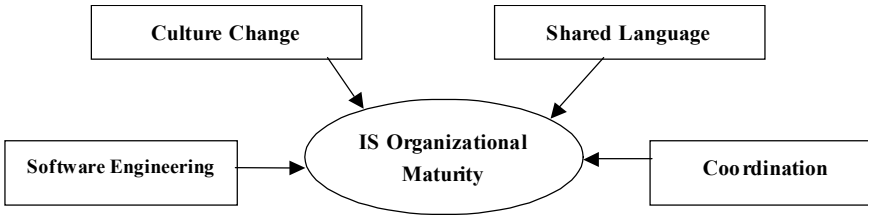

Figure 1
IS Organizational Maturity Model

6. DISCUSSION

The goal of Bluejay's SEI/CMM initiative was improved IS performance through organizational maturity. This study shows that while the CMM's prescribed software engineering practices are one factor in reaching maturity, they are not in themselves sufficient for success. It was a combination of software engineering practices, coordination, shared language, and culture change over a three year period that led to Bluejay's IS organizational transition. It is critical that IS decision makers understand that the CMM is a measurement framework, not a silver bullet that will fix all of their organizational problems (Brooks 1987). The results of this study strongly indicate that it would be extremely difficult for any organization to reach CMM Level 3 without a SDMM in place. IS organizations desiring maturity also have to commit to an investment in change agents. The Bluejay IS organization has demonstrated cost, quality, and customer satisfaction improvements by reaching CMM Level 3. However, these results were attained after a three year investment in people, process, and methodology. Becoming a mature IS organization is not a short-term event measured in quarterly results. It requires long term commitment and a willingness on the part of management to avoid rewarding firefighting behavior and to enforce documentation and process, even if this takes longer in the short-term. Without this commitment, IS organizations within corporations will continue to have difficulty introducing emerging technologies, and will continue to rely heavily on outside consulting services. Unless corporate IS organizations become totally outsourced, this trend will result in organizations left maintaining "new" legacy systems with no better processes than they used maintaining the old legacy systems. New technologies will emerge in the 21st century, but IS organizational immaturity will continue to prevent their full and productive utilization. The IS discipline needs to face the 21st century as a mature engineering discipline, contributing to stronger and more competitive organizations through continuous improvement and consistent process management.

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