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AN EXAMINATION OF THE ADOPTION OF COMPUTER-AIDED SOFTWARE ENGINEERING TECHNOLOGY AND PROGRAMMER PERSONAL FACTORS

by

Dennis Phillips

A dissertation submitted in partial fulfillment
of the requirements for the degree

of

DOCTOR OF PHILOSOPHY

in

Education/Business Information Systems & Education

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ABSTRACT

An Examination of the Adoption of Computer-Aided Software Engineering Technology and Programmer Personal Factors

by

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Computer-aided software engineering (CASE) tools have been advanced as a possible means to enhance the productivity and performance of the software development process. The use of CASE tools in business has had spotty success. Information systems departments have sought to use technological means to improve the success; however, this spotty success may be related to the personal factors associated with the programmer/analysts, the main users of the tools, rather than the technological means of implementation.

This study was conducted among consultants for a major western consulting firm. Data were collected using a questionnaire based on the writing of Tannenbaum and Schmidt. The instrument comprised the following components: Respondent's Profile, CASE Usage, and Personal

Factors. The personal factors used for this study were Need for Direction, Identity with the Problems and Objectives of the Organizations, and Information Systems (IS) Experience.

Multiple regression analysis was used to determine if a relationship existed between the personal factors and CASE usage. Major findings of the study were:

1. There was no relationship between the programmer/analysts' identity with the problems and objectives of the organization and CASE usage.

2. There was a relationship between CASE usage and the programmer/analysts' need for direction on the job. Those programmer/analysts with a desire to share in decision making were more likely to have used CASE.

3. There was a relationship between IS experience and CASE usage. Those programmer/analysts with higher education levels and more years of IS work were more likely to have used CASE.

(109 pages)

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Dennis Phillips

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CHAPTER I

INTRODUCTION

> To date, there has been no systematic examination or formulation of the organizational changes surrounding the adoption of computer-aided software engineering (CASE) tools. The literature on CASE tools has focused on such things as productivity, system quality, and development costs while neglecting the intentions and actions of key players, the process by which CASE tools are adopted and used, and the organizational context within which such events occur. (Orlikowski, 1993, p. 309)

The issues of intention, action, process, and context around the implementation of information technology are not new to information systems (IS) research (Orlikowski, 1993). Ginzberg (1981) and Rogers (1983) looked at the process of technology introduction. The social context in shaping and introducing technology was examined by Markus (1983) and George and King (1991). The changing structure of the organization as a result of technology introduction was studied by Orlikowski and Robey (1991), Kwok and Arnett (1993), and again by Orlikowski (1993). Yet contemporary discussions around CASE tools in research, education, and practice tend to gloss over the issue of organizational changes surrounding the adoption of CASE tools (Orlikowski, 1993).

The introduction of CASE tools in an information system (IS) organization promises many potential benefits and pitfalls. The benefits claimed by CASE tool proponents include: (a) increased productivity, (b) greater control

over the software development process, (c) greater flexibility, and (d) the simplification and reduction in software maintenance (Martin, 1995; Vandercook, 1989a). Among the potential pitfalls of implementing CASE in an organization is that CASE tools introduce significant change (Kwok & Arnett, 1993). According to Kwok and Arnett (1993), CASE will impose a radical change to organizations involved in the system development life cycle.

While significant research has been done to study the benefits of CASE and other technology in an organization, more research is needed to assist in understanding the organizational structures that are supportive of CASE usage for systems development (Rai & Howard, 1994). Researchers such as Walsham (1993) and Rai and Howard (1994) have suggested that organizational implementation of information technology involves substantial social change and cannot be achieved solely by successful technical implementation. Specifically, Rai and Howard have suggested that in a technological implementation such as CASE, the conditions for successful implementation should be identified at the individual (programmer/analyst), development team, and information systems department level. Such research should lead to the design of appropriate intervention strategies at each level to facilitate CASE innovation, given an implementation strategy. They suggested that the cumulative research stream should lead to an enhanced

understanding of implementation issues associated with innovations in systems development (Rai & Howard, 1993).

Statement of Problem

Improving the software development process and developing an architecture for information are among the top ten concerns facing senior IS managers (Niederman, Brancheau, & Weatherbe, 1991). CASE technology has been advanced as a possible means to enhance the productivity and performance of the software development process (Rai & Howard, 1994).

Most research on CASE adoption reports a positive rather than negative impact on quality of developed systems, and to a lesser extent on the productivity of the development process (Iivari, 1996). However, Iivari reported that the actual use of CASE technology has been much less than one would expect. Despite the increased attention to CASE tools, research has shown that less than a quarter of all companies have adopted them (Steinberg & Baram, 1992). In addition, Margolis (1989) reported that among those companies adopting CASE, the success has been spotty.

While information systems departments have continuously attempted to improve the implementation of CASE tools through technological means (Aeh, 1989; Burkhard, 1989; Steinberg & Baram, 1992), the spotty

success may be related to the personal factors associated with the main user of the tools, the programmer/analyst.

Purpose of Research

CASE tools have been available in the market place for many years. Some companies have made a significant investment in CASE technology only to find that the tools end up unused (Loh & Nelson, 1989). Despite the promises made by proponents of CASE, such tools continue to make slow headway and have not yet realized the promised potential within IS organizations (Burkhard, 1989). More research is needed into the organizational and managerial strategies that will provide support for technological implementations of CASE tools. More specifically, research is needed to identify the conditions for successful implementation of CASE innovation at the programmer/analyst level, which will lead to design of appropriate strategies to facilitate successful CASE implementation and use (Rai & Howard, 1994).

It would seem that a model of key personal factors that explain variations in the programmer/analysts' usage of CASE tools would provide much help and information to the IS professional. The purpose of this study was to investigate specific factors, at the individual programmer/analyst level, that influence the usage of CASE tools. Specifically, this research sought to determine if

there was a relationship between CASE usage and three factors affecting the programmer/analyst. The factors were the level of job-related direction needed by the programmer/analyst, the programmer/analyst identity with the problems and objectives of the organization, and the level of IS experience of the programmer/analyst.

Theoretical Base

The infusion of CASE technology into an organization most certainly requires changes in the way information systems are developed. It also requires that management evaluate management techniques and practices to support CASE (Kwok & Arnett, 1993; Orlikowski, 1993). Orlikowski found that reorientations in systems development due to CASE require that the IS managers institute significant structural, procedural, and cultural changes in the IS unit and throughout the entire organization (1993). Kwon and Zmud, in Rai and Howard (1994), suggested that researchers should investigate multiple factors and consider the differential impact of these factors on different stages of the innovation process.

Rai and Howard (1994) studied characteristics in organizations that successfully implemented CASE technology. They concluded that three organizational factors explain most of the variation in organizational usage of CASE. The factors are (a) organizational

structure and processes, (b) characteristics of the user, or the experience of the programmer/analyst with the CASE methodology, and (c) task characteristics or the job/role of the programmer/analyst. While Rai and Howard focused on the characteristics of the organization in general, there is a similarity between the organizational factors studied by Rai and Howard and the set of personal factors recommended by Tannenbaum and Schmidt (1981). According to the continuum of leadership behavior as put forth by Tannenbaum and Schmidt, managers should select a managerial style consistent with the factors affecting their subordinates. The factors affecting the subordinates can be broken down into three groups: (a) the amount of direction needed by the subordinate, (b) the identification the subordinate feels with the organization and the problems of the organization, and finally (c) the subordinate's experience. Tannenbaum and Schmidt recommended that these factors affecting the subordinate be considered by management in deciding which leadership style to use.

As with the implementation of any new technology or practice, when CASE is implemented within an organization, the factors affecting the programmer/analyst must be considered in order to select the appropriate management style, and to create the appropriate environment in which to facilitate CASE innovation. While Tannenbaum and

Schmidt do not specifically write to technological innovation, they do provide a theoretical framework for management to consider when selecting an appropriate strategy to support the introduction of CASE technology.

Research Model and Hypotheses

The purpose of this research was to determine if a relationship existed between the level of CASE usage and the personal factors of the programmer/analyst. The factors studied were a synthesis of factors recommended by Tannenbaum and Schmidt in the leadership continuum, those used by Rai and Howard to determine factors relating to the propagation of CASE, and those identified in Orlikowski's (1993) study on CASE and organizational change. The three factors are now presented with a theoretical foundation.

Identification with the Organization's Objectives

Tannenbaum and Schmidt wrote that subordinates who understand and identify with the organization's goals should be allowed more freedom from management. One of the major goals facing an organization's IS department is the need to maintain legacy systems with a smaller resource pool (Stamps, 1987). CASE is recognized as a possible solution offering greater productivity and performance for the software development process (Rai & Howard, 1994). Orlikowski (1993) found that among programmers/analysts

there were varied reactions to the introduction of CASE tools. Some welcomed the new technology as a means to bring order to a chaotic situation while enhancing skills and expanding job opportunity. Conversely, some were threatened by the introduction of CASE tools. These developers saw CASE as complicating the development process and depreciating their skills and career opportunities. Those who identified with the IS department's problems and the objective of increasing productivity and quality through use of CASE tools should have had higher levels of CASE usage. Therefore the following null hypothesis was tested:

H1: There was no relationship between the programmer/analysts' identity with the problems and objectives of the IS department as measured by self-report and the level of CASE usage for information systems development.

Personal Need for Direction on the Job

Tannenbaum and Schmidt (1981) wrote of several factors that would indicate a subordinate's need for direction on the job. The subordinate's need for independence, the subordinate's willingness to assume responsibility, and the subordinate's expectation of sharing in the decision-making process are all factors in determining the level of need for direction on the job. Cooprider and Henderson (1990)

found that successful implementation of CASE requires programmer/analysts involved in the implementation to possess strong business, analytical, and interpersonal skills. Rai and Howard (1994) speculated that the technical programmer lacking strong business and analytical skills might think that his/her importance would be diminished due to increased emphasis on logical aspects and automated generation of program code. The fact that CASE tools put more emphasis on analysis and design over just programming from specifications may mean that programmer/analysts with a greater sense of independence and willingness to assume responsibility for and share in the decision-making process are more likely to use CASE tools. Therefore, the following null hypothesis was tested:

> H2: There was no relationship between the programmer/analysts' personal need for direction on the job as measured by self-report and the level of CASE usage.

IS Experience

Finally, Tannenbaum and Schmidt (1981) wrote that the subordinate with the necessary knowledge and experience to deal with a problem should be allowed a greater level of freedom from management. Kimberly and Evanisko (1981), Meyer and Goes (1988), and Utterback (1971) found that the successful implementation of a technology will be substantially influenced by the technical experience within

the organization. Rai and Howard (1994) found a positive relationship between methodology expertise and organizational usage of CASE. The more experienced programmer/analyst is more likely to use CASE tools. Therefore the following null hypothesis was tested:

H3: There was no relationship between the programmer/analysts' IS experience as measured by self-report and the level of CASE usage.

Importance of the Study

As with any tool, the implementation of CASE is based on the hope for improved productivity and quality (Vandercook, 1989a). With the growth of the use of CASE tools in industry, management not only needs to be aware of the potential benefits but must also be aware of common problems in implementing CASE tools (Loh & Nelson, 1989).

Many researchers and writers have focused on studies and instances where CASE tools have increased productivity in the IS department (Azarnoff, 1988; Byrne, 1989; Granger, 1990; Loh & Nelson, 1989; McClure, 1989; Norman & Nunamaker, 1989). Other studies have found that the expected productivity gains are elusive (Card, McGarry, & Page, 1987) or eclipsed by lack of adequate training and experience, developer resistance, and increased design and testing time (Norman & Nunamaker, 1989; Orlikowski, 1988, 1989; Vessey, Jarvenpaaa, & Tractinsky, 1992). As with any

introduction of change, when technology is introduced into an organization, management practice must be reevaluated and modified to support the change.

This research was intended to add to the knowledge base that management might use in determining an appropriate strategy to assist in managing and implementing CASE technology. Managers need to understand the factors that differ between programmers using CASE tools and those not using such tools. The better the manager understands these personal factors, the more accurately the manager can determine what kind of behavior on his/her part will enable the programmer/analyst to act most effectively (Tannenbaum & Schmidt, 1981).

Definition of Terms

The following terms are defined as they are used in this study.

1. Computer-aided software engineering (CASE) Tools: CASE tools identify the general group of software programs that are used in any and all phases of developing an information system, including analysis, design, and programming. For example, data dictionaries and diagramming tools aid in the analysis and design phases, while application generators speed up the programming phase (Computer Desktop Encyclopedia, 1981-1997).

2. CASE Methods: CASE methods are the structured methods associated with the use of CASE tools.

3. Information Systems (IS): Information systems are the collection of computer hardware, programs, data, procedures, and trained personnel that interact to satisfy a business need (Kroenke & Dolan, 1988, p. 628).

4. Information Systems Department (ISD): An information systems department is the department within an organization with the responsibility to deliver information systems to the rest of the organization (Kroenke & Dolan, 1988, p. 628).

5. Legacy Systems: Legacy systems are information systems developed using older technology. Such systems are generally developed using procedural languages such as COBOL and FORTRAN and have been in use for many years (SYNON, 1995).

6. Personal Factors: Personal factors are the personal characteristics and attitudes of a person. For the purposes of this study, the personal factors are the individuals identification with the IS department's problems and objectives, the need for direction on the job, and IS experience (Rai & Howard, 1994; Tannenbaum & Schmidt, 1981).

7. Programmer/Analyst (PA): A programmer/analyst is the first-line employee within an information systems department. The PA develops the information systems by

specifying what information should be processed and how the information should be processed (Eliason, 1990, p. 7).

8. Systems Development Life Cycle: The systems development life cycle is the four-stage process of building a business computer system (Kroenke & Dolan, 1988, p. 635). The stages are requirements definition, alternative evaluation, system design, and system implementation.

CHAPTER II

SELECTED REVIEW OF RELATED LITERATURE

This chapter was designed to look at three specific areas of research. First, a theoretical basis is presented with regard to the factors affecting the subordinate. Second, an introduction of computer-aided software engineering (CASE) technology and practitioner literature is presented. Finally, research involving the use of CASE tools will be explored.

Factors Affecting the Subordinate

> It has long been acknowledged that what first-line supervisors can do to shape work-group performance and organizational effectiveness is circumscribed by factors outside their own control. (Hammer & Turk, 1987, p. 674)

The modern manager often finds him-/herself in an uncomfortable state of mind. The problem of how to be democratic in his or her relations with subordinates and at the same time maintain the necessary authority and control in an organization for which he/she is responsible has increasingly come into focus (Tannenbaum & Schmidt, 1981, p. 266). Leadership research has shown that no one style of leadership is equally effective in all situations (Gebert & Steinkamp, 1991). Rather, in selecting a leadership style, a manager must take into account a multitude of personal factors (Bass, 1981).

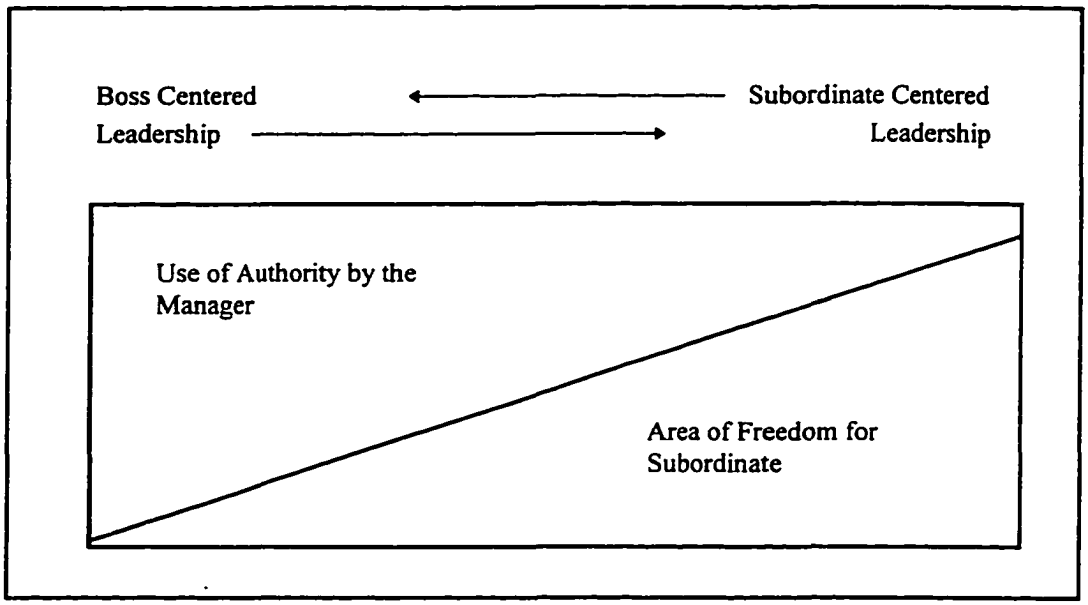

Figure 1. Continuum of leadership behavior (Tannenbaum & Schmidt, 1981).

Tannenbaum and Schmidt (1981) put forth a theory called the continuum of leadership behavior. Figure 1 graphically presents the continuum of possible leadership behavior available to a manager. As the continuum demonstrates, a number of alternative ways exist in which managers can relate to the group or individuals that they supervise.

On the far left of the continuum, the authoritative manager, with little or no help from subordinates, identifies the problem, identifies alternatives, makes a decision, and announces it. Such a manager may "sell" his or her decisions. Or, rather than simply announcing the solution, the manager may attempt to persuade the subordinates to accept his or her decisions.

Towards the middle of the continuum, managers present ideas and invite questions, or present a tentative decision subject to change. Such a manager may even make decisions after getting suggestions. Finally the subordinate can begin to exert some influence over the decisions made. The final decision is still left to the manager.

To the extreme right, the manager defines limits, and asks the group to make decisions. This manager may even permit subordinates to make decisions within limits defined by another superior. The right to make decisions is passed to the group. The subordinates can then make the decision within the bounds set by the manager. This is the extreme degree of group freedom, wherein the subordinates working within company bounds identify the problem, develop alternatives, and decide on the solution.

Tannenbaum and Schmidt went on to state that a manager might consider three forces in deciding how to manage. These are forces in the situation, forces in the manager, and forces in the subordinate. Many studies have been done to examine the forces that impact the selection of a leadership style. Examples are trade union presence (Homans, 1965); the nature of work carried out by subordinates (House & Mitchell, 1974); characteristics of the work force (Filley, House, & Kerr, 1976); government regulations of personnel policies (Hammer, 1979); demands from superiors, subordinates, and peers (Fleishman, Harris,

& Burtt, 1955; Lowin and Craig, 1968; Pfeffer & Salanick, 1975; Rosen, 1969); cultural considerations (Gebert & Steinkamp, 1991); and organization determinants (Hammer & Turk, 1987).

Many studies have also been done to examine the effects of subordinates' and superiors' expectations on supervisors' behavior (Hammer & Turk, 1987). But little empirical information exists on the external determinants of the subordinates' attitudes and expectations.

> Before deciding how to lead a certain group the manager will ... want to remember that each employee, like himself, is influenced by many personality variables. In addition, each subordinate has a set of expectations about how the boss should act in relation to him (the phrase "expected behavior" is one we hear more and more often these days at discussions of leadership and teaching). The better the manager understands these factors, the more accurately he can determine what kind of behavior on his part will enable his subordinate to act most effectively. (Tannenbaum & Schmidt, 1981, p. 272)

Tannenbaum and Schmidt explained that the manager can permit his or her subordinate greater freedom if certain essential conditions exist. The conditions can be divided into three main groups:

1. Need for direction:
    a. If subordinates have relatively high needs for independence, then more freedom can be permitted. As we all know, people differ greatly in the amount of direction that they desire.

b. If subordinates have a readiness to assume responsibility for decision making, then more freedom can be permitted. Some see additional responsibility as a tribute to their ability; others see it as "passing the buck."

c. If subordinates have a relatively high tolerance for ambiguity, then more freedom can be permitted. Some employees prefer to have clear-cut directives given to them; others prefer a wider area of freedom.

d. If subordinates have learned to expect to share in decision making, then more freedom can be permitted. Persons who have come to expect strong leadership and are then suddenly confronted with the request to share more fully in decision making are often upset by this new experience. On the other hand, persons who have enjoyed a considerable amount of freedom resent the boss who begins to make all the decisions himself.

2. Identity with problems and objectives of the organization:
   a. If subordinates are interested in the problem and feel it is important, then more freedom can be permitted.
   b. If subordinates identify with the goals of the organization, then more freedom can be permitted.
3. Knowledge and Experience:
   If subordinates have the necessary knowledge and experience to deal with the problem, then more freedom can be permitted.

The manager will probably tend to make fuller use of his or her own authority if the above conditions do not exist; at times there may be no realistic alternative to running a "one-man show" (Tannenbaum & Schmidt, 1981). Thus, it would seem that these three factors in the subordinate should be the basis for a manager in selecting an appropriate managerial style.

CASE Technology

Information systems (IS), once considered an expensive luxury of large, innovative, and profitable businesses, have become an essential competitive requirement for almost every business today (Vandercook, 1989b). The creation and management of effective information systems have always

been a great challenge for IS professionals. CASE tools are believed by many companies to be the key to increasing productivity, controlling quality, and introducing predictability into the software development process (McClure, 1989).

The three biggest complaints by information users continue to be the lack of timely, cost-effective, and accurate systems to meet information needs. For example, in a report published in September of 1987, the Defense Science Board said "the chief 'military software problem' is that we cannot get enough of it, soon enough, reliable enough, and cheap enough to meet the demands of weapons-systems designers and users" (Port, 1988, p. 142).

Ironically, computer programmers have, for many years, worked to produce computer systems that assist workers in many fields to become more productive without doing the same for their own profession. Computer-aided design (CAD), computer-aided manufacturing (CAM), automated accounting systems, and computer decision support systems are but a few examples of the productivity tools developed by the software industry. Noted systems expert James Martin points out that despite the great automation of others' jobs, only recently have members of the computer industry sought to automate their own jobs (Benyon & Skidmore, 1987, p. 137).

Since 1984 software engineers have started to automate their own jobs (Franch, 1989). Computing professionals have developed CASE technologies as a means of producing timely, reliable, accurate, and cost-effective information systems. Software vendors have touted CASE as the source of productivity improvements in IS departments (McClure, 1989). The demand for CASE tools by IS professionals has created a market that was valued at $273 million in 1989 and was predicted to swell to $1.5 billion by 1994 ("CASE Poised for Growth," 1990).

Case Tools

CASE tools represent a comprehensive means to model businesses, their activities, and information systems (Gibson, 1989). McClure defined CASE products as a software tool that gives automated assistance in creating, maintaining or managing software systems (1989).

According to Gibson (1989), CASE tools can be classified in three areas: upper CASE, middle CASE, and lower CASE. Upper CASE tools are those tools that assist in corporate planning. These tools are often referred to as computer-aided planning. Upper CASE tools would allow management to graphically describe the goals, objectives, responsibilities, resources, and problems of the company and its various functional areas. Such descriptions can then be used to create strategic plans.

Middle CASE tools are used in the analysis of problems and the design of solutions. Through the use of diagrams and dictionaries, analysts would use the middle CASE tools to automate the analysis of systems and then store the information in a format that is reusable. The results of such a process are system specifications, which provide a common base of knowledge that is invaluable (Gibson, 1989).

Lower CASE tools are used to generate the programs and user documentation of information systems often from the output of the middle CASE. While upper and middle CASE tools are related to broad functional areas, the lower case tools are tied very closely to the programs within a developed system. The lower CASE tools will most likely include a database of attributes, procedural logic, and a generator capable of combining the logic and database attributes to produce application programs.

While all three levels of CASE tools are generally available in the market place, very few products incorporate all levels of CASE into one tool (Ferko-Weiss, 1990). There is not yet a total CASE environment that is readily available in the software market (Azarnoff, 1988).

Benefits of CASE

Some proponents of CASE tools claim to include all factors identified as critical to the success of development of information systems (Franch, 1989). As Franch stated in 1989, "These factors include the ability

to react quickly to changing business conditions, to increase effective organizational communications, improve quality, boost application development productivity, and decrease maintenance burdens" (p. 49).

Franch further stated that while CASE offers productivity benefits, justifying CASE solely on productivity gains is shortsighted. Productivity gains are inevitable, but productivity metrics in software engineering are difficult to determine and defend.

Studies Involving CASE Tools

Some studies exist that show IS productivity gains from using CASE tools (Granger, 1990; Loh & Nelson, 1989). However, most of the empirical studies on CASE impacts were based on subjective, perceptual data (Iivari, 1996). No research was found to document organizational impacts associated with the adoption of CASE tools.

Most of the literature on CASE technology was not experimental and was generally not subjected to strict statistical analyses. In fact, it was difficult to find much written about CASE except for exposition or instruction (Norman & Nunamaker, 1989). There are, however, ten studies noted in this review of literature.

Loh and Nelson Study

A study conducted by Loh and Nelson of the University of Houston (1989) surveyed 40 analysts and programmers at

12 companies that had implemented CASE technology. The published report on the survey left out important information on how the participants were selected or about the survey instrument.

The major finding of the study was that the IS staff will realize productivity gains from the implementation of CASE technology depending on the suitability of the project and the programmers' acceptance of CASE. Loh and Nelson reported that among the major reasons for the failure of CASE tools were the involvement, attitudes, and acceptance of the programming staff in the implementation process. These findings seem to come from the opinion of the IS staff members surveyed and were not compared with any other group of systems developers. The findings were probably biased because the respondents reporting productivity gains were the same people who justified implementation of CASE technology.

Another major finding of the study was that the use of CASE tended to result in a shift in programming time to front-end development, such as planning and design. The study also found that time spent on writing and maintaining software decreased. Although CASE may explain the decreased programming time, experts in the field have for many years been exhorting programmers to spend more time on design and thereby cut down on time spent on writing code and maintaining software (McClure, 1988). The shift of

development time from programming to design and planning might require a shift in the management style.

Norman and Nunamaker Study

A study published in 1989 focused on the perceptions of IS professionals performing systems analysis using CASE tools. Multidimensional scaling was used to measure the mental traits, abilities, and processes of software engineering. The study examined 91 subjects from various industries and companies. All subjects were using a similar CASE tool, Excelerator. The survey asked the subjects to do paired comparisons of 17 factors by answering questions on a computer program. The result was a cluster analysis of functions based on perceived productivity ratings.

Norman and Nunamaker concluded that the software engineers perceived an increase in productivity due to the use of CASE tools. The study also identified the functional parts of the CASE tools that were perceived to provide the most productivity gains. While no control group was compared to the software engineers in the study, it was a step towards rigorous validation of the effects of CASE technology on software engineering. The authors made no claim as to the degree of productivity improvement or the economic benefit of using CASE tools, nor did they

address the organizational implications of CASE tool implementation.

Granger Study

In 1990, Granger performed an experimental study to examine the productivity gains associated with the use of CASE tools in development. An experimental study with a control group and a treatment group was utilized. The participants were students in two software engineering classes. All of the students were given the assignment to develop an identical computer system. The control group used traditional programming methods in creation of the system. The experimental group was given a CASE tool to use to create the system.

In this experiment, productivity was measured by comparing the amount of time needed to write the same system. System quality was measured by comparing the differences in complexity and the levels of completeness of the final system. Time needed to complete the assignment was fairly objective. The data were collected from the computer that the students used to program the system. The number of compiles, links, runs, and the total amount of time logged into the system were automatically captured by the computer. The judgment of the complexity of the systems was accomplished by counting the number of action

lines within the program, and the number of operands and operators within the program.

Subjects were not randomly assigned to a group; rather a natural selection took place depending on class enrollment. Also, the experimental group's design of the system came roughly 4 months after the control group finished the assignment. There was abundant opportunity for learning from the control group.

Granger concluded that the productivity of the programmer increased when CASE tools were used. She also concluded that while the size and the complexity of the systems were not significantly different, the more complete systems were produced in less time by the treatment group. This study also represented a positive step toward validating claims of improved productivity by proponents of CASE.

McClure Study

A study done by McClure in 1989 involved a narrative description of three companies that were currently using CASE. All three companies had great success with CASE tools and encouraged others to start using them. All three companies reported great gains in productivity over a five-year span. All three companies urged potential users to go slow and develop a strategy for CASE implementation before actually jumping in.

Although the McClure study was not a scientific study, it does illustrate many points that research should validate in the future. The McClure study illustrated three areas of need for further research: (a) the need to validate the gains in productivity; (b) the need to validate huge dollar savings reported by informal case studies; and (c) the need to investigate organizational impacts of CASE implementations.

Franch Study

Another study dealing with CASE was done by the staff writers of Systems/3X & AS World magazine and reported by Franch (1989). This study focused on IS computer professionals and their use of two software products: LANSA and Synon/2E. Names were supplied by the makers of the two products and telephone interviews were conducted. The interviews focused on the applications developed, who worked with the tools, and measures of effective performance.

Because the names were supplied by vendors and the persons interviewed were the buyers of the products, this study had potential threats to internal validity. Again, great gains in programmer productivity were reported. This study, unlike the McClure study, failed to report monetary savings or gains attributable to the implementation of CASE.

Rai and Howard Study

A study published in 1994 by Rai and Howard reported the results of a large-scale national survey of senior IS managers. The authors attempted to identify the key organizational correlates associated with the usage of CASE technology. Their study was grounded in innovation theory and research in IS implementation. The study was done first via interviews with five senior IS managers for validation of the research model. The second part of the research involved survey questionnaires sent to 2,700 IS professionals. The response rate was 15%, or 405 responses. Factor analysis, reliability assessment, and multiple regression analysis were used to analyze the data.

Seven factors were identified as facilitating the propagation of CASE. The factors were perceived threat to IS departments existence, methodological expertise within IS department, size of the IS department, technical support for CASE, CASE championship, top management support, and job/role rotation. While the response rate was somewhat low, the authors stated that those who responded represented the industry composition and size. The successful implementation of CASE may be influenced by factors not considered in this study (Rai & Howard, 1994). The factors studied by Rai and Howard were centered on the organization rather than the individuals involved in the CASE implementation. The authors recommended that the

factors be studied at the programmer/analyst level in order to design appropriate intervention strategies to facilitate CASE usage.

Orlikowski Study

The next study considered was done by Orlikowski (1993) of the Sloan School of Management. This was an empirical study into two organizations' experiences with adoption and use of CASE tools over time. Her study was grounded in change theory, or processes of incremental or radical change. The goal of the study was to develop a theoretical framework for conceptualizing the organizational issues around the adoption of CASE tools.

Two organizations were selected that had adopted CASE in the past few years. One company developed software for external use. The other developed internal information systems. Data were collected through unstructured and semi-structured interviews, documentation review, and observation. Over 200 interviews were conducted on the two sites to gather data for analysis.

While not exhaustive, Orlikowski's results form a rich basis for further study into CASE implementation. She determined that the organizational change process is influenced by the structural premise that human action and institutional contexts interact over time (Orlikowski & Robey, 1991). Of particular concern to this researcher were her findings concerning the IS staff. She found that

one company hired a wide spectrum of recent college graduates to fill entry-level programming positions and then spent considerable time in training the new programmers in the company's methodology. It seemed that the attitudes and personality of the prospective employee outweighed the technical background. Most of these employees welcomed the adoption of CASE tools.

The second company's staff were divided into two groups, technical-oriented and business-oriented. Many of the technical-oriented system developers looked upon the adoption of CASE tools as a great threat to personal career development. They felt that their technical expertise would no longer be marketable. The business-oriented developers looked upon the adoption of CASE tools as a welcome relief from the tedium of programming. They now could spend more time on activities they enjoyed, like business analysis. The perception was that CASE facilitated their work rather than jeopardized their expertise or status.

Orlikowski found that with regard to the IS staff, the system experience, career orientation, and attitudes toward CASE acted as either a facilitating or a constraining characteristic in the successful implementation of the tools.

Finlay and Mitchell Study

In 1994, Finlay and Mitchell of Loughborough University reported findings on a study of the perceptions of benefits from the introduction of CASE technology. The study was an empirical study of one company that adopted CASE. The authors attempted to determine if the introduction of CASE technology resulted in tangible benefits such as productivity, quality, and efficiency gains, as well as nontangible improvements such as improved perceptions in personal effectiveness and increased understanding by developers and users.

Data were collected from among 26 customers and 52 developers, which represented a response rate of 88.6%. Follow-up interviews were conducted with 10 of the respondents. Function-point analysis was used to measure productivity. Simple mean scores were computed for the comparison of responses.

The findings of the study indicated that in this one instance, the adoption of CASE led to increased productivity (85%) and increased system delivery (200%). The study also showed learning stalled early in the introduction process with little additional improvement over time. This study specifically stated that IS management should consider more fully the "softer" issues in IS development. There should be an appropriate

infrastructure required to support the introduction of CASE.

The weakness of this study was its generalizability. However, the high return rate and the validation methods used allowed for high internal validity.

Sumner and Ryan Study

In 1994, Sumner and Ryan reported on a study to determine the critical success factors in information systems analysis and design and to determine if CASE tools support these critical success factors. In order to determine the critical success factors, 88 members of a CASE user group were contacted. Of those contacted, 26 or 29.5% responded.

Following the identification of a set of critical success factors, 66 CASE users were contacted to indicate the extent to which CASE tools supported the achievement of these factors. Of these, 20 or 30.3% responded.

Raw scores and means were computed for the responses. The results of the survey indicated that CASE does not support the achievement of the critical success factors. The authors speculated that because CASE tools were super-imposed upon an existing work system with no thought to current technical processes, work roles, and social aspects, the benefits were not achieved as they hypothesized. An overemphasis on the technical aspects of systems design, without equal attention being paid to its

social aspects, will not improve the effectiveness of the work system.

Iivari Study

The final study considered in this study was reported in 1996. Iivari, of the University of Oulu, Finland, set out to determine why CASE tools were not widely used. He utilized a survey that was distributed by Finnish business managers to 322 potential respondents. Of those, 109 or 32.6% responded.

The survey sought information on the profile of the respondents, CASE usage, and factors of perceived quality and productivity. The perceptions of the respondents were used to measure quality and productivity gains as opposed to actual measurements by function points or some other means. Multiple regression analysis was used to analyze the data.

The author found that management support and perceived relative advantage were positively related to CASE usage. Voluntariness, the degree to which innovation was seen as voluntary, was a significant negative predictor of CASE use. This last predictor contradicted the results of prior research. The author recommended further research on the social determinants of CASE usage.

There were some limitations within the study. The study was a retrospective cross-sectional analysis that was based on perceptual data. The reliability of the data may

be questionable. However, the author argued that subjective perceptions provide a sounder basis for theory development than more objective data. The distribution of the questionnaires relied upon management to select the participants. No follow-up could be done, and therefore, it was not practical to estimate the nonresponse bias.

Finally, this study was done exclusively in Finland. The author made the point that the finding on voluntariness may be a cultural factor when compared with studies completed in North America. Further cross-cultural studies were recommended.

Summary

Few scientific studies have been undertaken to validate the effectiveness of CASE technologies in the development of successful systems (Norman & Nunamaker, 1989). Most literature involving the use of CASE tools was narrative and subjective. Most literature also tended to focus only on the impact of CASE on programmer/analyst productivity. A few recent studies concerning CASE tools have focused on the productivity gains of the programmer and organizational implications of the adoption of CASE tools. Both the Granger study and the Norman and Nunamaker study were scientific efforts to validate claims of increased productivity. Neither study made an effort to

show organizational impact related to the use of CASE technologies.

Some studies have considered programmer and management attitudes as possible factors in CASE success. But no research was found that explored the differences in programmer/analysts using CASE and those not using CASE. Only recently have studies looked at the possible need for change in style of management or social factors in organizations adopting CASE.

Several recent studies dealing with CASE (Finlay & Mitchell, 1994; Iivari, 1996; Orlikowski, 1993; Rai & Howard, 1994; Sumner & Ryan, 1994) make strong cases for continued research into the organizational and social or "softer" aspects of CASE implementation. Iivari specifically pointed out the need to do further cross-cultural studies of predictors of CASE usage.

Tannenbaum and Schmidt have given a model of leadership selection criteria. The factors mentioned in their writings closely resemble the factors attributed to propagation of CASE technology in organizations as stated by Rai and Howard. By using a synthesis of factors from Tannenbaum and Schmidt and the supporting industry-specific studies, this study was designed to develop a theoretical model of key personal factors that explain variations in the programmer/analysts' usage of CASE tools.

CHAPTER III

PROCEDURES

As noted in Chapter I, it was critical that research be directed toward understanding the organizational context supportive of computer-aided software engineering (CASE) usage for systems development (Rai & Howard, 1994). But the research seldom focused on the individual context of CASE implementations. This study addressed the issue of personal factors of the programmer/analysts in CASE implementations and in doing so limited its attention to the correlates of individual CASE usage. This chapter of the study has addressed the issues of the questionnaire development, questionnaire administration, variables, population and sample, statistical analysis, and threats to internal validity.

Questionnaire Development

A questionnaire was developed based on the industry literature. Three pieces of industry literature were of particular note. The first was the continuum of leadership behavior as proposed by Tannenbaum and Schmidt (1981). The second was the CASE research of Rai and Howard (1994). The third was the Orlikowski (1993) study on CASE tools as organizational change. The questionnaire was divided in two parts. Section 1 was used to determine CASE usage;

Section 2 was used to collect data relevant to the personal factors of the programmer/analyst.

Dependent Variable

The dependent variable, individual use of CASE tools, was measured by self-report. Each participant in the research was asked to answer several questions to determine the level of usage of CASE during his/her career. The first question determined if the programmer/analyst had used CASE in any area of his or her job assignments. Those who had some use of CASE were asked to identify the tools used and answer four questions for each tool used: frequency of use, importance of the tool to the project, level of expertise in using the tool, and length of time using the tool. The final question with regard to CASE usage identified the reasons that the tools were used (see Appendix A, Section 1, Questions 6, 7, 8, and 9).

Independent Variables

The three independent variables in this study were measured by the response to several questions (see Appendix A, Section 2). In order to measure the need for direction and the identity with the organizations problems and objectives, the programmer/analyst was asked to answer eight items on a 5-point Likert-type scale ranging from "strongly agree" to "strongly disagree." In addition, each participant was asked to indicate his or her education and

job experience levels. Two questions were asked using the same 5-point Likert-type scale to determine if the programmer/analysts' experience and knowledge were adequate for the job assignments performed.

Tannenbaum and Schmidt (1981) wrote that a manager should consider several factors in the subordinate in order to determine what kind of behavior on his/her part would enable the subordinate to act most effectively. The first four items centered around the concept of subordinates need for independence on the job:

1. Does the subordinate have a relatively high need for independence?

2. Does the subordinate have a readiness to assume responsibility?

3. Does the subordinate prefer a wider area of freedom or clear-cut directives?

4. Does the subordinate expect to share in the decision making process?

Orlikowski's findings indicated that the programmer/analysts' attitudes about how CASE would influence his or her job had a great impact on the successful implementation of CASE tools in the organization. Those who wanted to devote more time to business and process analysis welcomed the use of CASE tools. Those who valued the technical expertise and clear-cut nature of the traditional programmer's role resisted

the implementation of the tools. Questions 10-13 (see Appendix A) of the questionnaire addressed the issue of need for independence in the programmer/analyst.

Tannenbaum and Schmidt also suggested that a manager consider four other factors having to do with the subordinates identity with the problems and objectives of the organization:

1. Is the subordinate interested in the problems of the organization?

2. Does the subordinate feel that the problems of the organization are important?

3. Does the subordinate understand the goals of the organization?

4. Does the subordinate identify with the goals of the organization?

Orlikowski found that programmer/analysts who were concerned with job security, career mobility, and technical expertise more than getting the job done simply and effectively were less likely to support the implementation of CASE tools. Those programmer/analysts who viewed CASE tools as being integral to expediting the IS objective reacted very positively to the introduction of CASE tools. Rai and Howard (1994) found that in companies that perceived CASE tools as a threat to the existence of IS departments, CASE usage declined. Where CASE was seen as assisting IS meet its objectives, the tools usage

increased. Questions 14-17 (see Appendix A) of the questionnaire addressed the issue of the programmer/analysts' identity with the problems and objectives of the IS organization.

Finally, Tannenbaum and Schmidt suggested that the manager consider two more factors having to do with subordinates experience level:

1. Does the subordinate have the needed knowledge to deal with the problem?

2. Does the subordinate have the necessary experience to deal with the problem?

According to Orlikowski, the experience of programmer/analysts involved in the implementation of CASE tools critically influenced their attitude toward the tools. Those with greater time invested in traditional IS development practices resisted the change to CASE tools. While years of experience in programming might be negatively related to CASE usage, Rai and Howard found that methodology expertise was positively related to CASE usage. Questions 1-5, 18, and 19 (see Appendix A) addressed IS experience.

To conduct a face validity check of the research model (Kerlinger, 1986; Rai & Howard, 1994), an open-ended interview was used to validate the questionnaire. Five senior IS managers with different experience and background

were interviewed for this purpose. Based on the feedback from the interviews, the questionnaire was modified.

Questionnaire Administration

All data were collected via a research survey given to programmer/analysts at their place of employment. Each participant in the research was asked to complete a questionnaire covering computer-related experience, abilities, and personal situational factors. The process of filling out the questionnaire took 10 to 15 minutes. Surveys were sent to 686 programmer/analysts in the population.

Variables

The dependent variable in this study was CASE usage at the individual programmer/analyst level. CASE usage was self-reported by the respondent using six different levels:

0. Never used CASE.
1. Used CASE in an experimental/training situation.
2. Used CASE on one project.
3. Used CASE on several projects.
4. Used CASE on most projects.
5. Used CASE exclusively.

The respondents who had some CASE usage, 1 through 5 above, were asked further questions concerning the reason

for use of CASE and the significance of the use of CASE in their assignments.

The independent variables were the three factors derived from a synthesis of the Tannenbaum and Schmidt paper, the Rai and Howard study, and the Orlikowski study. The three factors were:

1. Need for direction on the job,
2. Identity with the problems and objectives of the organization, and
3. IS experience.

Population and Sample Selection

The sample in this study was chosen from a population of IS consulting firms. All regional IS consulting firms associated with BEST Consulting were invited to participate. The sample included all programmer/analysts from the IS consulting firms agreeing to participate in the study.

Statistical Analysis

Multiple regression analyses with backward elimination were used to test the formulated hypotheses for degree of CASE usage and the relationship with the personal factors of programmer/analysts.

Threats to Internal Validity

Nelson (1985) stated that the situation often arises in research in which it is impossible or impractical to collect data about people by observation. When the researcher wishes to gather data about a person's knowledge, attitudes, beliefs, feelings, motivations, anticipations, future plans, or past behavior, questionnaires are commonly used.

In such a situation, heavy reliance is put on self-reporting. For many years, a controversy has existed about the validity of self-reports (Kidder, 1981; Nelson, 1985).

> On the one hand, self-reports may be inaccurate because people are sometimes unwilling or unable to remember or to describe accurately what they know, what or how they feel, and what they do. On the other hand, all people have a unique opportunity to observe themselves. To the extent that they can and will communicate their knowledge about themselves, they provide the investigator with information that could otherwise be obtained, if at all, only by other, even more fallible methods than self-reports. (Nelson, 1985, p. 46)

This research was based on the collection of information about the personal factors of the programmer/analyst. As such, heavy reliance was placed on self-reports rather than some other method of reporting. The internal validity of the research may be questioned due to this reliance.

CHAPTER IV

FINDINGS

This chapter was designed to provide the data analyses and results of this study including the respondents' profile and analysis of study questions with regard to the relationship between programmer/analyst personal factors and CASE usage. The Statistical Package for the Social Sciences, SPSS Graduate Pack™ Advanced Version, was the primary statistical software used in the analyses.

Several studies dealing with CASE technology have focused on the productivity gains realized with the use of CASE tools. No studies were found that explored the differences between characteristics of programmer/analysts using CASE tools and those not using CASE tools. This research was developed and based on the conceptual framework of studies by Tannenbaum and Schmidt (1981), Rai and Howard (1994), and Orlikowski (1993). By using a synthesis of factors from these studies, this study explored the personal factors that explain variations in the programmer/analysts' usage of CASE tools.

The first factor considered was the programmer/ analyst's identity with the problems and objectives of the IS department. The research question was to determine if there was a relationship between the programmer/analysts' identity with the problems and objectives of the

organization and the use of CASE tools. The null hypothesis was:

H1: There was no relationship between the programmer/analysts' identity with the problems and objectives of the IS department as measured by self-report and the level of CASE usage for information systems development

The second factor considered was the programmer/analyst's personal need for direction on the job. The research question was to determine if there was a relationship between the programmer/analysts' personal need for direction on the job and the level of CASE usage. The null hypothesis was:

H2: There was no relationship between the programmer/analysts' personal need for direction on the job as measured by self-report and the level of CASE usage.

Finally, the third factor considered was the programmer/analysts' IS experience. The research question was to determine if there was a relationship between the programmer/analysts' IS experience and the level of CASE usage. The null hypothesis was:

H3: There was no relationship between the programmer/analysts' IS experience as measured by self-report and the level of CASE usage.

To test these hypotheses, a questionnaire was created incorporating the factors as described by Tannenbaum and Schmidt (1981). The face validity of the instrument was confirmed through open-ended interviews with a panel of five senior IS leaders. The panel was composed of the following leaders within the IS community:

1. Founder and CEO, major consulting firm with involvement in IS work for over 15 years.

2. Branch manager, major consulting firm with over 12 years of IS work including director, senior consultant, and programmer/analyst.

3. Director, major consulting firm with over 11 years of IS work including senior consultant, system manager, and programmer/analyst.

4. Senior IS consultant, major consulting firm with over 11 years of IS work including data processing manager, project manager, and programmer/analyst.

5. Senior IS consultant, major consulting firm with over 10 years of IS work including project manager, and programmer/analyst.

Based on their feedback, minor changes were made to the format and structure of the instrument to improve respondents' understanding of the questions and correctly identify the importance of CASE tools in the respondents' work.

The survey instrument used for this study was divided into two sections. Section 1 dealt with the respondents' profile and CASE usage. The respondents' profile consisted of the length of time working in current position, the length of time working in the IS area, age, level of education, and areas of study. Respondents were asked to indicate their usage of CASE tools. Respondents who had used CASE were asked to identify the two most frequently used tools. They were also asked to rate the frequency of the tool use, the importance of the tool to their project, and their expertise with the tool.

Section 2 was composed of 10 statements. The respondents were asked to indicate their level of agreement with each statement by checking one entry on a 5-point Likert-type scale. A copy of the questionnaire appears in Appendix A at the end of this document.

To obtain the greatest possible participation in the study, self-administered questionnaires were used to collect the data necessary to test the hypotheses. The data were collected from consultants working for BEST Consulting, Inc., with headquarters in Seattle, Washington. BEST has regional offices in Oregon, Idaho, California, Nevada, Arizona, and Utah. Each branch functions as an independent unit hiring consultants to meet the needs of their individual markets.

Branch managers for each of the different offices were contacted to gain their support for the study. The questionnaires were distributed through the payroll process of each branch. Questionnaires were distributed to all of the consultants working for BEST Consulting at the time of the research (N= 686). In order to increase the return rate, a letter was sent to all consultants from the President and CEO of BEST Consulting, encouraging their participation in this research project. Of the questionnaires distributed, 216 (31%) were returned within the 3 months allowed for return of the questionnaire.

This method of collecting data had several advantages and disadvantages. One advantage was that the number of individuals needing to be contacted personally by the researcher was limited. Another advantage was that the amount of time required by organization members was limited primarily to the time required to complete their own questionnaire. No expense other than the respondents' time was incurred by the organization. There also was no selection bias on the part of the researcher or the managers of the different branches. Questionnaires went to 100% of the consultants. However, a major disadvantage was that overall response was highly dependent on the consultant's willingness to participate in the study. Also, follow-up was restricted due to the researcher's

inability to contact directly all of the consultants to whom the questionnaire had been distributed.

The response rate for this study, 31%, was consistent with other studies with a similar methodology for data collection. The Rai and Howard study (1994) involved questionnaires sent to IS professionals and had a response rate of 15%. Sumner and Ryan (1994) utilized surveys sent to CASE users with a response rate of 29.5%. The Iivari study (1996) surveyed business managers and had a response rate of 32.6%.

Respondent's Profile

The frequency and percentage of responses to each question are shown in full in Appendix B (Tables B-1 through B-22).

Almost 60% of the respondents had never used CASE in a production environment. Only 30% of the respondents had used CASE on more than one project. Over two thirds of those using CASE did so because it was required by the employer. See Appendix B Table B-7 and Table B-8.

Those who used CASE were asked to identify the most frequently used CASE tools. Each respondent could have identified up to two CASE tools. Of the tools listed, 29 were listed by only one respondent. Only 8% of the respondents claimed to be experts with the CASE tools listed. See Appendix B Table B-9.

The respondents who had used CASE were asked to specify how frequently the CASE tools were used and how important the CASE tools were to the projects success, and finally to rate their level of expertise on the tool. Only 13% of the respondents reported using CASE tools exclusively. Over 50% of those using CASE stated that the CASE tools were extremely or very important to the success of the project. See Appendix B Tables B-10, B-11, and B-12.

The final 10 questions in the survey instrument required the respondents to rate themselves in 10 different personal factors. Appendix B Tables B-13 through B-22 show the frequency of the responses for each of the factors listed.

Multiple Regression Analysis

The purpose of the study was to determine if a relationship existed between the level of CASE usage and the personal factors of the programmer/analysts. The three factors studied in this research were the programmer/analyst's identification with the organization's problems and objectives, the programmer/analysts' need for direction on the job, and the programmer/analysts' experience within IS. As stated in Chapter III, hypotheses in this research were tested at an .05 level.

Multiple regression utilizing the backward elimination strategy was used to answer the questions of this study. The Statistical Package for the Social Sciences (SPSS Graduate Pack) was used to generate these analyses. The hypotheses are presented with the findings for each hypothesis.

Multiple regression analysis was conducted to determine which factors best explain the variance in CASE usage among programmer/analysts. This approach computed a sequence of regression equations, at each step deleting the independent variable that contributed the least unique variance. The independent variable that explained the greatest amount of variance in the dependent variable remained at the end.

The following hypothesis was tested:

H1: There was no relationship between the programmer/analysts' identity with the problems and objectives of the IS department as measured by self-report and the level of CASE usage for information systems development.

In order to evaluate the programmer/analysts' identity with the problems and objectives of the IS organization, the respondents were asked to state their agreement to four statements. Response was in the form of a Likert-type scale where 1 represented strong agreement and 5 represented strong disagreement.

First, the respondents were asked to indicate their level of agreement with the following four statements:

1. Problems I am asked to solve are interesting.
2. My assignments are important.
3. My employer's goals and my goals are different.
4. I am interested in the goals of my employer.

Results from the multiple regression analyses are shown in Table 1.

When the responses from all four questions were included in the regression analysis, the results were not significant at the .05 level ($F = 2.18643$). The resulting equation explained only 4% of the variance in CASE usage ($R^2 = .04054$), which was too low to be of practical significance. Based on this analysis, the researcher retained the null hypothesis.

The four factors associated with the programmer/analysts' identity with the problems and objectives of the organization had no meaningful or statistically significant relationship with CASE use. The use of CASE was not related to the programmer/analysts' identity with the problems and objectives of the organization.

Table 1

Identity with the Problems and Objectives of the Organization to Explain CASE Use

Statistic	Value
R	.20134
R^2	.04054
Adjusted R^2	.02200
F	2.18643
Significance of F	.0717

Variable	Coefficient	T	Sig T
Differing Goals	-.251917	-2.526	.0123
Important Assignments	-.236061	-1.462	.1452
Interested in Goals	.103172	.719	.4727
Interesting Problems	-.191336	-1.293	.1975
Constant	3.866157	6.130	.0000

The following hypothesis was tested:

H2: There was no relationship between the programmer/analysts' personal need for direction on the job as measured by self-report and the level of CASE usage.

In order to evaluate the programmer/analysts' need for direction, the respondents were asked to state their agreement to the following four statements. Response was in the form of a Likert-type scale where 1 represented strong agreement and 5 represented strong disagreement.

1. I need direction in my job.

2. When my supervisor gives me additional responsibility, she/he is just passing the buck.

3. I prefer a wide area of freedom with my assignments.

4. I expect to share in making decisions within my department.

Results from the multiple regression analyses are shown in Table 2. By including the responses from all four questions, the resulting Equation 1 proved to be statistically significance beyond the .05 level (F = 3.96567). The equation explained just over 7% of the variance in CASE usage (R^2 = .07182).

Backwards removal of the first three variables, all with coefficients that were not significantly different than zero, is shown in Equation 2. The remaining variable was the programmer/analysts' desire to share in the decision-making process. The resulting equation was statistically significant beyond the .05 level (F = 15.24015). The amount of variance in CASE usage explained was just under 7% (R^2 = .06827).

Table 2

Need for Direction on the Job to Explain CASE Use

Equation 1:

Statistic	Value
R	.26800
R^2	.07182
Adjusted R^2	.05371
F	3.96567
Significance of F	.0040

Variable	Coefficient	T	Sig T
Need for Direction	.039020	.456	.6490
Prefer Freedom	-.075978	-.561	.5756
Pass the Buck	.009694	.088	.9300
Share in Decisions	-.363784	-3.732	.0002
Constant	3.079538	4.732	.0000

Equation 2:

Statistic	Value
R	.26128
R^2	.06827
Adjusted R^2	.06379
F	15.24015
Significance of F	.0001

Variable	Coefficient	T	Sig T
Share in Decisions	-.373720	-3.904	.0001
Constant	3.866157	6.130	.0000

Based on this analysis, the researcher rejected the null hypothesis. The four factors associated with the

programmer/analysts' need for direction on the job when taken in combination had a statistically significant relationship with CASE usage. The single variable, the programmer/analysts' desire to share in the decision-making process, also had a statistically significant relationship with CASE use. Those programmer/analysts with a stronger desire to share in the decision-making process were more likely to have used CASE tools.

The following hypothesis was tested:

H3: There was no relationship between the programmer/analysts' IS experience as measured by self-report and the level of CASE usage.

In order to evaluate the experience of the respondents, the following questions were asked. The first four questions required a direct response in terms of number of years or level of education acquired. The last two questions required a response in the form of a Likert-type scale where 1 represented strong agreement and 5 represented strong disagreement.

1. Years in present position.
2. Years involved in information systems work.
3. Age.
4. Education level.
5. My experience is adequate for the problems with which I am asked to deal

6. My knowledge is adequate to handle my current assignment.

Results from the multiple regression analysis are shown in Table 3. By including the responses from all six questions, the resulting Equation 1 proved to be statistically significant beyond the .05 level (F = 3.33497). The equation explained just under 9% of the variance in CASE usage (R^2 = .08893).

Elimination of the variable associated with adequacy of knowledge resulted in an equation that explained 8.8% (R^2 = .08781) of the variance. Further elimination of the variable associated with adequacy of experience resulted in an equation that explained 8.7% (R^2 = .08746) of the variance.

When the variables that did not make a significant contribution (adequacy of knowledge, adequacy of experience, and years in current position) were eliminated, three variables (age, education level, and years of IS work) remained. The resulting equation was statistically significant (F = 5.66146). The amount of variance in CASE usage explained was just over 7.5% (R^2 = .07549).

Based on this analysis, the researcher rejected the null hypothesis. The six factors associated with the experience of the programmer/analyst when taken in combination had a statistically significant relationship with CASE usage.

Table 3

Experience to Explain CASE Use

Equation 1:

Statistic	Value
R	.29821
R^2	.08893
Adjusted R^2	.06226
F	3.33497
Significance of F	.0037

Variable	Coefficient	T	Sig T
Adequate Knowledge	.099181	.501	.6167
Adequate Experience	-.102273	-.542	.5885
Age	-.241755	-2.306	.0221
Education Level	.226385	2.325	.0211
Years of IS work	.273160	2.986	.0032
Years in Position	.159804	1.609	.1091
Constant	.519561	.673	.5015

Equation 2:

Statistic	Value
R	.27476
R^2	.07549
Adjusted R^2	.06216
F	5.66146
Significance of F	.0010

Variable	Coefficient	T	Sig T
Age	-.219848	-2.116	.0356
Education Level	.216999	2.232	.0267
Years of IS work	.308883	3.503	.0006
Constant	.679390	1.010	.3135

The final three variables (age, education level, and years of IS work) when combined had a statistically significant relationship with CASE use, and there was not a significant reduction in the proportion of variance explained by the reduced equation. The relationship with age was somewhat curvilinear, that is, the younger and older respondents appeared to have lesser use of CASE while the respondents with ages in the middle appeared to have had more CASE use. Higher levels of education and more years of IS work seemed to indicate more opportunity to use CASE.

Summary of Hypotheses Testing

There were three hypotheses tested dealing with programmer/analysts' personal factors and CASE usage. Two of the three hypotheses were rejected because of the statistically significant relationship among the measures of their variables and the measures of CASE usage.

In summary, the study's findings showed that programmer/analysts' identity with the problems and objectives of the organization as measured in this study was not related to CASE usage, and programmer/analysts' need for direction and IS experience as measured by this study were related to CASE usage. The study also showed that the relationships were not strong.

The next chapter was designed to summarize and interpret the study's findings. Conclusions were drawn about the factors influencing CASE usage. Recommendations for future research were made.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

There have been many researchers and writers who have focused on studies and instances concerning computer-aided software engineering (CASE). The purpose of this study was to determine if a relationship existed between the personal factors of the programmer/analyst and the use of CASE tools. The results of this study should add to the knowledge base that management might use in determining an appropriate strategy to assist in managing and implementing CASE technology. Chapter II included the research framework with the intent of providing a meaningful context from which the research hypotheses were tested. The methodology used to conduct the research was described in Chapter III. Chapter IV contained the research findings. The summary, conclusions, and recommendations for this study are presented in this chapter.

Summary

The infusion of CASE technology into an IS organization most certainly requires changes in the way that information systems are developed. It also requires that management evaluate management techniques and practices to adequately support the technology. Three factors have been identified in multiple studies as important to management in determining the appropriate

management techniques needed in an organization. The three factors identified in the literature are (a) identity with the problems and objectives of the organization, (b) personal need for direction on the job, and (c) IS experience.

The research model as explained by Tannenbaum and Schmidt, Rai and Howard, and Orlikowski was used to explain the relationship between the three factors and CASE usage by a programmer/analyst.

Statement of the Problem

CASE technology has been advanced as a possible means to enhance the productivity and performance of the software development process. Despite the increased attention to CASE tools, research has shown that less than a quarter of companies use them and the use of CASE tools has had spotty success. While information systems departments have continuously attempted to improve the implementation of CASE tools through technological means, the spotty success may be related to the personal factors associated with the main user of the tools, the programmer/analyst.

Purpose of Research

The purpose of this study was to identify the antecedents of CASE innovation at the programmer/analyst level that will lead to design of appropriate strategies to facilitate successful CASE implementation and use. The

purpose of this study was to investigate specific factors, at the individual programmer/analyst level, that influence the usage of CASE tools. Specifically, this research sought to determine if there was a relationship between CASE usage and three factors affecting the programmer/analyst. The factors were the level of job-related direction needed by the programmer/analyst, the programmer/analyst identity with the problems and objectives of the organization, and the level of IS experience of the programmer/analyst.

Research Procedures

This study was conducted among the consultants associated with BEST Consulting. BEST Consulting is one of the largest IS consulting firms in the western United States, with offices in Seattle, Washington; Boise, Idaho; Portland, Oregon; Sacramento, California; Phoenix, Arizona; and Salt Lake City, Utah. Data were gathered using a questionnaire modeled after the personal factors as described by Tannenbaum and Schmidt. The questionnaire contained two sections: Section 1, Programmer/Analyst Questionnaire, which included respondents' profile and CASE usage; and Section 2, Programmer/Analyst Personal Factors.

The face validity of the instrument was confirmed through open-ended interviews with five senior IS leaders. The IS leaders provided suggestions on questionnaire

improvement. Minor changes were made to the survey instrument prior to the study being conducted.

Data Analyses

Data collected from the questionnaire were analyzed to determine possible relationships between the independent and dependent variables. The dependent measure, CASE usage, was obtained through self-report in Section 1 of the questionnaire. Measures of the independent variables were derived from questions within the survey instrument. Measures for the programmer/analysts' identification with the IS organization's problems and objectives were derived from answers to questions 14-17 of the survey. Measures for the programmer/analysts' personal need for direction on the job were derived from the answers to questions 10-13 of the survey instrument. Measures for IS experience were derived from questions 1-5 in Section 1, and questions 18 and 19 from Section 2 of the survey.

The information collected was designed to answer the questions of the study. Multiple regression analysis with backward removal of variables was used to describe the relationship between the dependent variable and the independent variables.

Respondent's Profile Findings

The majority of the respondents (70%) were between the ages of 26 and 45. Over 75% of the respondents had a

bachelor's degree or higher. While the majority (75%) of the respondents had been in their current job less than 4 years, over 78% of the respondents had worked in IS 7 or more years.

Respondent's CASE Usage

The majority (59.7%) of the respondents had not used CASE in a production environment. Only 30.6% of the respondents had used CASE more than once in a production environment. The majority of those using CASE indicated multiple reasons for using CASE. However, the reason cited most commonly (67%) for using CASE was that CASE technology was required by the employer. While only 13% of the respondents reported using CASE tools exclusively, over 50% of those using CASE stated that the CASE tools were extremely or very important to the success of the project.

Findings of Hypotheses Testing

The results of the statistical procedures were used to answer the questions of the study.

First, was there a relationship between the programmer/analysts' identity with the problems and objectives of the IS department and the level of CASE usage for information systems development? Questions 14-17 (See Appendix A) were used to test this hypothesis.

The following hypothesis was tested:

H1: There was no relationship between the programmer/analysts' identity with the problems and objectives of the IS department as measured by self-report and the level of CASE usage for information systems development.

Multiple regression analysis of the respondents' answers to four questions (14-17) were analyzed to determine whether or not there was a relationship between the programmer/analysts' identity with the problems and objectives of the IS department and the level of CASE usage.

The results of the multiple regression analysis were not statistically nor practically significant. There was no relationship between the programmer/analysts' identity with the problems and objectives of the organization and the use of CASE.

Therefore, the researcher failed to reject the null hypothesis that there was no relationship between the programmer/analysts' identity with the problems and objectives of the organization and CASE usage.

Second, was there a relationship between the programmer/analysts' need for direction and CASE usage? Questions 10-13 (See Appendix A) were used to test this question. The following hypothesis was tested:

H2: There was no relationship between the programmer/analysts' personal need for direction

on the job as measured by self-report and the level of CASE usage.

Multiple regression analysis of the respondents' answers to four questions (10-13) were analyzed to determine whether or not there was a relationship between the programmer/analysts' need for direction and the level of CASE usage.

The results of the multiple regression analyses were statistically significant; however, the single variable, desire to share in decision making, accounted for most of the variance in the equation. The respondents who had a higher desire to share in the decision-making process were more likely to have used CASE.

Therefore, the researcher rejected the null hypothesis that there was no relationship between the programmer/analysts' need for direction on the job and CASE usage.

Third, was there a relationship between IS experience and CASE usage? The following hypothesis was tested:

H3: There was no relationship between the programmer/analysts' IS experience as measured by self-report and the level of CASE usage.

Multiple regression analyses of the respondents' answers to six questions (1-4, 18, 19 in Appendix A) were conducted to determine whether or not there was a

relationship between the programmer/analysts' IS experience and the level of CASE usage.

The results of the multiple regression analyses were statistically significant for all six variables. Backwards removal of the variables showed that age, years of IS work, and education level accounted for most of the variance in the relationship. The results indicated that the age of the programmer/analyst was related to CASE use. The relationship was curvilinear in that the younger and older groups had less CASE use and the medium group had more CASE use. One could speculate that the younger group had had less opportunity to use CASE and the older group started careers when CASE was not available, but these are only speculations.

The variables of education level and years of IS work were also significant in their relationship with CASE use. The higher the level of education and the longer one worked in IS, the greater the chance of CASE usage.

Therefore, the researcher rejected the null hypothesis that there was no relationship between the programmer/ analysts' IS experience and CASE usage.

Conclusions

The conclusions for this study were derived from the analyses of the respondents' profile, respondents' personal factors, and CASE usage. Based on the results of the

statistical tests computed, the following conclusions were made:

1. The population sampled represented IS consultants between the ages of 26 and 45, with at least a bachelor's degree, and over 10 years of IS work. The respondents were all located in the western United States. While the conclusion could be made that the population sampled was generalizable to like populations, future researchers must be cautious when generalizing these findings due to the low (31%) response rate.

2. Since the majority of respondents had not used CASE in a production environment, knowledge of and experience using CASE tools was not predominate in the IS industry.

3. Since the programmer/analysts' identity with the IS department's objectives and problems was not statistically significant for CASE usage, the conclusion was made that programmer/analysts who identify with the problems and objectives of the organization were as likely to have used CASE technology as were programmer/analysts who did not identify with the problems and objectives of the organization.

4. Since the need for direction on the job was statistically significant for CASE usage, the conclusion was made that the variance in CASE usage can in part be

explained by some of the factors associated with the need for direction.

5. Since the programmer/analysts' expectation to share in decision making was statistically significant for CASE usage, the conclusion was made that the variance in CASE usage can be explained in part by this variable. Programmer/analysts with great desire to share in decision making were more likely to have used CASE.

6. Since the programmer/analysts' IS experience was statistically significant for CASE usage, the conclusion was made that the variance in CASE usage can in part be explained by IS experience as defined by age, years in IS, and education level. Programmer/analysts in the medium age groups were more likely to have used CASE. One could speculate that programmer/analysts in the younger age groups have not had as much opportunity to use CASE, and that programmer/analysts in the older age groups started their careers when CASE was not prevalent in the industry. The findings also indicate that programmer/analysts with more years of IS work and higher education levels were more likely to have used CASE.

Recommendations

The following recommendations were based on the findings and conclusions of this study:

1. Since the programmer/analysts' expectation to share in decision making was significant to CASE usage, IS management should consider this variable in determining a strategy to support the implementation of CASE within an organization.

2. Since the programmer/analysts' experience model was significant for CASE usage, IS management should consider the experience level of the programmer/analysts, years in IS, and education level, in determining a strategy to support the implementation of CASE within an organization.

3. While this study may not be generalizable to all groups of programmer/analysts, managers should consider social and personal factors at the individual programmer/analyst level when determining a strategy to support the implementation of CASE within an organization.

The following recommendations for further study were made:

1. To validate the findings of this study, this study should be replicated among other IS professionals both within and outside of the consulting sector.

2. Further research and theory development should be conducted to determine if other factors explain the variance in CASE usage among programmer/analysts.

3. Since usage of CASE among all respondents was low, continued research should be done to determine the factors influencing the usage of CASE tools in organizations.

4. Further research should be conducted to determine the organizational factors associated with successful CASE usage among programmer/analysts and within organizations.

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APPENDICES

Appendix A. Survey Instrument

Thank you for participating in this research project. We are collecting information from programmers and analysts across the nation to better understand the software development environment and the use of CASE tools in that environment.

Your answers will be totally anonymous. Please answer all applicable questions by filling in the blank or checking the appropriate box.

When you have completed the questionnaire, please fold in half and seal in the addressed and stamped envelope provided. Please mail the envelope directly after completing the survey. Your prompt reply will be greatly appreciated.

Again, thank you very much for your participation in this research.

Sincerely,

Dennis Phillips
Graduate Student
Department of Business Information Systems Education
Utah State University
Logan, Utah

SECTION 1
PROGRAMMER/ANALYST
QUESTIONNAIRE

1. Years that you have worked in your present position:_____
2. Years that you have been involved in information systems work:_____
3. Your age:_____
4. The highest level of your formal education:
   - ☐ Lower than High School Diploma
   - ☐ High School Diploma
   - ☐ Some College
   - ☐ Associate Degree
   - ☐ Bachelor's Degree
   - ☐ Master's Degree
   - ☐ Doctoral Degree
   - ☐ Other (specify)_____

5. The major area of your formal educational training (for example, accounting, computer science, finance, etc.): _____

6. Please indicate your use of case tools on the job by checking only one of the following statements that most accurately reflects your use of computer-aided software engineering (CASE) tools.
   Check one only:
   - ☐ 1. I have never used CASE tools.
   - ☐ 2. I have used CASE in an experimental/training situation.
   - ☐ 3. I have used CASE on one project.
   - ☐ 4. I have used CASE on several projects.
   - ☐ 5. I use CASE on most projects.
   - ☐ 6. I use CASE exclusively.

⊠ **IF YOU ANSWERED 1 (Never used CASE), please skip to Section 2.**

7. Please indicate the reason(s) you have used CASE in your job assignments.
   (CHECK AS MANY AS APPLICABLE)
   - ☐ CASE was required by employer
   - ☐ I prefer CASE methodology over traditional methods of programming
   - ☐ CASE tools will increase my technical skills
   - ☐ CASE tools will increase my marketability as a consultant
   - ☐ CASE tools will improve my effectiveness as a programmer
   - ☐ CASE tools improve the quality of programs written
   - ☐ Others: Please explain _____

_____

Please indicate the CASE tools (Oracle CASE, SYNON, IEF, Knowledgeware, Excelerator, etc.) that you have used in your job assignments. If more than two, please list the two tools that you have used most frequently. After identifying the tool, please answer three questions with specific regard to your use of that tool.

8. MOST FREQUENTLY USED CASE TOOL:_____

8a. How frequently was the CASE tool used:

- ☐ All work was done in the CASE tool.
- ☐ More than half, but not all of the work was done in the CASE tool.
- ☐ About half of the work was done with the CASE tool.
- ☐ Less than half of the work was done with the CASE tool.
- ☐ Very little of the work was done with the CASE tool.

8b. How important was the CASE tool to the successful project completion?

- ☐ Extremely important.
- ☐ Very important.
- ☐ Important
- ☐ Somewhat important
- ☐ Not important at all.

8c. What is your level of expertise with the CASE tool.

- ☐ Expert
- ☐ Very good
- ☐ Good
- ☐ Fair
- ☐ Poor

9. SECOND MOST FREQUENTLY USED CASE TOOL:_____

9a. How frequently was the CASE tool used:

- ☐ All work was done in the CASE tool.
- ☐ More than half, but not all of the work was done in the CASE tool.
- ☐ About half of the work was done with the CASE tool.
- ☐ Less than half of the work was done with the CASE tool.
- ☐ Very little of the work was done with the CASE tool.

9b. How important was the CASE tool to the successful project completion?

- ☐ Extremely important.
- ☐ Very important.
- ☐ Important
- ☐ Somewhat important
- ☐ Not important at all.

9c. What is your level of expertise with the CASE tool.

- ☐ Expert
- ☐ Very good
- ☐ Good
- ☐ Fair
- ☐ Poor

SECTION 2
PROGRAMMER/ANALYST
PERSONAL FACTORS

Please mark the appropriate response to each of the following statements. For example:

	SA	A	N	D	SD	NA	
EX.	☐	☐	☒	☐	☐	☐	I enjoy my job.

The mark indicates that the respondent neither agrees nor disagrees with the statement.

SA: Strongly Agree
A: Agree
N: Neither agree nor disagree
D: Disagree
SD: Strongly Disagree
NA: Not applicable

	SA	A	N	D	SD	NA	
10.	☐	☐	☐	☐	☐	☐	I need direction in my job.
11.	☐	☐	☐	☐	☐	☐	When my supervisor gives me additional responsibility, she/he is just passing the buck.
12.	☐	☐	☐	☐	☐	☐	I prefer a wide area of freedom with my assignments.
13.	☐	☐	☐	☐	☐	☐	I expect to share in making decisions within my department.
14.	☐	☐	☐	☐	☐	☐	Problems I am asked to solve are interesting.
15.	☐	☐	☐	☐	☐	☐	My employer's goals and my goals are different.
16.	☐	☐	☐	☐	☐	☐	My assignments are important.
17.	☐	☐	☐	☐	☐	☐	I am interested in the goals of my employer.
18.	☐	☐	☐	☐	☐	☐	My experience is adequate for the problems with which I am asked to deal.
19.	☐	☐	☐	☐	☐	☐	My knowledge is adequate to handle my current assignment.

Appendix B. Tables

Table B-1

Response by State

State of respondent	Frequency	Percentage
Not specified	2	.9
Arizona	4	1.9
California	14	6.5
Idaho	9	4.2
Nevada	7	3.2
Oregon	46	21.3
Utah	31	14.4
Washington	103	47.7
Total	216	100.0

Table B-2

Response by Age

Age category	Frequency	Percentage
No Response	6	2.8
25 and younger	3	1.4
26-35	79	36.6
36-45	74	34.3
46-55	48	22.2
56 and older	6	2.8
Total	216	100.0

Table B-3

Response by Years of Experience in Current Position

Years in current position	Frequency	Percentage
No response	5	2.3
Less than 1 year	44	20.4
1-3 years	120	55.6
4-6 years	26	12.0
7-9 years	9	4.2
10 or more years	12	5.6
Total	216	100.0

Table B-4

Response by Years of Experience in IS

Years in IS	Frequency	Percentage
No response	3	1.4
Less than 1 year	4	1.9
1-3 years	19	8.8
4-6 years	21	9.7
7-9 years	35	16.2
10 or more years	134	62.0
Total	216	100.0

Table B-5

Response by Level of Education

Education categories	Frequency	Percentage
No response	1	.5
Lower than HS diploma	1	.5
High school diploma	2	.9
Some college	32	14.8
Associate degree	19	8.8
Bachelor degree	117	54.2
Masters degree	43	19.9
Doctoral degree	1	.5
Total	216	100.0

Table B-6

Response by Area of Study

Area of study	Frequency	Percentage
Computer Science	91	35.5
Business	41	16.0
Management Information Systems	21	8.2
Mathematics	20	7.8
Electrical Engineering	13	5.1
Accounting	12	4.7
Economics	12	4.7
Physics	9	3.5
Psychology	8	3.1
Engineering	7	2.7
Finance	7	2.7
Biology	4	1.6
Electronics	4	1.6
Music	4	1.6
Topics listed less than 3 times	23	9.0
Total subjects listed	256	100.0

Table B-7

CASE Usage of Respondents

Level of CASE usage	Frequency	Percentage
Never used CASE	87	40.3
Used CASE in training	42	19.4
Used CASE on one project	20	9.3
Used CASE on multiple projects	52	24.1
Used CASE on most projects	8	3.7
Used CASE exclusively	6	2.8
No response	1	.5
Total	216	100.0

Table B-8

Reasons for CASE Usage

Reasons for CASE use	Frequency	Percentage
CASE required by employer	61	67.0
CASE improves marketability	51	56.0
CASE improves program quality	47	51.6
CASE improves effectiveness	45	49.5
CASE increases technical skills	36	39.6
CASE preferred methodology	30	33.0
Other reasons for CASE use	20	22.0
Total	290	100.0

Table B-9

CASE Tools Used

CASE tools used	Frequency	Percentage
Excelerator	23	14.6
Knowledgeware	22	13.9
Oracle CASE	18	11.4
IEF	17	10.8
ERWIN	13	8.2
SYNON	11	7.0
System architect	6	3.8
LBMS	4	2.5
Powerbuilder	4	2.5
STP	3	1.9
EZCASE	2	1.3
PAC BAS	2	1.3
Silverrun	2	1.3
Teamwork	2	1.3
Named by only 1 respondent	29	18.4
Total	158	100.0

Table B-10

Frequency of CASE Tools Use

CASE tool	All work in CASE	More than half	Half of work	Less than half	Very little in CASE	Total
Excelerator	0	6	4	8	5	23
Knowledgeware	3	4	2	5	8	22
Oracle CASE	4	6	0	5	3	18
IEF	4	5	3	0	4	16
ERWIN	0	2	2	5	4	13
SYNON	2	1	3	2	2	10
System architect	0	3	1	1	0	5
LBMS	0	0	1	3	0	4
STP	0	0	0	1	2	3
EZCASE	0	1	0	0	1	2
PAC BAS	1	0	0	1	0	2
Powerbuilder	2	0	0	0	0	2
S-Designer	0	0	1	1	0	2
Silverrun	0	2	0	0	0	2
Teamwork	0	1	0	0	1	2
Named by 1 resp.	4	4	9	4	7	28
Totals	20	35	26	36	37	154
Percent	13	23	17	23	24	100

Table B-11

Importance of CASE Tools Use to Project's Success

CASE tool	Extremely Important	Very Important	Important	Somewhat Important	Not Important	Total
Excelerator	3	4	7	6	3	23
Knowledgeware	3	3	1	10	5	22
Oracle CASE	6	1	4	3	3	17
IEF	4	3	5	2	2	16
ERWIN	2	2	7	2	0	13
SYNON	2	0	5	1	1	9
System architect	1	2	2	1	0	6
LBMS	0	1	1	2	0	4
STP	0	0	0	2	1	3
EZCASE	0	1	0	1	0	2
PAC BAS	0	1	1	0	0	2
Powerbuilder	2	0	0	0	0	2
S-Designer	0	0	1	1	0	2
Silverrun	2	0	0	0	0	2
Teamwork	1	0	0	0	1	2
Named by 1 resp.	4	5	8	7	5	29
Total	30	23	42	38	21	154
Percent	19	15	27	25	14	100

Table B-12

Level of Expertise with the CASE Tools

CASE Tool	Expert	Very Good	Good	Fair	Poor	Total
Excelerator	2	4	10	5	2	23
Knowledgeware	2	4	3	8	5	22
Oracle CASE	1	5	5	6	1	18
IEF	2	3	4	3	5	17
ERWIN	1	5	1	5	1	13
SYNON	0	1	3	2	4	10
System architect	1	4	0	0	0	5
LBMS	0	1	2	1	0	4
STP	0	0	1	2	0	3
EZCASE	0	1	0	1	0	2
PAC BAS	1	0	0	0	1	2
Powerbuilder	0	2	0	0	0	2
S-Designer	0	1	1	0	0	2
Silverrun	1	0	0	1	0	2
Teamwork	0	1	0	0	1	2
Only 1 respondent	1	11	7	7	3	29
Total	12	43	37	41	23	156
Percent	8	28	24	26	15	100

Table B-13

I Need Direction in My Job

Need for direction	Frequency	Percentage
Strongly agree	5	2.3
Agree	40	18.5
Neither agree nor disagree	37	17.1
Disagree	68	31.5
Strongly disagree	54	25.0
Not applicable	7	3.2
Missing	5	2.3
Total	216	100.0

Table B-14

When My Supervisor Gives Me Additional Responsibility, She/He Is Just Passing the Buck

Passing the buck	Frequency	Percentage
Strongly agree	1	.5
Agree	7	3.2
Neither agree nor disagree	27	12.5
Disagree	77	35.6
Strongly disagree	92	42.6
Not applicable	10	4.6
Missing	2	.9
Total	216	100.0

Table B-15

I Prefer a Wide Area of Freedom with My Assignments

Prefer wide area of freedom	Frequency	Percentage
Strongly agree	95	44.0
Agree	96	44.4
Neither agree nor disagree	47	7.9
Disagree	4	1.9
Strongly disagree	0	0
Not applicable	1	.5
Missing	3	1.4
Total	216	100.0

Table B-16

I Expect to Share in Making Decisions Within My Department

Share in decision making	Frequency	Percentage
Strongly agree	66	30.6
Agree	114	52.8
Neither agree nor disagree	21	9.7
Disagree	4	1.9
Strongly disagree	2	.9
Not applicable	6	2.8
Missing	3	1.4
Total	216	100.0

Table B-17

Problems I Am Asked to Solve Are Interesting

Interesting problems	Frequency	Percentage
Strongly agree	43	19.9
Agree	131	60.6
Neither agree nor disagree	29	13.4
Disagree	11	5.1
Strongly disagree	0	0
Not applicable	0	0
Missing	2	.9
Total	216	100.0

Table B-18

My Employer's Goals and My Goals are Different.

Differing goals	Frequency	Percentage
Strongly agree	11	5.1
Agree	40	18.5
Neither agree nor disagree	69	31.9
Disagree	66	30.6
Strongly disagree	22	10.2
Not applicable	5	2.3
Missing	3	1.4
Total	216	100.0

Table B-19

My Assignments Are Important

Important assignments	Frequency	Percentage
Strongly agree	66	30.6
Agree	129	59.7
Neither agree nor disagree	12	5.6
Disagree	6	2.8
Strongly disagree	1	.5
Not applicable	0	0
Missing	2	.9
Total	216	100.0

Table B-20

I Am Interested in the Goals of My Employer

Interested in goals	Frequency	Percentage
Strongly agree	64	29.6
Agree	125	57.9
Neither agree nor disagree	18	8.3
Disagree	5	2.3
Strongly disagree	1	.5
Not applicable	1	.5
Missing	2	.9
Total	216	100.0

Table B-21

My Experience Is Adequate for the Problems with Which I Am Asked to Deal

Adequate experience	Frequency	Percentage
Strongly agree	77	35.6
Agree	121	56.0
Neither agree nor disagree	8	3.7
Disagree	8	3.7
Strongly disagree	0	0
Not applicable	0	0
Missing	2	.9
Total	216	100.0

Table B-22

My Knowledge Is Adequate to Handle My Current Assignment

Adequate knowledge	Frequency	Percentage
Strongly agree	83	38.4
Agree	117	54.2
Neither agree nor disagree	9	4.2
Disagree	5	2.3
Missing	2	.9
Total	216	100.0

VITA

DENNIS PHILLIPS

Candidate for the Degree of
Doctor of Philosophy

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An Examination Of The Adoption Of Computer-Aided Software Engineering Technology And Programmer Personal Factors

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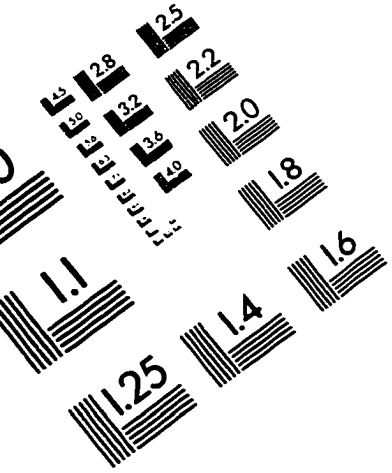
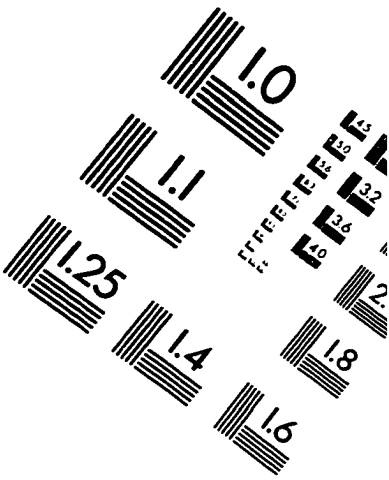
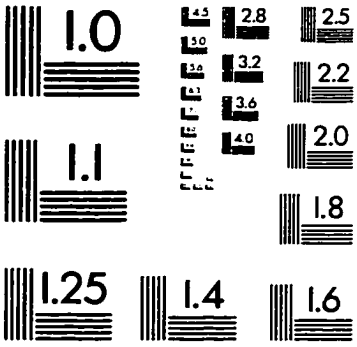
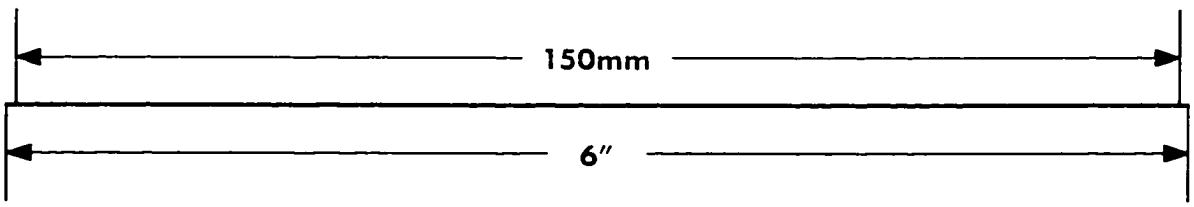
- Instructor, Computer Information Systems, Ricks College, Rexburg, Idaho, 1985 to 1990.
- Manager, Pacific Bell, San Jose, California, 1984 to 1985.
- Supervisor, Foster Farms, Livingston, California, 1982 to 1984.

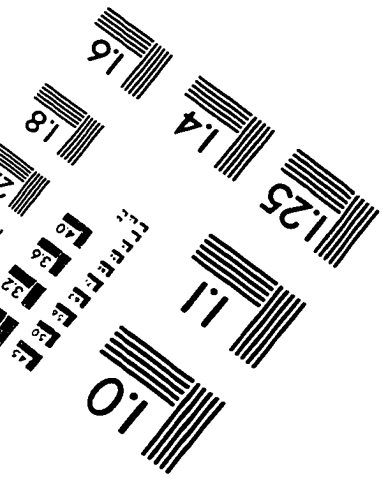
IMAGE EVALUATION TEST TARGET (QA-3)

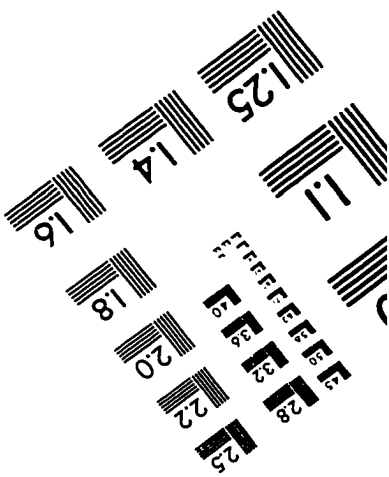












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