Order Number 9114513

Stimulating the use of computer-aided software engineering in information system departments: An empirical test of elements of innovation theory

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Kent State University, 1990

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STIMULATING THE USE OF COMPUTER-AIDED SOFTWARE ENGINEERING IN INFORMATION SYSTEM DEPARTMENTS: AN EMPIRICAL TEST OF ELEMENTS OF INNOVATION THEORY

A dissertation submitted to the
Kent State University Graduate School of Management
in partial fulfuillment of the requirements
for the degree of Doctor of Philosophy

by

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December, 1990

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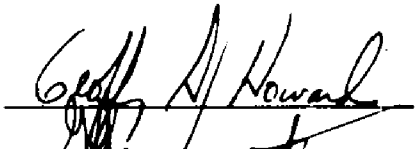

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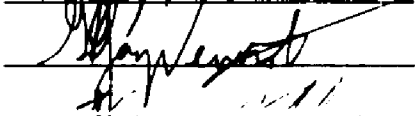

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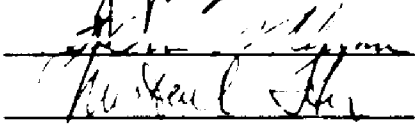

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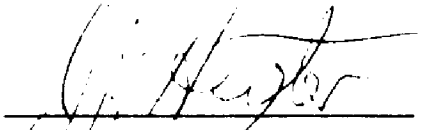

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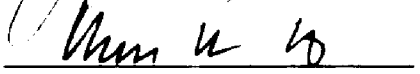

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ACKNOWLEDGEMENTS

It was my late father's dream to see me complete a Ph.D. However, God willed it otherwise and, he passed away exactly two months after I joined the doctoral program. To him I dedicate this dissertation.

There have been a number of individuals who made this endeavor feasible. My dissertation director, Dr. Geoffry S. Howard, has been my mentor from my initial days in the doctoral program. He was instrumental in cultivating a "research spirit" in me at a very early stage in the program. As part of the dissertation project, he drove with me on many snowy days for corporate interviews. Dr. Howard put in several hours toward helping in the conceptualization and design of the study, and provided almost instant feedback on stacks of writing. I was fortunate in not only having him direct my dissertation but also in getting to know an intelligent, caring and dedicated individual.

The other members of the dissertation committee raised thought-provoking questions, provided useful suggestions and supported the project in any way that they could. Dr. Glenn Thomas always encouraged me, and raised critical and important questions about the study. He has been a great

support, not only during the dissertation phase but right from the day I joined Kent State.

Despite the number of dissertation committees which Dr. Michael Hu was on, he always made time for my questions. His suggestions, especially in the areas of methodology and data analysis, were extremely useful.

Dr. Jay Weinroth, with whom I have had the opportunity of working with on other research projects as well, raised thought-provoking conceptual issues. I would also like to thank my graduate representative, Dr. Robert Krampf, for his suggestions.

I would like to express my gratitude to Dr. Robert Smith and the Center for Information Systems at Kent State University for their support and for partially funding this project.

It is very difficult to accomplish a professional endeavor without support from near and dear ones. The list of people I would like to thank is a long one. My wife, Sujata, stood by me in all possible ways. I cannot forget the several nights she sat up with me, stuffing questionnaires and sticking stamps. On other days, when I was busy working till "unearthly" hours, she would try to make sure I had nothing else to worry about. It is hard to

gone through the program without her being by my side.

My grateful thanks also go to two extremely important people to me-- my brother, Amit, and my mother-- for standing by stolidly and providing me all the emotional and moral support all through the program.

I would also like to express my thanks to Cynthia Ruppel, a colleague and close friend, for helping me with the editing of this manuscript.

Of course, none of this would've been possible without the Almighty standing by me through it all.

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CHAPTER I

INTRODUCTION

Problem Area

A recent technological innovation in Information Systems (IS) development and maintenance is Computer-Aided Software Engineering (CASE). CASE has been documented as a technology that can bring about productivity gains, increase competitiveness of organizations and reduce costs and lead times involved in systems development work (Feuche, 1989; Martin, 1989). These issues are of great importance to management. It is, then, important to understand how to successfully implement the use of CASE in Information Systems Departments (ISDs).

The practitioner press has provided guidelines to increase the odds of success with CASE technology. However, these guidelines are based on experiences and opinions and are not the results of scientific study. Empirical study is needed to answer critical questions about how organizations can best implement CASE technology. Such study will be even more valuable to the extent that it is rooted in theory. One of the problems with most research in Information Systems (IS) is the proliferation of frameworks at the expense of explanatory models based on a general theory, and the lack of reference disciplines that can provide appropriate theories (Keen, 1981). Since CASE can clearly be viewed as an innovation, innovation theory can

provide the reference discipline for this empirical study of CASE technology.

Review of the innovation literature reveals that research in technological innovation has been fragmented and contradictory (Kimberly and Evanisko, 1981). Hence, as a first step, this study proposes a consolidated model of technological innovation. This model unifies elements of innovation theory that have evolved from a number of important studies (Utterback, 1971; Chakrabarti, 1974; Kimberly and Evanisko, 1981; Ettlie and Bridges, 1982; Rogers, 1983; Popper, 1983; Van de Ven, 1986; Dewar and Dutton, 1986; Meyer and Goes, 1988). CASE is used as a convenient instance of a technological innovation to empirically test the proposed model.

The remaining part of this chapter elaborates on the growing importance of Information Technology (IT) in today's post-industrial environment, the emergence of CASE as an innovation of interest, the proposed research models/ questions and the overall findings of this study.

Increasing Use & Importance of Information Technology

The post-industrial society is characterized by problems of information overload (Huber, 1984). There is a general shift from organizing to produce effectively to

organizing to process information (Simon, 1973). As a result the IS field has been receiving rapidly increasing attention. The clientele of ISDs have expanded to include almost every person in the organization (Rockart, 1982). Thus, today IS is of importance to many people in an organization.

Information systems can lead to gains in efficiency, enhance effectiveness in decision making and provide competitive advantage to organizations (Senn, 1990; Porter & Millar, 1985; Ives & Learmonth, 1984; Boynton & Zmud 1987). An efficient organizational IS will allow users to focus on projects and processes rather than tasks and procedures. Researchers have shown that IT can enhance creativity and enhance the limits of bounded rationality in decision making (Senn, 1990).

More than 200 articles have addressed the issue of identifying opportunities to support management processes with information technology (Bakos & Treacy, 1989). Numerous examples have been reported in the IS literature on the successful deployment of IT to enhance business opportunities and provide competitive advantage (McFarlan, 1984).

IT has also been used to shape and design organizations Issues such as degree of integration and differentiation within an organization are closely related to the effective

design of the organizational information processing system (Senn, 1990).

There has been a surge in the availability of computing and communication technologies (Huber, 1986; Van de Ven, 1986). The profusion of these new technologies, catalyzed by the numerous potential advantages of IT, has lead to a large and diverse base of computer-based activities (Rockart, 1987).

A study done by Rockart (1987) revealed that technically oriented IS executives are being replaced by managerially oriented executives in companies that have successfully used IT to gain strategic advantage. These executives have a well-defined perspective on IT and a clear vision of how IT can be used to support and achieve corporate goals. These managers can plan the acquisition and diffusion of emerging information technologies.

Thus it is imperative, in such a fast changing field that managers instill a climate of innovation which will enable harnessing the returns of promising emerging technologies like CASE. The acquisition and use of some of these new information technologies may improve the quality of their organizational information system. This could potentially lead to gains in efficiency, enhancements in effectiveness and possibly result in a competitive advantage.

Computer-Aided Software Engineering: An Innovation in Information System Development

ISDs have long sought to impose structured discipline on the information systems development process. The systems development life cycle (SDLC) has four main steps: analysis, design, coding and testing (Gane and Sarson, 1979).

In the analysis phase the systems analyst studies the existing system and identifies user-requirements. Changes to be made to the existing system are determined. The design phase focuses on identifying the logical processes and the logical data flow within the system. The coding phase involves the actual programming of the logical processes. The coded system is then tested using representative test data to "debug" the system.

Maintenance is an ongoing process after the initial delivery of the system to the users. Many ISDs have traditionally followed the "straight line" approach to building systems with the four phases of the SDLC being performed in sequence. As a result, a large number of systems did not meet the specifications of end-users, mostly because of the passage of large amounts of time between inception and delivery of systems. It has been recognized and strongly advocated that the system development process should proceed much more rapidly and iterate among the

stages of analysis, design, coding and testing (Gane & Sarson, 1979).

Further, the premature physical coding of systems has been strongly denounced (Inmon, 1988). The use of structured techniques to aid the systems analyst in the analysis phase of the SDLC has been advocated. These techniques include entity-relationship diagrams, data flow diagrams, flowcharts, structure charts, Warnier-Orr diagrams etc. These techniques force the systems analyst to focus on logical aspects of the system rather than physical implementation details.

Some ISDs have adopted formalized procedures for systems development which mandate the sequence of steps to be followed, the products to be developed at each stage of the life cycle and the management controls to be applied. A few ISDs have developed their own methodologies while many of them adopted one of the "packaged" methodologies developed by vendors.

Despite the development of several structured techniques and systems development methodologies, the IS industry still faces a high performance gap. The time spent on maintenance activities is consuming about 70% of the total time spent on applications (Stamps, 1987). This leaves less than 30% of programmer/analyst time for the development of new projects. If the present trend

continues, eventually all development resources will be consumed by maintenance related activities (Bachman, 1989). As a result of the above, there are very long lead times in meeting user requests for new systems (Stamps, 1987; Inmon, 1988). The average user-backlog is approximately 30 months. Practitioners say that there is about an equal if not greater invisible user backlog. This is made up of applications that never got formally requested because of long lead times.

A recent technology that has been receiving increasing interest is Computer-Aided Software Engineering (CASE). CASE tools automate one or more functions of the systems development life cycle (Schussel, 1987). The broadest definition of CASE has been provided by Stamps (1987) as the "automation of anything a human does to software".

There are a number of commercial CASE products in the market place. These vary greatly in the range of system functions they automate. CASE products can help in diagramming, building data dictionaries and repositories, restructuring poorly written code, code generation or project management. Commercially available CASE products are linked to structured design methodologies (Stamps, 1987).

Some CASE products assist in drawing DFDs, maintaining data dictionaries/repositories and designing reports and

screens. An example of one such tool is Excelerator, a PC-based product developed by Index Technologies Inc (Whitten & Bentley, 1987).

Some CASE tools possess forward and reverse engineering capabilities. Starting with an entity-relationship diagram, the process of forward engineering automatically generates code in a language such as COBOL. Reverse engineering products generate logical specifications such as entity-relationship diagrams, based upon the underlying code. Bachman's product developed by Bachman Inc. is a good example of a CASE tool which has such capabilities (Bachman, 1988). Thus, CASE tools could help the programmer/analyst perform one or more system development functions.

There are CASE products which integrate all system development functions (McWilliams, 1988). Such CASE products span the entire SDLC and are called "full life cycle" products. Some full life cycle tools help the user to identify business plans, tie these plans to application systems, document application requirements and translate these requirements into logical system design. These designs are translated to physical designs and then application code is generated (Andrews, 1989). Such CASE products have also been referred to as Information Engineering (IE) tools (Inmon, 1988). Examples of such

tools are IEW by KnowledgeWare Inc. and IEF by Texas Instruments Inc.

The above discussion shows that there is a wide variety of CASE tools. Further, as with any other software, there is great variation in the degree of sophistication of CASE tools for a specific function. Thus, though two different CASE tools may assist a systems analyst in diagramming, one of the tools could be much more sophisticated than the other for this particular function.

CASE has been recognized as a technology that can enhance productivity and companies using CASE for their systems work have reported significant productivity improvements (Martin, 1989).

In summary, researchers and practitioners have shown the tremendous potential of IT. At the same time, ISDs in many organizations face large performance gaps. CASE technology is a possible solution to achieve productivity gains and build integrated systems that support business plans. It is important, then, to understand how to successfully initiate and implement CASE technology.

Trade publications in the field have provided guidelines for the introduction and implementation of CASE in ISDs. Though, not based on a general body of theory or a scientific study, this practitioner literature does nevertheless provide useful implementation guidelines. Some

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nevertheless provide useful implementation guidelines. Some of the guidelines provided for the implementation of CASE by Feuche (1989) and Martin (1989) include:

- .Top management commitment is essential
- .Start with a small pilot project
- .Have an agent of change/sponsored advocate of the technology in the ISD
- .Provide training in the use of structured methodologies/techniques and in the use of the CASE tool(s)
- .Assess the skill and experience level of potential users
- .Control expectations
- .CASE is a "people issue" . Crucial steps in implementing CASE have nothing to do with the technology
- .Cold response to CASE could be due to the impact CASE will have on the application developers' way of traditionally doing things.
- .Dramatic results in productivity cannot be achieved fast enough to justify costs of some expensive products.
- .Political problems will arise as a result of a closer tie between data administration and application development.

However, these practitioner guidelines must be supplemented with theory-based guidelines in order to fully understand the role of CASE in organizations. Innovation theory, even though it is more fragmented than unified, provides a useful and relevant foundation upon which to study CASE.

Problems with Innovation Theory

In general, management of innovations is the primary concern of CEO's (Van de Ven, 1986). The increasing turbulence and competitiveness of organizations' environments have made the identification, evaluation, and adoption of technological innovations a critical determinant of organizational performance (Zaltman, Duncan & Holbeck, 1973).

Despite the great volume of work on innovation, there is no well developed theory (Kimberly and Evanisko, 1981). Researchers have examined isolated stages of the innovation process such as the diffusion phase (Rogers, 1983). They have typically examined technological or administrative innovation in isolation (Utterback, 1971). Further, most studies have focused on one type of an industry such as steel plants, hospitals etc.

In fact, no real theory exists that provides guidance

to those seeking to influence the rate and direction of technological change (Tornatzky & Klein, 1983). It is, therefore, first necessary to develop a unifying model of innovation.

Stage Model of Technological Innovation

It is clear from the organizational innovation literature that initiation and implementation of technologies are two distinct phases of the innovation adoption process (Zaltman, 1973; Duncan, 1977; Van de Ven, 1986). These phases apply to CASE. Initiation is brought about by a few individuals (Van de Ven, 1986). These individuals are typically members of a technology assessment/exploration group in an ISD. After an initial study of the CASE product offerings, the exploratory group typically purchases some CASE tools. These CASE tools may be very sophisticated or very rudimentary. In the present study, the collective degree of CASE sophistication possessed by the organizational unit is called depth of penetration. Possession of CASE tools does not assume their usage, other than on an experimental or "trial" basis. Hence an important feature of the present model is that the depth of penetration of a technology is considered a separate phenomenon from actual routine use of that

technology.

Implementation is the phase of getting essentially all individuals in the organizational unit to use the new technology (Van de Ven, 1986). For purposes of this study, the degree of usage of the technology by members of the organizational unit will be called breadth of penetration. A technology that is achieving breadth of penetration is becoming part of every day practice for a large proportion of the people in the organization unit.

The separate stages of initiation and implementation suggest that a stage model could be used to achieve a better understanding of the technological innovation process.

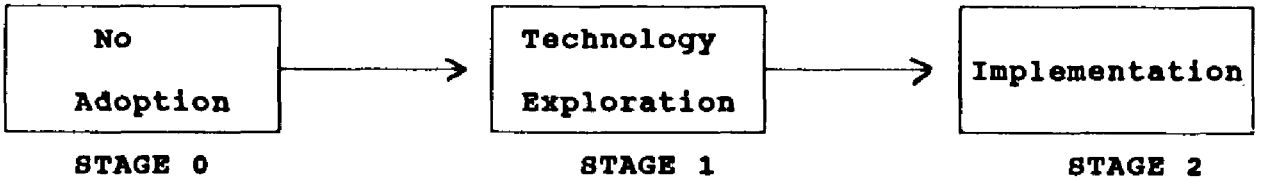

Figure 1: Stage Model of Technological Innovation

Stage 0: There is no adoption of the innovation i.e. virtually nothing is being done with the technology. Organizational units with no depth of penetration will be in this stage. This implies that the organizational unit has not yet purchased any form of the new technology.

Stage 1: Some degree of capability with the particular technological innovation has been acquired by the organizational unit. Exploratory study of the innovation is occurring. This may be accompanied by limited used by experimentation groups. The use of the innovation is far from spreading and is not yet standard practice throughout the organizational unit. The minimal criteria for an organizational unit to be classified into this stage is the acquisition of some degree of depth of the innovation. Organizations in Stage 1 are classified as having : a) some depth but no breadth, (b) low depth and low breadth and (c) high depth and low breadth.

Stage 2: There is nearly full implementation of the technological innovation. It has become part of standard practice for most members in the organizational unit. Organizational units with a high breadth of penetration belong to this stage. Organizations in Stage 2 can be further classified based on the degree of sophistication of the technology they possess into two sub-groups namely (a) organizations with high degrees of usage (high breadth) and possessing highly

sophisticated forms of the technology (high depth) and, (b) organizations with high degrees of usage (high breadth) and possessing lower degrees of sophistication of the technology (low depth).

Research Questions

The primary research problem of the present study is to identify organizational variables that relate to the degree of penetration of a technological innovation. As the penetration of technological innovation is defined using depth and breadth, the research problem translates to the following research questions:

1. What are the variables that relate significantly to the depth of penetration of technological innovation?
2. What are the variables that relate significantly to the breadth of penetration of technological innovation?

The proposed correlates and a brief discussion on each correlate are presented in the next section. A detailed discussion is included in Chapter 2. The model and the hypothesized correlates are not specific to CASE, but apply generally to technological innovation. CASE has been used as a convenient instance of a technological innovation to empirically validate the proposed correlates of depth and

breadth of technological innovation. In addition, the empirical study of CASE technology provides a number of useful guidelines for IS practitioners trying to infuse a climate of innovation in general and in particular to those exploring possible implementation of CASE for their systems work.

A secondary research objective was to develop a nationwide descriptive categorization of the present implementation status of CASE in ISDs. ISDs were classified using the depth and breadth of CASE penetration.

Hypothesized Correlates of Depth and Breadth of Technological Innovation

Figures 2 and 3 show the hypothesized correlates of depth and breadth of CASE penetration. As the technology being considered is CASE, the appropriate organizational unit of analysis is the Information System Department (ISD). The rationale for the inclusion of each variable is briefly discussed in this section, and in more detail in Chapter 2.

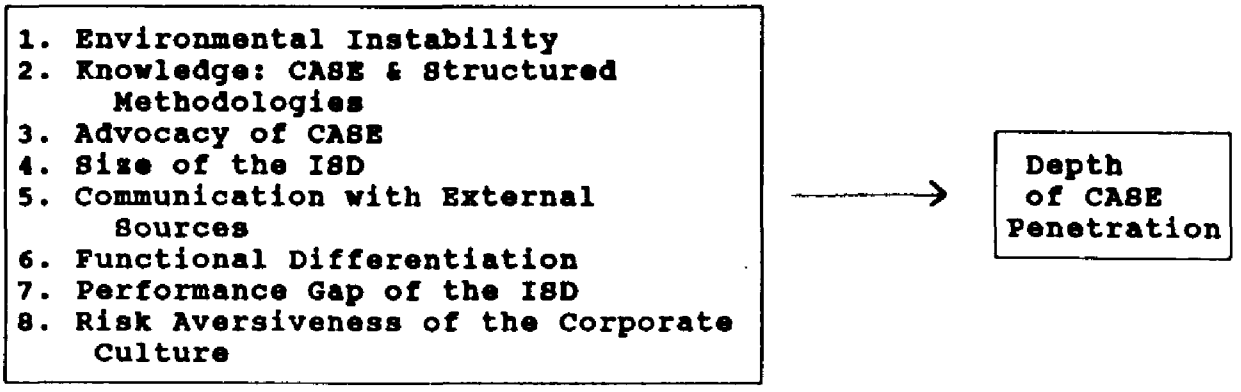

Figure 2: Hypothesized Correlates of Depth of CASE Penetration. Research Model I

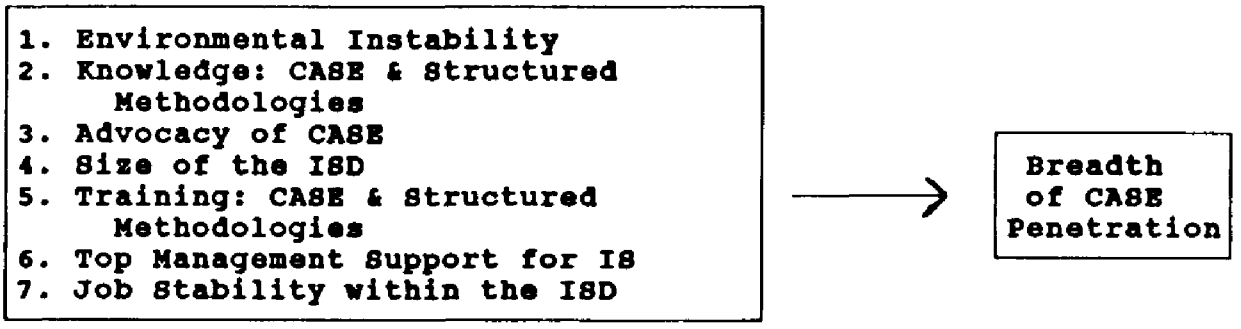

Figure 3: Hypothesized Correlates of Breadth of CASE Penetration. Research Model II

The importance of environmental instability in the innovation process has been recognized but rarely examined empirically (Kimberly & Evanisko, 1981). Researchers have found that high degrees of uncertainty make firms become more future oriented and promote consideration of innovations (Duschesneau, Cohn and Dutton, 1979; Myers and

Marquis, 1969). Increased consideration would imply that firms would purchase some degree of sophistication of the new technology and propagate its use in the relevant organizational unit. Thus an ISD that is unstable in its environment should try to acquire and subsequently diffuse the use of new information technologies such as CASE, with the intent that such innovative efforts would enhance its stability.

The viability of exploring or implementing any new technology is greatly influenced by the current state of technical knowledge in the organization (Utterback, 1971). In fact, personnel composition has been recognized as the most important source of any organizational change (Hannan & Freeman, 1984; Pfeffer, 1983). Thus the degree of programmer/analyst's knowledge about CASE technology and structured methodologies should be an important ingredient that influences the degree of sophistication of CASE acquired and used in an ISD.

An innovation without a champion is unlikely to succeed (Van de Ven, 1986). Innovation champions have been called agents/catalysts of change. Past research has shown that the presence of power elites or champions supporting the innovation has been associated with higher degrees of innovation (Glassman, 1984). This implies that higher levels of CASE advocacy will lead to higher degrees of CASE

penetration, both, in terms of sophistication possessed and usage of the technology.

Organizational size has been shown to be positively related to innovation adoption (Pierce & Delbecq, 1977). Very small firms cannot afford the high costs involved with many technically sophisticated innovations. However, in recent years it has been shown that size promotes innovation up to a point after which there is a decrease in the rate of innovation diffusion (Kimberly & Evanisko, 1981; Meyer and Goes, 1988). These diminishing returns observed in large organizations have been attributed to large degrees of investment in existing methods of operations and technologies thereby making the exploration and diffusion of improved technologies difficult. Thus, increasing size of ISDs should facilitate the exploration of sophisticated CASE tool(s) and their subsequent diffusion up to a point after which diminishing returns should be observed.

It is important to trigger peoples' action thresholds to pay attention to new ideas, needs and opportunities (Van de Ven, 1986). Greater degrees of communication with external information sources on developments in database technologies have resulted in ISDs acquiring and exploring sophisticated database technologies (Nilakanta and Scamell, 1990). This suggests that higher degrees of communication with external information sources on CASE should promote the

acquisition and exploration of sophisticated CASE tool(s) by the ISD.

If existing procedures and technologies do not allow an organizational unit to meet expected performance standards, new technologies will be explored as a way to rectify existing performance gaps (March & Simon, 1958). The degree of performance gap has been shown to be a good predictor of innovation adoption by shoe manufacturers (Duschesneau, 1979). ISDs with high performance gaps should therefore explore sophisticated CASE tools as a means to address their performance problems.

Differentiation represents the extent to which an organizational unit is divided into functional subunits. Increased functional differentiation leads to multiple interest groups and multiple demands for the elaboration of the technology (Hage & Aiken, 1967; Hyderbrand, 1973). ISDs with distinct functional subunits of testing, methodology, R&D and experimentation would be qualified as being highly differentiated. Such groups maybe likely to explore the acquisition of sophisticated innovations in information systems development such as powerful CASE tool(s) that could improve existing methods of system development.

The IS literature documents that firms exploring emerging decision information technologies recognize that short payback periods and stringent ROI calculations will

not justify large investments associated with some of these technologies (Keen, 1981; Emery, 1987). Further, many investments in IT lead to intangible benefits which cannot be quantified (Lockett,1987). ISDs not exploring sophisticated and expensive CASE tool(s) could be operating in risk aversive corporate cultures where investment in slow return technologies is not encouraged.

Lack of institutional leadership has been recognized as a critical strategic impediment to the diffusion of innovations. If institutional skills are not used, innovations are characterized by individual self-interest and differentiation with evidence of drift and disillusionment (Lodahl and Mitchell, 1980). Meyer and Goes (1988) have shown that CEOs have a substantial impact on the assimilation of medical innovations. Thus, organizations where top management supports the IS function should be categorized by greater use of IT innovations such as CASE.

Popper (1983) has shown that the degree of usage of innovations in structured methodologies is enhanced by training provided to programmer/analysts. Schien (1985) has shown that negative attitudes towards a technology may be rooted in technological inertia. Training imparts necessary technical skills and removes unfounded fears about the technology. ISDs that provide training to programmer/ analysts in the use of structured methodologies and CASE

tools should have higher degrees of usage of CASE technology.

Resistance to change is inevitable if employees perceive the source of change would delete entire functions or cross functional boundaries (Tomeski, 1975). Change could be viewed as threatening if present skills were to become obsolete due to restructuring in tasks, technology or workflows. However, employees rotated among different tasks would not be threatened by a technology that combines or redefines workflows between tasks. On the contrary, it would be viewed as a means to enhance effectiveness of the different tasks. Thus, programmer/analysts who are rotated among different system development functions would view CASE as a supplemental rather than a replacement technology. Such ISDs should then be characterized by a greater breadth of CASE usage.

This concludes a brief discussion of the independent variables and their expected relationship with the dependent variables. A detailed treatment of the literature and the formal hypothesis of expected relationships are presented in Chapter 2.

The Empirical Study

Overview of Methodology

Interviews were conducted with 13 IS managers to provide an initial confirmation of the research models. Further, the interviews provided useful insights in terms of operationalizing variables in the context of ISDs and CASE technology. A draft measurement instrument was prepared after the interviews. This instrument was tested using a convenience sample of 21 IS managers from different ISDs. A copy of the draft instrument is included in Appendix 1. Minor revisions were made to the instrument prior to using it in the national study.

A national study of 2,700 IS managers was conducted using a purchased mailing list of IS executives. The sample included ISDs in all states nationwide. As the unit of analysis was an ISD, only one questionnaire was sent to the IS manager of each ISD. A detailed description of the make up of the sample and the mechanics of the data collection process are presented in Chapter 3. A copy of the questionnaire used in the final study is included in Appendix 2.

A total of 405 usable responses were received back representing a response rate of 15%. A chi-square test

indicated that there was no difference in the proportionate make-up of the sample and the responses received (α = .05).

Factor analysis was used to verify the factor structure of the set of independent items included in the measurement instrument. A detailed treatment of the data analysis procedure and results is presented in Chapter 4.

Observed Factor Structure

Approximately four questions were written to measure each independent variables. The meaningfulness of the study depends heavily upon whether these questions did in fact measure the variables they purported to measure. Factor analysis was used, then, to test the construct validity of the measures. If the items (questions) believed to be associated with a particular independent variable did in fact load significantly on a particular factor, that was taken as evidence that the groups of questions all measured essentially the same thing.

Orthogonal rotation (varimax rotation) was used to extract independent factors and the results generally complemented the hypothesized independent variables. One exception was that the two items on the degree of CASE expertise and the items on CASE expertise would load on one factor. However, the items on CASE expertise loaded with

the items on CASE training and the items on degree of expertise in structured methodology loaded on a different factor. The two redefined factors were called "Company CASE Training Availability" and "Knowledge of Structured Methodology". The above redefinition suggested that "Company CASE Training Availability" be added to the hypothesized correlates of depth of CASE[1]. All other items loaded cleanly on orthogonal factors. Interpretation of the factor structure revealed that the hypothesized independent variables emerged as distinct factors as had been expected. A detailed analysis of the factor analysis procedure and interpretation of factors is deferred to Chapter 4.

The dependent variables in the study were measured following Nilakanta and Scamell (1990), who measured the diffusion of data base technologies in data processing organizations by using a two-dimensional table. Along one dimension they listed important functions related to data base development and maintenance. The other dimension categorized the extent of usage of data base technologies for each function in the data processing organization. A similar approach was adopted in the present study to measure both the depth and breadth of CASE penetration. Thirteen functions were identified to represent important aspects of

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[1]Training was already hypothesized as correlate of breadth.

systems development work. The relevance and completeness of the functions identified was confirmed during the interviews and pilot study. These functions were listed along one dimension of the tables used for the measurement of the dependent variables.

In the case of depth, the second dimension specified ordinal categories of CASE tool(s) sophistication possessed for each system function, regardless of usage levels. A sum of the sophistication possessed for each function led to an overall measure of CASE sophistication possessed by the ISD.

In the case of breadth, the second dimension specified ordinal categories of extent of usage of CASE tool(s) for each of the system functions. An aggregate of usage levels for each function provided an overall measure of degree of CASE usage in the ISD.

The hypothesized relationships were tested using stepwise regression.

Results: The Empirically Derived Models

The empirically derived models are shown in Figures 4 and 5 below.

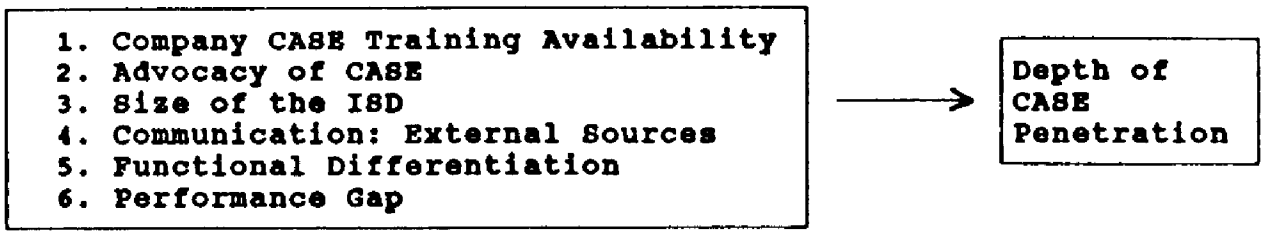

Figure 4: Empirically Derived Correlates of Depth of CASE

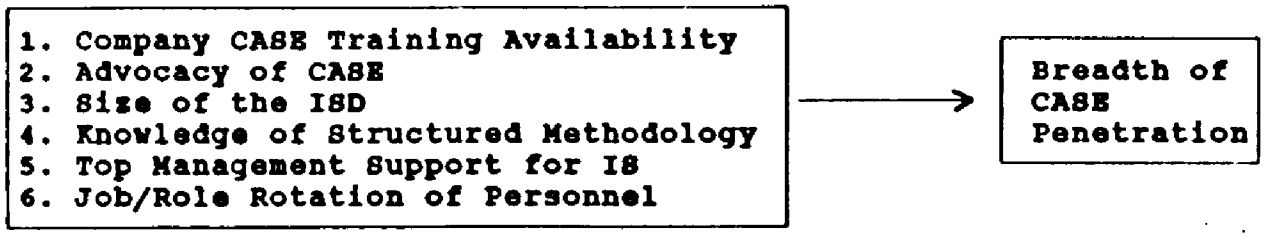

Figure 5: Empirically Derived Correlates of Breadth of CASE

Environmental Instability of the ISD, Knowledge of Structured Methodologies and Risk Aversiveness of the Corporate Culture were not found to be significantly related to depth of CASE penetration. Environmental Instability was not found to be significantly related to breadth of CASE penetration. The significant variables are shown in the above models ($\alpha = .05$). All variables had the expected

coefficient signs in the stepwise regression results.

Of the 405 responses, 92 were found to have depth = 0 (did not possess any CASE tools). The regression analysis was replicated after deleting these cases. This was done to detect changes in the set of independent variables after some initial CASE sophistication had been acquired by the ISD.

It was found that Communication with External Information Sources and Performance Gap were no longer significantly related to depth of CASE after the ISDs had acquired some initial CASE sophistication. This seems to suggest that these variables are important in differentiating between ISDs who possess some CASE sophistication and those who do not.

Among the set of variables hypothesized to relate to breadth of CASE penetration only environmental instability was found to be insignificant. However, environmental instability faced by the ISD was found to be significant when the reduced data set was considered. Thus, environmental instability is not a significant factor in explaining the level of CASE usage when all ISDs are considered but is significant in determining the degree of usage of CASE by adopting units. As this relationship was negative, adopting units operating in unstable environments may be forced to slow down their diffusing efforts as

environmental instability could lead to shortages in resources needed to diffuse a new technology such as CASE.

Classification of ISDs

A two-way cross tabulation of all ISDs was done using their scores on the depth and breadth of CASE penetration. ISDs with scores greater than the mid-range were considered to have a "high" depth (or breadth) of CASE penetration. ISDs having scores less than the mid-range but greater than 0 were considered to have a "low" depth (or breadth). As the range of possible values on the scales for depth and breadth scales was 0 - 65, the mid-range on both these scales was 32.5.

		BREADTH			
		0	Low	High	Cumulative
DEPTH	0	92			92
	Low	6	269	2	277
	High	0	30	6	36
	Cumulative	98	299	8	405

Table 1: Classification of ISDs using Depth and Breadth of CASE Penetration

The classification reveals that 92 (22.72%) of ISDs did not possess any CASE capability. As per the stage model,

22.72% of ISDs would thus be classified into Stage 0 of the CASE innovation-adoption process.

6 ISDs had purchased CASE tools but had not started using them. 269 ISDs possessed low sophistication CASE tools and had low usage levels. 30 ISDs had high sophistication CASE tools and low degrees of usage. Together, these 305 (74.31%) are in Stage 1 of the CASE innovation process.

Only 8 ISDs (1.98%) were found to be in Stage 2 with high degrees of usage of CASE. Of these, 6 ISDs had high sophistication tools and 2 had low sophistication tools.

Thus, most ISDs are experimenting with CASE. A large number have not started exploring the technology and only 1.98% are using the technology as part of standard practice. Further, most ISDs possess low sophistication CASE tools, though about 7.41% (30 ISDs) are experimenting with sophisticated CASE products.

Implications and Significance of the Study

Managing innovation has been recognized as one of the prime concerns of CEO's. Organizations have to innovate to remain competitive in an economy which faces both national and international competition.

The study builds a consolidated framework which

identifies organizational variables which relate to the penetration of technological innovation. Specifically, two empirical models are derived and validated in the present study. The first model identifies variables that relate to the degree of sophistication (depth) of technological innovation, and the second model identifies variables that relate to the degree of usage (breadth) of the innovation.

The identification of these variables relating to depth and breadth of technological innovation gives useful guidance to managers. It enables them to identify what organizational factors should be monitored/managed in order to maximize the chances of achieving desired levels of innovation penetration. Traditionally, nominal approaches have been used to measure innovation adoption. Previous approaches included such variables as adopters/non-adopters and length of time since initial adoption. The present study measures the degree of adoption by considering both the degree of sophistication and degree of usage of the technology in the organizational unit. This leads to a more comprehensive measure of the degree of penetration of an innovation within the organizational unit. Thus, in addition to classifying organizations into different stages, it is possible to identify distinct sub-classes based on the degree of sophistication possessed.

Most innovation researchers in the past have examined

social and scientific innovations. The consolidation and testing of the elements of innovation theory using an IS innovation, provides a better understanding of the innovation process within ISDs. This expands innovation theory to an IS environment. Thus, this study provides a good understanding of innovation acquisition, experimentation and assimilation within ISDs.

Specifically, the identification of correlates of depth and breadth of CASE provides IS managers knowledge of the organizational factors to be monitored that are likely to relate to (i) sophistication of CASE possessed and (ii) degree of CASE usage. The study also identifies variables whose effects persist -- that remain significantly related to depth of penetration -- after an initial commitment is made to the technology.

The categorization of ISDs provides IS managers a useful basis of comparing their current degree of CASE penetration with industry trends. A breakdown of the classification by industry class has been provided as well (Appendix 9).

Researchers in IS implementation should explore the validity of the proposed model by considering additional emerging information technologies. Further, the robustness of the model can be tested by researchers interested in organizational innovation outside of IS.

CHAPTER 2

HYPOTHESES DEVELOPMENT AND LITERATURE REVIEW

Introduction

This chapter first presents some definitions of innovation and distinguishes between different types of innovation. A three-stage model for CASE innovation is then proposed. The last part of the chapter consolidates organizational type factors, as suggested by the innovation literature, that may relate to the degree of CASE penetration in ISDs. This leads to several hypotheses on expected relationships between the organizational factors and the degree of CASE penetration in an ISD.

Innovation Defined

Shepard (1967) defined innovation as an organization learning to do something which it did not know how to do earlier. Evan and Black (1967) defined innovation as the implementation of new procedures or ideas. Sapolsky (1976) says it is a fundamental change in a significant number of tasks. Zaltman, Duncan and Holbeck (1973) and Rogers (1983) have defined innovation as an idea, practice, or material artifact perceived to be new by the relevant unit of adoption. The definition adopted for innovation in the present study is similar to that proposed by Van de Ven (1986) which suggests that an innovation is an idea or

product which is new to the relevant unit of adoption.

Likewise, the extent of "diffusion" in the present study refers to the degree of penetration of a technological innovation within an organizational unit. This is to be differentiated from the penetration of a technological innovation at the market level. Thus, the terms diffusion and penetration are used at the organizational unit level and not at the market level.

America's declining productivity and aging of its infrastructure have led to the claim that America is losing its innovativeness (Van de Ven, 1986). There is a general consensus on the need to understand and manage the innovation process. In fact, the general topic of innovation has inspired voluminous research. There have been more than 2,000 items published on the topic of organizational innovation (Gordon, Kimberly and MacEachron, 1975). Popular books on the subject have been written by Ouchi (1981), Pascale and Athos (1981), Peters and Waterman (1982) and Kanter (1983). Until recently, research on innovation has been limited to scientific or social inventions (Nilakanta and Scamell, 1990). Researchers such as Nilakanta and Scamell (1990) and Melone and Bayer (1990) are among the first to investigate the diffusion process of certain information technologies.

Researchers have tried to explain why certain

organizations are more likely to explore and adopt innovations as compared to others. Despite the broad interest, the present knowledge and understanding of the innovation process remains at a relatively undeveloped stage (Biogness, W.J. and Perreault, W.D., 1982; Kelly and Kranzberg, 1978). The past research has been largely fragmentary (Kimberly and Evanisko, 1981) and contradictory (Downs and Mohr, 1976). Researchers have examined isolated stages of the innovation adoption process such as the diffusion stage (Rogers, 1983). Further, researchers have typically looked at technological and administrative innovations in isolation of each other (Utterback, 1974).

Though past research has provided useful insights into specific aspects of innovation, many encompassing problems confronting managers have been overlooked (Van de Ven, 1986). As a result no real theory has emerged that permits researchers to predict the extent to which a given organization will employ a given innovation (Mohr, 1982). Further, the literature offers little guidance to those seeking to influence the rate or direction of technological innovation (Tornatzky & Klein, 1983).

Different Types of Innovations

The literature makes a distinction between radical and

incremental innovations based on the degree of new knowledge contained in the innovation. Researchers have also examined the relationship between technological and administrative innovations.

Radical versus Incremental Innovations

Innovations vary in the degree of newness to the adopting unit. One of the theoretical typologies that has emerged in the literature on organizational innovation is the dichotomy of radical versus incremental innovations (Ettlie, Bridges & O'Keefe, 1984). The radicalness of an innovation can be gauged by the perceived degree of new knowledge brought about by the innovation in question (Dewar & Dutton, 1986, Ettlie, 1983). Radical innovations represent clear departures in fundamental aspects of existing practices (Duschesneau, Cohn & Dutton, 1979; Ettlie, 1983). Incremental innovations represent minor improvements or adjustments to existing practices. Ettlie (1983) suggested that aggressive technology policies accompany radical innovations.

Technical versus Administrative Innovations

Technical innovations concern new technologies,

products and services. They have had a tremendous impact on international trade, industry structure, formation/ development of new firms and in the revitalization of existing firms and industries (Utterback, 1974). A decision to adopt technical innovations is usually driven by the needs of employees in the technical core or needs that arise due to decisions previously taken with regard to domain, structure and scale (Kimberly & Evanisko, 1981).

Administrative innovations involve new procedures, policies and organizational forms (Van de Ven, 1986). Decisions to adopt administrative innovations are driven by managers seeking to insure coordination and control. The complexity of a core technology could stimulate a decision for administrative changes (Kimberly & Evanisko, 1981). Most innovations include both technical and administrative changes (Leavitt, 1965). The success of many technological innovations is largely due to accompanying innovations in institutional and organizational arrangements. Ruttan and Hyami (1984) have shown that many technological innovations could not have occurred without innovations in institutional and organizational arrangements. For example, in a study of hospitals adopting innovations, Kimberly & Evanisko (1981) confirmed that a positive correlation exists between technological and administrative innovations.

A Consolidated Model of Technological Innovation

This section first presents a stage model of technological innovation. The categorization of ISDs into different stages based on the values of depth and breadth of CASE penetration is explained. The second part of this section identifies the correlates of depth and breadth of CASE penetration.

The Stage Model

Innovations infiltrate organizations moving between social units and passing through phases such as awareness, evaluation, adoption, utilization and institutionalization (Beyer & Trice, 1978; Daft, 1982; Ettlie & Vallenger, 1979). However, few studies have assessed the utilization of innovations after their initial adoption (Kimberly, 1981).

It is important to make a distinction between producers of the innovation and users of the innovation. Huber (1984) has asserted the importance of separating the innovation-initiation function from the innovation-production function. The literature points out that the innovation adoption process consists of two distinct stages, namely, initiation and coordinated implementation (Zaltman et al., 1973; Duncan,1977). Van de Ven (1986) has emphasized that

initiation and subsequent diffusion of an innovation are temporal processes. Earlier definitions of innovation have also emphasized the idea of a temporal process.

Some researchers have questioned the validity of stage models (March & Olsen, 1976; Mintzberg, Raisinghani & Theoret, 1976; Witte, 1972). It has been suggested that stage models are more applicable to innovations embodied in concrete products than those embedded in adaptable processes (Pelz & Munson, 1982). Among others, this has been confirmed by Meyer & Goes (1988) in a recent study of equipment-embodied innovations in hospitals. It is, therefore, important to look at the CASE innovation-adoption process with two main stages: exploration and implementation.

Exploration is typically done by few individuals (Huber, 1984; Van De Ven, 1986). In this stage, technology exploration/ assessment groups become aware of the new technology. This study is followed by acquiring some degree of the technology thereby attaining a particular level of "sophistication" with respect to that technology. Members of the exploration groups experiment with the technology. If satisfied with the technology, an attempt is made to diffuse its use to other members within the organizational unit. In the present study, the degree of sophistication of the technology possessed regardless of the degree of usage

is called depth of penetration of the innovation.

An ISD exploring CASE could purchase some CASE tools and thus achieve some level of CASE sophistication. The degree of CASE sophistication possessed (regardless of the degree of its usage) is thought of here as the depth of CASE penetration for that ISD.

Implementation is defined as the aspect of getting all individuals in the organizational unit to use the acquired technology. Van de Ven (1986) defines it as the collective achievement of pushing and riding an innovation into good currency. After the initial start-up, the primary steps will include acceptance, communication and diffusion of the innovation (Utterback, 1974). For purposes of this study, the degree of usage of the technology is called breadth of penetration of the innovation.

After achieving some degree of CASE depth, there would initially be limited usage by experimentation groups. Subsequently, the challenge would be to spread the use of the technology among programmer/analysts. A completely implemented situation would be one where the technology is used essentially by all staff for all projects. The extent of usage of the tool is a measure of breadth of penetration. The stage model of innovation from Chapter 1 is shown in Figure 6 as it would specifically apply to CASE.

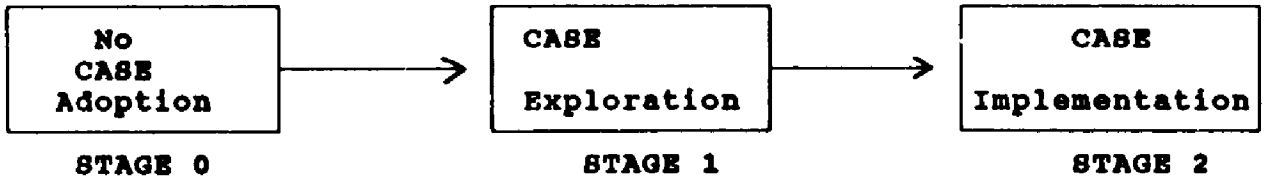

Figure 6: A Stage Model of CASE Innovation

Downs and Mohr (1976) have pointed out that innovation researchers have seldom measured their dependent variables with precision. The most common measure established the date of an innovation's initial adoption. The next common measure drew a nominal distinction between adopters and non-adopters. In the present study, depth and breadth measure the degree of sophistication and degree of usage of the innovation in the adopting unit.

If an ISD possesses some depth of penetration it has entered the phase of exploration. This would include ISDs who have purchased CASE tool(s) and have not started active experimentation or ISDs where some limited experimentation with the technology is occurring.

ISDs with a high breadth of penetration would be in the implementation stage. These ISDs can be further subdivided into two classes namely (i) high breadth, low depth and (ii) high breadth, high depth.

The research models presented in Chapter 1 introduced

the hypothesized correlates of depth and breadth of CASE penetration. The remaining part of this chapter examines these hypothesized correlates of depth and breadth of innovation.

Correlates of Depth and Breadth of Innovation

Environmental Instability

In the post-industrial society, organizations do not have control over their environment (Huber, 1986). Contingency theory and systems theory tell us that in order to survive an organization has to be compatible with its environment. As the environment is continuously changing, organizations must continuously innovate to ensure compatibility with change (Huber, 1986).

The importance of the organization's environmental context has been recognized but rarely examined empirically (Kimberly & Evanisko, 1981). The primary limitation to a firm's effectiveness in innovating appears to be its ability to recognize needs and demands in its external environment (Utterback, 1971).

Technological uncertainty has been recognized as one of the prime determinants of environmental uncertainty (Porter, 1980). A firm could continue to invest in existing

technology, alternatively innovate and adopt another technology or altogether quit the industry (Abernathy & Utterback, 1978). Instability of an organizational unit within its operating environment can be caused by obsolescence of products and services provided (Porter, 1980). The signals to be monitored are changes in demographics, trends in needs, and changes in relative position of substitutes and complementary products.

Duschesneau, Cohn and Dutton (1979) found that environmental uncertainty was related to a shoe firm's competitive strategy to the extent that it became more future oriented and promoted consideration of innovation. Economists hold that competition increases the likelihood of adoption of an innovation (Utterback, 1971). Pierce and Delbecq (1977) have also found that environmental uncertainty is positively related to organizational innovation.

Myers & Marquis (1969) reported statistics on the technical and economic inputs leading to over 500 innovations which were identified by over 100 firms as being their most important new products or processes. 53% of these cases were initiated in response to market, competitive or other factors of the external environment.

Ettlie (1983), in a study conducted with 54 equipment and packaging suppliers in the food processing industry,

found that the organizational policy is related to environmental uncertainty and that policy has an important outcome on the innovative outcomes of the firm.

Based on the above discussion, ISDs which are unstable within their organizations would try to innovate to meet the information demands of the company better. They would try to acquire and use new technologies such as CASE to improve productivity and reduce the environmental instability. Thus, the degree of environmental instability faced by an ISD should be positively related to the sophistication of the CASE tools acquired and the degree of usage of the technology. This leads to the hypothesis:

H(Depth$_1$):	**There is a positive relationship between the degree of environmental uncertainty faced by an ISD and the depth of CASE penetration.**
H(Breadth$_1$):	**There is a positive relationship between the degree of environmental uncertainty faced by an ISD and the breadth of CASE penetration.**

Extent of Specialist Knowledge

Personnel composition has been recognized as the most important source of organizational change (Hannan & Freeman, 1984; Pfeffer, 1983). The existing personnel composition of an organizational unit, if found to be waning in skills and knowledge levels, could be the biggest source of inertia.

The viability of adopting any new technology is greatly influenced by the current state of technical knowledge in the organization (Utterback, 1971). The specialized expertise of members of the organizational unit make available necessary skills required to use a particular equipment (Meyer & Goes, 1988).

An aggressive technology policy promotes the concentration of technical specialists which in turn increases innovation adoption (Duschesneau et al. 1979; Ettlie and Bridges, 1982). Employment of a variety of specialists provides access to broader knowledge of new ideas, techniques and products and becomes an important determinant of adoption and utilization of innovations (Aiken & Hage, 1971; Hage & Aiken, 1967; Mytinger, 1967). Kimberly and Evanisko (1981) found a positive relationship between adoption of innovations in core technologies and the appropriate degree of specialization in the organizational unit.

ISDs with a high degree of knowledge in CASE technology and structured methodology will have the necessary expertise to acquire and experiment with sophisticated CASE tool(s). The diffusion process will be facilitated as programmer/ analysts could address any problems to the specialists. The above discussion leads to the hypotheses:

H(Depth$_2$):	**There is a positive relationship between the degree of knowledge about CASE/structured methodology in the ISD and the depth of CASE penetration.**
H(Breadth$_2$):	**There is a positive relationship between the degree of knowledge about CASE/structured methodology in the ISD and the breadth of CASE penetration.**

Sponsors/Advocates

An essential preinnovation condition is the presence of an innovation champion (Ettlie et al., 1984). The existence of an innovation champion depends on an aggressive technology policy and concentration of specialists (Chakrabarti, 1974). Van de Ven (1986) strongly expresses a predominant view shared by researchers that an innovative idea without a champion will not progress.

The product champion is typically a manager who convinces higher management that a new product or process is feasible and economically attractive and worthy of significant investment (Burgelman and Sayles, 1986).

The degree of sponsorship/championship of an innovation has been associated with higher degrees of innovation in new product management (Chakrabarti, 1974), R & D management (Lovelace, 1986; Glassman 1984) and creativity management (Kanter 1983; Delbecq & Mills 1985).

Zmud (1984) found that managerial influence is stronger for technical than administrative innovations. Daft (1978) presents a contrary argument by saying that skilled individuals may doubt the adequacy of their management's expertise to judge a technical innovation.

Balridge & Burnham (1975) have shown that organizational position and role appear to influence innovative behavior. Ideas gain legitimacy when they are taken up by people who are powerful. It has been shown empirically by Hage and Dewar (1973) and Kimberly and Evanisko (1981) that those who allocate resources can influence adoption of innovations. Innovation adoption is, thus, strongly influenced by those with power, communication linkages, and with the ability to impose sanctions.

The degree of advocacy of CASE is thus expected to relate to the degree of CASE sophistication acquired. The sponsor will encourage experimentation with sophisticated products and will encourage programmer/analysts to use CASE in their system development work. This suggests a positive relationship between the degree of advocacy of CASE technology and the depth and breadth of CASE penetration. This leads to the hypotheses:

H(Depth$_3$):	**There is a positive relationship between the degree of advocacy of CASE technology and the depth of CASE penetration.**
H(Breadth$_3$):	**There is a positive relationship between the degree of advocacy of CASE technology and the breadth of CASE penetration.**

Organizational Size

It is generally held that innovation adoption is positively related to size. Several studies have found a direct relationship between organizational size and the adoption of innovations (Armour & Teece, 1979; Blau & McKinley, 1979; Carter & Williams, 1959; Moch & Morse, 1977; Pierce & Delbecq, 1977; Rogers, 1983). There are two possible explanations for this. First, larger firms are more innovative due to the possible availability of slack resources (Barreyre, 1978; Bourgeois, 1981). Also, certain administrative innovations become necessary as a result of increasing size (Kimberly & Evanisko, 1981). In fact, in a study of innovation adoption by hospitals, it was found that organizational size was the sole determinant of administrative innovations (Kimberly and Evanisko, 1981).

There has been some contradictory empirical evidence on the relationship between organizational size and innovation adoption. Mohr (1969) found a negative relationship between

size and innovation adoption behavior. Mueller et al. (1979) found that small (annual sales under $10 million) food equipment suppliers account for a surprisingly large percentage of innovations (44 percent) among food processor customers. In fact, it has been suggested that mergers and joint ventures between small and large firms occur primarily for innovating purposes (Globerman, 1975; Hlavacek, Dovey & Biondo, 1977; Owen, 1977).

Small firms establish themselves through new product innovations in their industries. Organizations become more conservative as they grow into medium and large sized organizations. The risk of changing established technologies is greater for larger organizations because of the degree of investment in existing technologies and procedures (Ettlie, 1983).

A compromise position was adopted by Kimberly & Evanisko (1981) i.e. size promotes innovation adoption up to a point after which diminishing returns set in. They empirically showed that the natural logarithm of organizational unit's size was positively related to administrative and technological innovation adoption by hospitals. The same relationship was confirmed by Meyer and Goes (1988) in a study of the assimilation of 12 medical innovations by 25 hospitals. Nilakanta and Scamell (1990) found that organizational size served to enhance both the

initial adoption and subsequent implementation of incremental data base innovations in data processing centers. These include tools used for requirements analysis functions. However, they found that increases in size had no impact on the diffusion of logical data base design tools during the implementation phase. Their results are to be viewed with caution as they used only two categories for size in their analysis (>= 100 employees and < 100 employees). Further, their sample included only 22 organizations from the Houston area. In spite of its limitations, though, the above study suggests that, as the degree of sophistication of tools increases, the size of the organization will have no impact on the diffusion of the technology.

The accumulated empirical evidence suggests that size of ISDs should positively influence innovation acquisition and implementation. However, very large ISDs will find it difficult to acquire and implement sophisticated CASE tools due to the high degree of investment in existing system development technologies and approaches. A lot of the resources of such ISD's are typically consumed to support existing procedures and systems.

At the other end of the spectrum, very small ISDs will not have resources to acquire and implement sophisticated CASE tools. Thus, size of the ISD should be positively

related to the degree of sophistication and degree of usage of CASE to a point after which diminishing rates of increase will result. This suggests the hypotheses:

H(Depth$_4$):	**There is a positive relationship between the natural logarithm of size of an ISD and the depth of CASE penetration.**
H(Breadth$_4$):	**There is a positive relationship between the natural logarithm of size of an ISD and the breadth of CASE penetration.**

Communication with External Information Sources

Innovation is most often the result of the communication of a need followed by the search for information about a means to meet the need (Utterback, 1971; Baker, Siegman & Rubenstein, 1967). The need could be one of new demands or dissatisfaction with existing products/services.

It is, therefore, important to trigger peoples' action thresholds to pay attention to new ideas, needs and opportunities. The managing of information flow from both the economic and technical information environments into the firm becomes an important issue for managers seeking to maintain a culture of continuous improvement and innovation (Van de Ven, 1986). This leads to direct personal

confrontations with problem sources and motivates people to take corrective action.

Information about technical means normally comes from technical sources. This includes technical literature, discussions outside the firm, membership in trade or professional associations, contact with vendor representatives and professional seminars. Further, transfer of information appears to occur more often through discussion and personal contact than through other means.

Tushman (1977) has developed an information processing view of the organization innovation process. Individuals play special boundary roles contingent on the nature of the organization's work. These boundary roles help link the organization's innovative system with various sources of external information and feedback. The innovation adoption takes place through a limited set of individuals able to translate external information to internal decisions.

In general, boundary transfers could occur due to:

(1) someone within the firm communicating with technical sources outside the firm and with end-users of information within the firm,

(2) migrating personnel across organizational boundaries. This includes migration from customers' and competitors' organizations, universities etc.

(3) employing consulting relationships (Utterback, 1971).

Thus, the greater the degree of communication between the firm and external information sources, the more effective the firm will be in generating new technology.

The primary research on this topic has been done in areas in which the individual is the adopting unit (Coleman, Katz & Menzel, 1966; Burt, 1973). These researchers found communications to be central to the adoption of innovations by individuals.

Very little research has been done on this topic at the organizational level. Kimberly (1978) found a positive relationship between integration with external sources of information and innovation adoption by hospitals. Nilakanta and Scamell (1990) found that though external information sources and communication channels are necessary for the diffusion of innovations, their effects on the diffusion process are not uniform across all stages. The degree of communication with external information sources has a stronger impact on the diffusion of relatively newer technologies. It is to be recognized that information sources, and the amount of communication with each source, will impact innovation diffusion.

ISDs with greater communication with the external environment about CASE technology will be aware of the latest product developments and their capabilities. Exposure to different CASE products through different forms

of communication might lead to discussions, evaluations and, perhaps a decision to acquire and experiment with the technology. Communication with external information sources creates the "awareness" necessary for the possible entry of a new technology such as CASE into an organizational unit. Thus, communication should relate positively with the degree of CASE sophistication acquired and not with the degree of usage by programmer/analysts for the various projects in the ISD.

This leads to the hypothesis:

$H(Depth_5)$:	**There is a positive relationship between the degree of communication with external information sources about CASE technology and the depth of CASE penetration.**

Performance Gap

A performance gap can result from changing the output standards required from an organizational unit as well as from declining performance standards (Hage, 1980). Performance gaps could also be caused by changes in the technological environment or due to increasing pressure from competitors (Zaltman, Duncan and Holbeck, 1973).

March and Simon (1958) suggest that the rate of innovation is likely to increase when changes in the

environment make existing organizational procedures unsatisfactory. They predict innovation in a company whose share of the market, total profits, or rate of return on investment has declined. The primary motive for innovating in such cases would be to remain competitive.

Duchesneau et al. (1979) found that performance gaps perceived by managerial staff were consistently good predictors of the adoption of innovations by U.S. shoe manufacturers. Some contradictory evidence has been provided by Ettlie (1983). In a study of supplier firms in the food processing industry, he found that extreme performance gaps adversely affect slack resources for innovation.

ISDs suffering from performance gaps categorized by high maintenance times, large user backlogs, lack of integration of systems and poor quality of code will possibly try to use productivity enhancement technologies such as CASE to maintain existing systems and build new ones. The use of CASE might be a viewed as a possible remedy to performance problems.

The existence of a performance gap will possibly initiate exploration of CASE by the acquisition of some degree of CASE sophistication (depth). The propagation of the technology across the organizational unit to address performance gaps will only occur subsequently. The above

discussion suggests that a performance gap might initiate the examination of CASE by the acquisition of some degree of sophistication. Experimentation groups will examine the technology in pilot projects and if found suitable, diffusion efforts will be subsequently initiated by using training programs and other means. Thus, the existence of a performance gap should influence the degree of sophistication acquired. This leads to the hypothesis:

$H(Depth_6)$:	**There is a positive relationship between the degree of performance gap faced by an ISD and the depth of CASE penetration.**

Functional Differentiation

Functional differentiation represents the extent to which an organization is divided into a number of subunits. Horizontal differentiation is the most common operational definition of complexity (Hall, 1987) i.e. number of different services provided. Rogers (1983) found that structural complexity is positively related to the adoption of innovations. It has been generally hypothesized that a high degree of functional differentiation leads to increased adoption of innovations (Hage & Aiken, 1967; Hyderbrand, 1973; Kimberly & Evanisko, 1981).

There is a strong connection between special structural arrangements and an aggressive technology policy. An aggressive technology policy promotes the development of specialized structural arrangements (Ettlie et al., 1984). One of the most typical of these is the division of an organizational unit into multiple interest groups. Such interest groups examine possible elaboration of technologies in which they are most interested.

In an ISD, the existence of distinct functional groups concerned with systems development will imply efforts to elaborate the sophistication of technologies used to build and maintain systems. Examples of such groups are standards, research/technology exploration, testing and methodology groups. These functional groups will serve to examine alternative technologies which could improve the systems development process currently in place in their ISDs. Thus, such functional groups can play an important role in determining whether a technology such as CASE should "enter" the ISD and what degree of sophistication should be acquired. However, they may not be directly involved in getting all programmer/analysts to use it in their everyday systems work. Thus, it is expected that there will be a positive relationship between the degree of functional differentiation and the degree of CASE sophistication possessed by an ISD.

This leads to the hypothesis:

H(Depth$_7$):	**There is a positive relationship between the degree of functional differentiation in an ISD and the depth of CASE penetration**

Risk Aversiveness of the Corporate Culture

It is important to maintain experimenting organizations in the post-industrial environment (Hedberg, Nystrom & Starbuck, 1976). Experimenting organizations would be effective discoverers of innovations (Huber, 1984). The word "experimenting" implies a corporate culture that supports investments in R&D and technology exploration activities.

The IS literature documents that fast payback and stringent ROI calculations will not justify investment in many sophisticated information technologies (Runge and Earl, 1988; Emery, 1987). An ISD that does not rely on fast payback and stringent ROI calculations would be able to purchase and experiment with the more sophisticated and expensive CASE tools. Corporations recognizing gradual intangible benefits that could emerge from the use of CASE such as overall improvement in the quality of their organizational information systems will be more likely to acquire powerful CASE products. The above discussion shows

that risk aversiveness of the corporate culture may determine the approach used to compare possible payoffs and costs involved in acquiring a certain degree of CASE sophistication. This could directly impact the degree of CASE sophistication that "enters" the ISD and not the propagation and usage of the technology by members of the ISD. The above discussion suggests that a negative relationship should exist between the degree of risk aversiveness of the corporate culture and the depth of CASE penetration.

This leads to the hypothesis:

$H(Depth_8)$:	**There is a negative relationship between the degree of risk aversiveness of the corporate culture and the depth of CASE penetration.**

Institutional Leadership

Institutional leadership has been qualified as the strategic problem of innovation. Institutional leadership is critical in creating a cultural context that fosters innovation and in establishing organizational strategy, structure and systems that facilitate innovation (Van de Ven, 1986). Hackman (1984) points out that "an unsupportive organizational context can easily undermine the positive features of a well designed team".

Innovation requires a supportive kind of leadership:

> "This type of leadership offers a vision of what could be and gives a sense of purpose and meaning to those who would share that vision. It builds commitment, enthusiasm and excitement. It creates a hope in the future and a belief that the world is knowable, understandable and manageable. The collective energy that transforming leadership generates, empowers those who participate in this process. There is hope, there is optimism, there is energy" (Roberts, 1984 p.3).

Selznick (1957) emphasizes that the control and distinctive responsibility of institutional leadership creates the organization's character or culture. In this context, top management has four key functions:

1. defining the institution's mission
2. embodying purpose into the organization's structure and systems
3. defending the institution's integrity and
4. ordering internal conflict.

Lodahl and Mitchell (1980) point out that an innovation is an institutional success to the degree that it exhibits authenticity, functionality, and flexibility over time. Authenticity requires that the innovation embodies the organization's ideas; functionality requires that the innovation work; and flexibility requires that the innovation can incorporate the inputs and suggestions of its members. If institutional skills are not used while technical skills are in operation, the innovation may be an

organizational success but an institutional failure. Typically such innovations will be characterized by individual self-interest, differentiation and technical efficiency. However, there will be clear evidence of drift and disillusionment.

Messages about the adoption of an innovation issued by an "authority source" (Kocher & Deutsch, 1980) generally alter the receiver's adoption decision process. The alteration could be caused by making the decision for the receiver or by enforcing a decision already made. The message is much more likely to elicit action than a message issued by a person without authority (Price, 1968).

There have been several studies that have shown a positive relationship between the extent to which an organization's CEO champions adoption of an innovation and the actual adoption of the innovation by the organization (Beyer & Trice, 1978; Daft & Becker, 1978). In a recent study of medical innovations in hospitals, Meyer & Goes (1988) found that CEOs have a substantial impact on the assimilation process by championing specific innovations. In a study of supplier firms in the food processing industry, Ettlie (1983) found that the successful development and marketing of innovations required top management involvement. This reduced the risk barriers of adoption, integrated marketing and technical efforts, and

increased the probability of success of a new venture by insuring concentration of the most skilled personnel in the innovative effort.

On the contrary, Lieberson & O'Connor (1972) found that industry and company factors accounted for more variance in certain indicators of performance in large corporations than did leadership effects. Tornatzky et al. (1983) concluded that leader characteristics afford poor predictions of innovation adoption. In a study of mayors' effects on city budgets, Salanick & Pfeffer (1977) found that leadership effects are constrained by factors such as the potency of organized interests and contextual factors over which the leader has virtually no control.

In general, there is a considerable debate found in the literature concerning the effects of leaders on organizational outcomes. Whether leaders' impacts on their organizations are instrumental or symbolic is an unresolved issue (Pfeffer and Davis-Blake, 1983).

Lederer and Mendelow (1986) showed that top management in many organizations view IS in a strictly operational sense. They consider any investment in the technology as a necessary evil to facilitate labor reduction and enhance operational efficiency. Thus, in many organizations the IS function is not linked to the business plan and consequently does not receive support from top management.

The importance of degree of top management support for the IS function in assimilating new technologies seems apparent. The implementation of new ITs will be aided and expedited by the fact that top management has a keen interest in the IS function. The above discussion does not suggest advocacy of CASE by top corporate management. On the contrary, what is of interest is whether top management is a champion of the broader area/function within which the innovation is applicable. Of course, it is possible that top corporate management in some firms (perhaps very few) might be direct advocates of CASE as well. The above discussion clearly shows that top management's support for IS will encourage the usage of new technologies such as CASE but will not play a direct role in determining the degree of sophistication of CASE that will enter the ISD.. Thus, the degree to which top management supports the IS function should be positively related with the breadth of CASE penetration. This leads to the hypothesis:

H(Breadth$_5$):	**There is a positive relationship between the degree of top management support for IS and and the breadth of CASE penetration.**

Training

Schien (1985) suggests that negative attitudes towards a technology may be rooted in technological inertia. Chao and Kozlowski (1986) in their study of employee perceptions of robotic technology decomposed technology attitudes into feelings about the new technology itself and views about the impact of the new technology on job content. They concluded that training not only imparts necessary skills but also generates positive feelings about the new technology by enriching the job content. In a study of innovation adoption in hospitals, Greer (1986) found that the skill required to use an innovation would be a less important determinant of adoption in a hospital where medical training was relatively recent. Popper (1983), in a study on the implementation of structured methodologies for systems development found that the rate of diffusion of an innovation can be influenced by training.

In their study on the adoption of Ada by 66 aerospace and defense industry software firms, Melone and Bayer (1990) found that groups that had obtained high degrees of implementation were allocating large amounts of resources toward in-house training. It follows from the above discussion that, in an ISD, the availability of company training in CASE technology and structured methodologies

will influence the degree of usage of CASE technology observed in an ISD. Further, as sophisticated CASE tool(s) focus on logical as opposed to physical detail, an attempt to retrain the technical 3GL programmer has to be made. It is important to ensure that, in the retraining process, the technical programmers are convinced that the new technology will lead to job enrichment and will not deskill them.

However, training should not directly impact the degree of CASE sophistication entering the organizational unit as it is primarily used by companies to educate and provide their staff with the necessary skills needed to use new technologies that have been acquired. The above discussion suggests a positive relationship between the degree of training provided to programmer/analysts in CASE/structured methodology and breadth of CASE penetration. This leads to the hypothesis:

$H(Breadth_6)$:	**There is a positive relationship between the degree of CASE/structured methodology training provided to programmer/analysts and the breadth of CASE penetration.**

Job Stability

Employees need to effectively predict what they face in the future (Mealiea, 1978). Resistance to change is inevitable if employees perceive the source of change would delete entire functions or cross departmental boundaries (Tomeski, 1975). Employees might find themselves in a situation where present skills are obsolete due to restructuring in tasks, technology and work flows. Employees if rotated among different job responsibilities/ tasks would possess a broader "skill" base. They would be consequently more open to innovations that cross boundaries but enhance productivity.

Van De Ven (1986) says that individuals, if rotated among various functions, will appreciate how each function relates to the other. Individuals in such organizations will have a better understanding of how acquired innovations relate to the "master blue print" of the composite of all functions.

CASE might be viewed by some as a deskilling technology. The technical programmer may think that his importance will be diminished due to an increased focus on logical aspects. Further, CASE does mandate increased communication between people in the data administration and the systems analysis functions. As the technology calls for

skills which span certain traditional system development functions, some programmer/analysts might resist the implementation of the technology.

On the contrary, the overall understanding and appreciation for the technology will be greater if programmer/analysts are rotated among different functions or have blended job roles of analysis and design. This approach will instill an atmosphere of learning among members of the organizational unit. Job/role rotation thus should not influence the degree of sophistication entering an ISD but should facilitate the assimilation of a task integrative technology such as CASE by making essentially all programmer/analysts possess a broader skill set compared to the isolated programmer and analyst approach.

It is, therefore, expected that a positive relationship will exist between the degree of job/role rotation of employees within the ISD and the degree of usage of CASE. This leads to the hypothesis:

$H(Breadth_7)$:	**There is a positive relationship between the degree of job/role rotation in an ISD and the breadth of CASE penetration.**

This completes a discussion of the hypothesized correlates of depth and breadth of CASE penetration.

Another interesting relationship to be examined is that between depth and breadth of CASE penetration. These two dependent variables have been formulated for the first time in the present study. Naturally, no past empirical evidence exists on the direction of the relationship.

A negative relationship might exist between the degree of sophistication of CASE acquired and the degree of its usage. The contention is that the "effort" required to diffuse higher degrees of CASE sophistication will be more than that required to diffuse lower degrees of CASE sophistication.

However, on the contrary, ISDs acquiring sophisticated CASE tools might have the organizational support characteristics needed to bring the acquired degree of CASE to rapid use.

Thus in addition to testing the hypothesis relating to the correlates of depth and breadth of CASE, the relationship between the degree of sophistication of CASE possessed by an ISD and its degree of usage will also be examined. As the relationship is being explored for the first time and no past studies have been done along these lines, a formal hypothesis is not stated.

There is little doubt that a positive relationship will exist between the time elapsed since initial adoption of a new technology such as CASE and the extent of its

assimilation. CASE emerged about three years ago and has developed rapidly since. CASE was made available to all ISDs interested in exploring the technology at the same time when it first entered the market.

Some ISDs started exploring the technology immediately, others followed a little later, and there are some who have not yet started any exploratory activities. The present study is specifically interested only in the organizational type variables which determine the innovativeness of an ISD. The innovativeness is measured using the constructs of depth and breadth of CASE penetration.

CHAPTER 3

METHODOLOGY OF THE STUDY

Overview

This chapter discusses the methodology employed in the present research. The study uses CASE technology as a convenient instance of a technological innovation to test the proposed theoretical model. A detailed discussion of the hypothesized correlates of depth and breadth of CASE was presented in Chapter 2. The first part of this chapter restates the research questions and also proposes all the null hypotheses of the study.

As a first step towards validating the hypothesized model, senior IS managers from 13 organizations in the northeastern Ohio area were interviewed. The interviews were conducted to provide preliminary confirmation of the theoretical model and to help in operationalizing variables. The methodology and interviews results are presented in the second part of this chapter.

After the interviews were completed, a draft of the survey instrument was developed. The resulting draft was then tested in a pilot study. Based on the feedback received from the pilot, minor revisions were made to the instrument. The details of the drafting of the measurement instrument and pilot testing have been discussed in the third part of the chapter.

The fourth part of the chapter discusses the details of

conducting the national survey. This includes details of the final measurement instrument used, the sampling procedure employed and mechanics of the questionnaire administration. The changes made to some scales to improve their internal consistencies, prior to data analysis, are also discussed.

Research Questions

The research objectives of this study which appear in Chapter 1 are reproduced here for the reader's convenience. The primary research objectives were to determine :

1. Variables that relate significantly to depth of CASE penetration.
2. Variables that relate significantly to breadth of CASE penetration.

A secondary research objective was to develop descriptive classifications of ISDs by industry, based on the depth and breadth of CASE penetration.

As discussed in Chapter 2, each primary research question led to a number of hypotheses. All the null hypotheses that emerged are stated in the next section.

Hypotheses

This section lists each hypothesis in true null hypothesis form. Each hypothesis is labeled to indicate the research question with which it is associated. The first field in the parentheses following each hypothesis will contain "Depth" or "Breadth" for research question 1 or 2. The second field indicates the hypothesis number for the particular research question.

Hypothesis (Depth, 1)

H_o: There is no significant relationship between the degree of environmental uncertainty faced by an ISD and the depth of CASE penetration.

Hypothesis (Depth,2)

H_o: There is no significant relationship between the degree of specialist's knowledge in the ISD of CASE technology and structured development methodologies and the depth of CASE penetration.

Hypothesis (Depth,3)

H_o: There is no significant relationship between the degree of sponsorship of CASE technology and the depth of CASE penetration.

Hypothesis (Depth,4)

H_o: There is no significant relationship between the natural logarithm of size of an ISD and the depth of CASE penetration.

Hypothesis (Depth,5)

H_o: There is no significant relationship between the degree of communication with external information sources about CASE technology and the depth of CASE

penetration.

Hypothesis (Depth,6)

H_o: There is no significant relationship between the degree of performance gap of an ISD and the depth of CASE penetration.

Hypothesis (Depth,7)

H_o: There is no significant relationship between the degree of functional differentiation within the ISD and the depth of CASE penetration.

Hypothesis (Depth,8)

H_o: There is no significant relationship between the degree of risk aversiveness of the corporate culture and the depth of CASE penetration.

Hypothesis (Breadth, 1)

H_o: There is no significant relationship between the degree of environmental uncertainty faced by an ISD and the breadth of CASE penetration.

Hypothesis (Breadth,2)

H_o: There is no significant relationship between the degree of specialist's knowledge in the ISD of CASE technology and structured development methodologies and the breadth of CASE penetration.

Hypothesis (Breadth,3)

H_o: There is no significant relationship between the degree of sponsorship of CASE technology and the breadth of CASE penetration.

Hypothesis (Breadth,4)

H_o: There is no significant relationship between the natural logarithm of size of an ISD and the breadth of CASE penetration.

Hypothesis (Breadth,5)

H_o: There is no significant relationship between the degree of top management support for IS and the breadth of

CASE penetration.

Hypothesis (Breadth,6)

H_o: There is no significant relationship between the degree of CASE training provided to programmer/analysts and the breadth of CASE penetration.

Hypothesis (Breadth,7)

H_o: There is no significant relationship between the degree of job/role rotation of programmer/analysts and the breadth of CASE penetration.

A preliminary assessment of these hypotheses was performed during the interview process. The next section describes the methodology and results of the interviews.

Interviews

Method

As suggested by Kerlinger (1986), interviews were used as exploratory devices in the present research project. They were used to confirm the rationale of the study, provide insight into hypothesized relationships and determine methods of operationalizing variables. Interviews were conducted with 13 senior IS managers in different northeastern Ohio companies. In 4 instances there were two interviewers and in 9 instances there was one interviewer. The interviewees were asked questions to determine the types of tools possessed by the ISDs and the degree to which CASE

was being used for different system development functions. Questions were also posed to gauge organizational characteristics of the ISD. Notes were taken during the interviews. Transcripts of each interview were typed shortly after the conclusion of the interview.

Observed Stages

The interviews confirmed that CASE was an innovation of tremendous interest to the IS practitioner. Further, there was a consensus that no mature CASE product existed in the market that could be classified as a true "full life cycle" CASE tool.

There was only one ISD that had not acquired a CASE tool. Among the others, there was a variation in the degree of sophistication of CASE tools acquired for different system functions. Variation in the degree of actual use of CASE tools for different system functions was also observed. Most of the ISDs were experimenting with acquired tools. Some were using them on a routine basis.

Some preliminary support was provided for the idea that CASE innovation occurs in stages. The one ISD that had not acquired a CASE tool could be classified in Stage 0 (no adoption). ISDs that were experimenting with the technology could be classified to be in Stage 1 (technology

exploration). Those who were using CASE technology on a routine basis could be classified to be in Stage 2 (coordinated implementation).

ISDs observed in Stage 1 could be further classified into three sub-categories based on the degree of sophistication of CASE tools possessed:

1. some depth, no breadth: CASE tool(s) acquired by the ISD but no use of the tool(s) is taking place.
2. low depth, low breadth: The portfolio of CASE tools possessed by the ISD are of a low degree of sophistication. The degree of usage of CASE is at an experimental level.
3. high depth, low breadth: The portfolio of CASE tools possessed by the ISD are highly sophisticated. The degree of usage of CASE is at an experimental level.

Similarly, ISDs observed in Stage 2 could be further classified into two sub-categories based on the degree of sophistication of CASE tools acquired:

1. low depth, high breadth: The portfolio of CASE tools possessed by the ISD represent a low degree of sophistication. Further, CASE is used on a routine basis.
2. high depth, high breadth: The portfolio of CASE tools possessed by the ISD represent a high degree

of sophistication. Further, CASE is used on a routine basis.

Thus, a more comprehensive classification of ISDs is obtained by using the dimension of degree of sophistication in conjunction with the dimension of degree of usage of CASE.

Preliminary Observed Relationships

ISDs operating in uncertain environments felt that environmental uncertainty and economic instability were impediments to the acquisition and implementation of innovations such as CASE. In such situations, resources were typically cut back from technology exploration activities. As a consequence, innovations such as CASE could not be explored. Further, ISDs that had acquired CASE tool(s) were constrained by the resources available in implementing the technology. The interviews suggested a negative relationship between the degree of environmental uncertainty and the depth and breadth of CASE penetration. This is contrary to the relationship suggested by the literature.

The IS managers felt that the existence of in-house CASE expertise encouraged the acquisition of new CASE tools. Further, expertise was voiced as a necessary resource in the

subsequent diffusion of CASE. Thus, the interviews suggested that a positive relationship may exist between degree of knowledge in CASE/structured methodology and the depth and breadth of CASE.

ISDs with strong CASE advocacy were using sophisticated tools. They played an important role in convincing top management of the importance of the technology. In some cases, they were instrumental in getting funds released for exploratory activities. Further, the sponsors made efforts to diffuse the use of CASE among programmer/analysts as the sponsors were convinced that CASE was a productivity tool. This suggested that a positive relationship may exist between the degree of sponsorship of CASE technology and the depth and breadth of CASE penetration.

Some ISDs were characterized with high degrees of communication about CASE. The information sources included peers in other companies, vendor representatives, trade publications, product shows, attendance of seminars, electronic networks, etc. Some ISDs used these sources to maintain a strong information link with developments in the CASE market. These ISDs possessed the more powerful CASE products and were conversant with latest developments in the technology. This suggests that a positive relationship may exist between degree of communication with external

information sources and depth of CASE penetration.

The larger ISDs were concerned about the substantial resources required to acquire reasonable sophistication and consequent diffusion of CASE technology. Also, the very small ISDs complained of inadequate resources to acquire and implement a new technology such as CASE. Thus, the interviews seemed to suggest that a positive relationship exists between the size of an ISD and the depth and breadth of CASE technology, up to a point, after which there are diminishing rates of increase in innovation penetration.

All 13 IS managers viewed CASE as a promising technology to address performance problems. ISDs that were using CASE reported significant improvements in terms of maintenance time, user- backlogs, quality of code, documentation and integration between systems. All ISDs were hopeful of acquiring CASE tools so as to help them meet expected performance standards. The interviews suggested a positive relationship between the degree of performance gap of an ISD and the depth of CASE penetration.

Some ISDs had distinct functional groups to monitor performance standards, assess, experiment and test new technologies. Consequently, they served as agents to investigate improved system development approaches. It was observed that ISDs with these functional groups possessed sophisticated CASE products. A positive relationship may,

therefore, exist between degree of functional differentiation and depth of CASE penetration.

All 13 organizations demanded some kind of payback calculation prior to making investment decisions. However, there was a great variation in payback periods required to justify investments. They ranged from a couple of months to 3 years. ISDs not pressured to demonstrate quick returns could invest in sophisticated and expensive CASE products. Though most ISDs did not have separate R&D budgets, some had discretionary resources for technology exploration. Others had to convince top management of the necessity to acquire a new technology before resources were made available. The former were, then, less averse to taking risks. These ISDs were exploring other new ITs such as artificial intelligence, end-user computing and relational databases. The above observations suggested that a negative relationship may exist between degree of risk aversiveness of the corporate culture and depth of CASE penetration.

Lack of top management participation in the IS function was a common grievance voiced by many interviewees. If top corporate management recognized data as a strategic resource, their involvement and consequent support for the IS function was high. The use of new information technologies such as CASE was encouraged. Such ISDs actively deployed CASE tools in new projects, conversion of

old systems and encouraged all programmer/analysts to use the technology. Some support is provided for a positive relationship between top management's support for IS and breadth of CASE penetration.

A variety of training approaches were adopted by different ISDs. These included training the trainer, continuing education classes, using consultants or training in-house. ISDs with such training programs found it easier to diffuse the technology and were characterized by a greater breadth of CASE penetration.

ISDs with high degrees of CASE usage recognized that training in both system development methodologies and CASE tools was critical. Retraining of the technical programmer was voiced as an important concern. CASE technology focuses on logical and analytical aspects of system development as opposed to physical coding. One IS manager said "Looping in logical design/analysis is the crux of CASE as opposed to the conventional approach of looping in cumbersome physical code". The interviews suggest that a positive relationship may exist between the degree of training provided to programmer/analysts and the breadth of CASE penetration.

Powerful CASE tools provide an integrated platform for analysis, design, implementation and maintenance. The interviews confirmed that programmer/analysts who had worked in multiple phases of the systems development life cycle --

each worker in several phases -- would find it easier to use such CASE tools. Thus, the diffusion of CASE will be easier in environments where the job roles of programming and analysis are blended. Thus, a negative relationship may exist between the degree of job role stability of programmer/analysts and breadth of CASE penetration.

The interviews provided some preliminary support for the hypotheses. A draft survey instrument was then developed based on these interviews and relevant literature from the fields of organizational innovation, IS implementation and CASE technology. The details of the draft survey instrument and the pilot study conducted are described in the next section.

Pilot Study

Method

A pilot test of the measurement instrument was conducted with 21 IS managers. These included the 13 IS managers who were interviewed and 8 others. This sample was selected for convenience as the intent was to ensure clarity of instructions and questions prior to the large scale national mailing. As in the case of the interviews, only one IS manager from each ISD was included in the mailing

list. The draft questionnaire with an accompanying cover letter and reply paid return envelope was mailed to the IS managers on 22nd March, 1990. A copy of the questionnaire with the cover letters used is included in Appendix 1.

The IS managers were asked to answer the questionnaire and make any suggestions prior to the national mailing. Of the 21 questionnaires mailed out, 14 were returned representing a response rate of 66.67 %.

Draft Measurement Instrument

This section discusses the operationalization of all variables in the pilot study. The variables were operationalized using a consolidated questionnaire composed of different measurement scales and questions. Table 1 identifies the class of each variable, the relevant research question associated with the variable, the polar extremes of each measurement scale, the range of possible values and the items associated with each variable in the draft instrument.

The questions associated with each variable were intentionally scattered throughout the questionnaire to eliminate response bias due to patterning of responses. To further reduce response bias, most scales were a mixture of directly and inversely worded items.

Questions 45 and 46 were included to collect additional

descriptive data. These items included 1) time since the ISD began experimentation with CASE and 2) the four most-used CASE tools in the ISD.

Table 2

Variables & Scales in the Pilot Questionnaire

Variables	Short Name	Research Question	Polar Extremes	Range of Possible Values	Items
Depth of CASE penetration	DPTH	1	Do Not Possess this Tool - Have Tools of Very High Sophistication	0-65	13 items. Table on 1st Page
Breadth of CASE penetration	BRTH	2	Tool Not Used At All - Tool Used on a Routine Basis	0-65	13 items. Table on 2nd Page.
Environmental Instability	ENVU	1,2	Strongly Disagree - Strongly Agree	4-28	1,15, 22,30
Knowledge Of CASE/Structured Methodologies	KNOW	1,2	Strongly Disagree - Strongly Agree	4-28	8,23, 32,41
Sponsorship of CASE Technology	SPON	1,2	Strongly Disagree - Strongly Agree	4-28	19,26, 38,43
Size of the ISD	SIZE	1,2		1-7	44
Communication with External Sources	COMM	1	Strongly Disagree - Strongly Agree	4-49	5,11,14 18,37, 39,42
Performance Gap of the ISD	PERF	1	Strongly Disagree - Strongly Agree	4-28	2,9, 25,40
Functional Differentiation within the ISD	FDIF	1	Strongly Disagree - Strongly Agree	4-28	24,29, 31,34
Risk Aversiveness of the Corporate Culture	CCUL	1	Strongly Disagree - Strongly Agree	4-28	3,13, 27,35
Top Management Support for IS	TMGT	2	Strongly Disagree - Strongly Agree	4-28	6,20 21, 33
Training in CASE/ Structured Methodologies	TRNG	2	Strongly Disagree - Strongly Agree	4-28	4,10, 12,16
Job Stability in the ISD	JSTB	2	Strongly Disagree - Strongly Agree	4-28	7,17, 28,36

Modification of Draft Questionnaire

The feedback received from the pilot and an inspection the responses resulted in some minor changes to the questionnaire. Items 3, 6, 22, 25, 29 and 36 were reworded. Item 44 (size of the ISD) was changed to include three additional categories. Also, item 46 was changed from "what the four most-used CASE tools", to " ..... the six most-used CASE tools". Question 47 on industry classification was deleted since the national mailing list acquired provided the industry classification of all ISDs.

The details of the national survey in terms of sample characteristics, description of the final measurement instrument and administration of the questionnaires is discussed in the next section. The final form of the questionnaire is shown in Appendix 2.

The National Survey

Sample Selection

The sample was selected from the population of ISDs in U.S. organizations. A mailing list purchased from Applied Computer Research Inc., Phoenix, Arizona, was used for the present study. This list was selected after an extensive

search of a suitable mailing list for the present study. A further consideration was the fact that the chosen mailing list is updated twice a year thereby ensuring its currency.

The mailing list includes 11,626 mainframe sites and titles of 34,581 executives across the country. The organizations listed had to meet at least one of three criteria to be included. These criteria are : (i) a company within the fortune 500 and the six non-industrial sectors or, (ii) a company with an MIS budget exceeding $ 250,000 or, (iii) a company with an annual sales greater than $50 million.

This list was sorted by state, city and name of the organization. A systematic simple random selection of 3,000 MIS executive names and addresses were then obtained from the vendor. The use of the systematic random selection technique on a sorted list ensures the representativeness of the obtained list and the source list. Thus, any company in the source list is equally likely to be present in the obtained list.

The vendor provided the industry classification of each ISD. Multiple records from a site (an ISD) were eliminated and only the first occurrence was retained. This was done to ensure that only one questionnaire was sent to each ISD and that the questionnaire was directed to the most senior manager in that ISD. A total of 2,740 ISDs were retained

after this revision.

Measurement

The details describes the measurement instrument used in the national study. Table 3 gives details of the variables, the items composing each scale and range of possible values in the final form of the questionnaire. The final form of the questionnaire is included in Appendix 2.

The dependent variable, depth of CASE penetration, was measured by asking respondents the degree of sophistication of CASE tools possessed by their ISDs, regardless of the degree of use, for thirteen important system development functions. The thirteen functions were identified based on the functions during the different phases of the systems development life cycle. The relevance and reasonable completeness of the list was confirmed during the interviews.

The other dependent variable, breadth of CASE penetration, was measured by asking respondents the degree of CASE usage for each of the thirteen system functions identified.

The independent variable items measured characteristics of the ISDs. Size of the ISD was operationalized by using the number of full-time employees (operations, development

etc). For the other variables, respondents were asked to answer each item on a seven point Likert scale ranging from "Strongly Disagree" to "Strongly Agree". Typically, a four item scale was used to operationalize a variable. These scales had some items which were worded in a reverse manner. The answers to reversed items were scored accordingly. However, a seven item scale composed entirely of all directly worded questions was used to measure the degree of communication with external information sources.

A four item scale was developed to measure the degree of environmental uncertainty. Two items asked direct questions on the stability of the respondent's ISDs. The other two items measured the threat to the ISD stability due to the advent of end-user computing and the use of outside contractors.

A four item scale was created for this study to measure the degree of expertise/knowledge in CASE/structured methodology in the ISD.

A four item scale was constructed to measure degree of CASE advocacy. The items gauged the degree of advocacy and enthusiasm for CASE by members in the corporation/ organization.

A seven item scale was created to measure the amount that was learned about CASE by programmer/analysts from different external information sources. Most communication

sources considered were adapted from Nilakanta and Scamell's (1990) list of external communication sources impacting the diffusion of database technology in organizations. These included seminars and product shows, consultants, trade publications, vendor representatives, video/audio tapes, text and reference books and through contacts with programmer/analysts in other organizations. Items were reworded to apply to CASE.

The number of full-time employees (operations, development etc.) was used as a surrogate of size of the ISD. It was measured using one question which considered 10 possible ranges of size. The first range was 1-10 people and the 10th range was > 350 people.

A four item scale was developed to assess the degree of deviation in performance standards from those expected from the ISD. Specifically, system development backlog, user-satisfaction and pressure to improve performance were used to operationalize the measurement of this variable.

A four item scale was developed to measure the degree of functional differentiation in an ISD The different functional groups considered included a methodology, standards, testing, R&D, experimentation, technology exploration and other specialized technical groups.

A four item scale was created to assess the degree of risk aversiveness of the organization towards investments in

new projects/slow return technologies. The items considered the portion of the IS budget being used for R&D/technology exploration, pressure on the ISD to demonstrate quick return on investments and overall propensity of the organization to invest in slow return technologies/risky projects.

A four item scale was developed to measure the degree of support provided by top management to the IS function. Items assessed the degree to which top management championed innovations in IS, provided leadership in IS and if they had determined the relationship between IS and corporate goals.

A four item scale was constructed to measure the degree of training given to programmer/analysts in CASE/structured development methodology.

Finally, a four item scaled was constructed to gauge the stability of job roles within the ISD. The items measured the degree to which personnel were rotated among different positions and frequency with which their job responsibilities were changed.

Table 3

Variables & Scales in Final Questionnaire

Variables	Short Name	Research Question	Polar Extremes	Range of Possible Values	Items[1]
Depth of CASE penetration	DPTH	1	Do Not Possess this Tool - Have Tools of Very High Sophistication	0-65	13 Items. First Page
Breadth of CASE penetration	BRTH	2	Tool Not Used At All - Tool Used on a Routine Basis	0-65	13 Items. Second Page
Environmental Instability	ENVU	1,2	Strongly Disagree - Strongly Agree	4-28	1,15, 22*,30
Knowledge of CASE/ Structured Methodologies	KNOW	1,2	Strongly Disagree - Strongly Agree	4-28	8,23, 32,41
Sponsorship of CASE Technology	SPON	1,2	Strongly Disagree - Strongly Agree	4-28	19,26, 38,43
Size of the ISD	SIZE	1,2		1-10	44*
Communication with External Sources	COMM	1	Strongly Disagree - Strongly Agree	4-49	5,11,14 18, 37,39,42
Performance Gap of the ISD	PERF	1	Strongly Disagree - Strongly Agree	4-28	2,9, 25*,40
Functional Differentiation within the ISD	FDIF	1	Strongly Disagree - Strongly Agree	4-28	24,29*, 31,34
Risk Aversiveness of the Corporate Culture	CCUL	1	Strongly Disagree - Strongly Agree	4-28	3*,13, 27,35
Top Management Support for IS	TMGT	2	Strongly Disagree - Strongly Agree	4-28	6*,20, 21,33
Training in CASE/ Structured Methodologies	TRNG	2	Strongly Disagree - Strongly Agree	4-28	4,10, 12,16
Job Stability in the ISD	JSTB	2	Strongly Disagree - Strongly Agree	4-28	7,17, 28,36*

[1] * : Item was changed after the pilot study.

Administration of the Questionnaires

This section discusses the procedure used for the administration of questionnaires. First, mechanics of the initial and follow-up mailings are discussed. Then details of the response rate and, the degree of representativeness of the respondent set are presented.

The questionnaire packet was sent to 2,740 IS managers using first class mail. Each packet included a personally addressed cover letter, a copy of the questionnaire and a business reply-paid envelope. The cover letter briefly outlined the rationale of the study. As an incentive to answer the questionnaire, the IS managers were promised a quick return of a copy of the study's results.

Each record in the mailing list was assigned a unique number. A label, with this number printed, was affixed at the back of each questionnaire. The unique number enabled classification of responses by industry as the mailing list provided the industry classification. Further, it provided a convenient method of tracking respondents versus non-respondents. The respondents were assured that their anonymity would be maintained and the serial numbers would only be used to classify responses.

Due to the large volume of the mailing, the questionnaires were mailed in three batches over a period of

ten days. The first two batches consisted of 900 questionnaires and the third batch consisted of 500. Three weeks after the first 900 questionnaires were mailed, follow-up letters were sent to non-respondents from this set. It was decided to observe if the reminders were having the desired effect prior to sending them to the rest of the sample. Ten days after mailing the follow-up letters, only 5 responses were received from the non-respondents of the first batch. As the follow-up did not have a significant effect, it was decided not to send reminders to the rest of the sample.

It is recognized that the data collected could have a response bias, based possibly on degree of CASE penetration in an ISD. An encouraging point to be noted is that 92 of the 405 respondents had no CASE penetration in their ISDs. However, the information available about the sample does not facilitate testing for the significance of such a bias.

Of the 2,740 questionnaires mailed, 20 were returned as bad mail. 16 responses were unusable as the questionnaires had been only partially filled out. 4 respondents said that they did not perform any application development and worked only with "off-the shelf" application packages. This made the effective number of questionnaires sent out to be 2,700.

A total of 405 usable questionnaires were received. This

represents a 15% response rate.

Table 4 shows an industry-wise breakdown of the source list, the sample used and the responses received. An industry-wise comparison of the three lists is also shown in Table 4 below.

A chi-square test revealed that the compositions of the source list and responses received were not significantly different (α = 0.05). The computed value for chi-square was 4.73. The critical value at α=.05 and 10 degrees of freedom is 18.31. As the computed value is less than the critical value, there is insufficient evidence to conclude that the composition of the source list differs from that of the respondents.

Likewise, a chi-square test revealed that the compositions of the sample used and responses received were not significantly different (α = 0.05). The computed value for chi-square was 16.109. The critical value at α=.05 and 10 degrees of freedom is 18.31. As the computed value is less than the critical value, it is concluded that the industry composition of the sample and responses are not different.

Industry Classification	Source (%)	Sample N (%)	Responses n (%)
Manufacturing	(47)	1375 (50.93)	187 (46.17)
Commercial Banking	(5.3)	138 (5.11)	13 (3.21)
Diversified Finance	(4.2)	120 (4.44)	19 (4.69)
Insurance	(5.5)	154 (5.70)	25 (6.17)
Retail	(4.2)	112 (4.15)	17 (4.20)
Transportation	(1.4)	43 (1.59)	8 (1.98)
Utilities	(3.2)	85 (3.15)	17 (4.20)
Education	(9.8)	144 (5.33)	26 (6.42)
Health Service	(5.0)	146 (5.41)	19 (4.69)
Government Agencies (Federal, State & Local)	(13.4)	361 (13.37)	73 (18.02)
Other	(1.0)	22 (0.81)	1 (0.25)
TOTAL	34,581 (100)	2700 (100)	405 (100)

Table 4: Comparison Of Source List, Sample Used And Responses by Industry

Appendix 3 contains a frequency tabulation of all items on the questionnaire. The means and standard deviations of each item have also been shown.

Modification of Independent Variable Scales

The internal consistency of each independent variable scale (except size of the ISD) was determined by computing

Cronbach's alpha. Four scales were found to have values of Cronbach's $\alpha < 0.7$. These included the scales of environmental instability, risk aversiveness of the corporate culture, functional differentiation within the ISD and stability of job roles. A further analysis revealed that the internal consistency of three of these scales could be improved by deleting certain items. The only scale whose internal consistency could not be increased was that for functional differentiation. The original Cronbach's alpha for each scale, the items deleted from each scale and the values of alpha for the modified scales are indicated in Table 5.

Many of the variables in the present study are made up of sub-constructs. The aim of the present study is not to develop a specialized scale for measuring each sub-construct of these variables. On the contrary, the present instrument aims to capture an approximate value for the variable in order to support the correlate study. As a consequence, low internal consistency on a few scales is not a major concern.

Table 5

Reliabilities Of Independent Variable Scales In the Survey Questionnaire (N=405)

Scale[2]	Original Item Pool	Cronbach's Alpha	Items Deleted	New Cronbach's Alpha
Environmental Instability	1,15,22,30	.471	22,30	.746
Knowledge of CASE/ Structured Methodologies	8,23,32,41	.718		
Sponsors/Advocates of CASE	19,26,38,43	.913		
Communication with External Sources	5,11,14,18, 37,39,42	.834		
Performance Gap of the ISD	2,9,25,40	.702		
Functional Differentiation within the ISD	24,29,31,34	.648		
Risk Aversiveness of the Corporate Culture	3,13,27,35	.387	3,13	.484
Top Management Support for IS	6,20,21,33	.843		
Training in CASE/ Structured Methodologies	4,10,12,16	.838		
Job Stability within the ISD	7,17,28,36	.631	28,36	.722

[2]Size of the ISD is not included in the above table. This variable was meaured using 1 question.

These scales (Table 5) are organizational independent variable scales. To confirm the dimensions (different factors) underlying the data set, factor analysis was employed. The next chapter discusses details of the factor analysis procedure and other analytical approaches used to test the hypothesized relationships.

CHAPTER 4

DATA ANALYSIS AND RESULTS

Overview of Analytical Approach

This chapter describes the details of the analytical procedures adopted and the results of the data analysis. As advocated by Stewart (1981), factor analysis was employed to validate the different dimensions underlying the data set. This would reveal if, in fact, the proposed independent variables were distinct factors in the present data set. SInce the study is exploring relationships, it was decided to extract a simple factor structure (independent factors). Varimax orthogonal rotation was employed to extract the factors. The first part of this chapter discusses the factor analysis procedure.

Stepwise regression was used to test the hypothesized relationships between the independent variables and the two dependent variables, depth and breadth of CASE penetration. This regression procedure was employed so that only the significant independent variables would be retained in the models. The details of the stepwise regression analyses are presented in the second part of this chapter.

The last part of this chapter deals with the classification of ISDs into different categories based on the depth and breadth of CASE penetration in the ISD. This classification enables the categorization of the ISDs into different stages of CASE innovation.

Factor Analysis

Procedure

Factor analysis was employed to validate the dimensions underlying the collected data. This is a powerful way to check if, in fact, the hypothesized independent variables correspond to the extracted factors. Given the correlational nature of the study, it was decided to extract a simple factor structure (orthogonal and independent factors) rather than adopt confirmatory factor analysis approaches. Thus, this simple structure enables identification of orthogonal independent factors and also complements the regression approach by eliminating any concerns of multicollinearity.

A total of 37 items were submitted to the factor analysis procedure. Kerlinger (1986) recommends that about 10 observations should be provided for every item in the factor analysis. The same opinion has been expressed by a number of other researchers (Cattell 1978; and Everitt, 1975). As the data set had 405 observations and 37 items, the suggested 1:10 ratio for every item included in the factor analysis procedure was satisfied.

Table 6 shows the pattern matrix obtained after orthogonal rotation. Orthogonal rotation was used as the extracted factors are uncorrelated with this approach. All

factors with eigenvalues greater than one were considered. The first 10 factors were found to have eigenvalues greater than 1. The 10th factor had an eigenvalue of 1.14 and the 11th factor had an eigenvalue of 0.94.

Only item loadings >= |0.48| were used to interpret the factor patterns. Any item have a loading of at least |0.48| on any factor is shown in Table 6. Loadings below |0.48| have not been shown to facilitate reading and interpretation of the factor pattern matrix. The 10 extracted factors together explained 66.35% of the variance in the set of the independent variables[1].

[1]Excluding size of the ISD.

Table 6

Rotated Factor Matrix for the Variables Hypothesized to Relate to Depth and Breadth of CASE Penetration (Only loadings >= .48 are shown) (N=405)

Item	Variables	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10
4.	Company CASE training	.750									
8.	Knowledge of CASE & CASE tools	.613									
10.	Training -structured methodologies	.606									
12.	Training -CASE & CASE tools	.813									
16.	Training -system design techniques	.646									
23.	CASE experts in the ISD	.623									
19.	Advocates of CASE technology		.779								
26.	People pushing for CASE		.781								
38.	Leaders for CASE adoption		.753								
43.	People pressing for CASE usage		.825								
5.	Learned from seminars/product shows			.480							
11.	Learned from CASE consultants										
14.	Learned from trade publications			.746							
18.	Learned from vendors			.494							
37.	Learned from video/audio tapes			.632							
39.	Leaders from programmer/analysts-other companies			.769							
42.	Learned from text/reference books			.747							
6.	Top mgmt approach to IS				.765						
20.	IS leadership by top mgmt				.851						
21.	IT innovations and top mgmt				.700						
33.	IS and corporate goals				.728						

Item	Variables	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10
2.	Development Backlog					.652					
9.	User-satisfaction with the ISD					.737					
25.	Satisfaction with application portfolio					.681					
40.	Need to improve performance					.708					
24.	Methodology, standards group etc						.639				
29.	Specialized technical groups						.782				
31.	R&D, experimentation groups etc						.523				
34.	Specialized job roles						.726				
32.	Knowledge -methodologies							.826			
41.	Knowledge -structured development							.849			
1.	Threat of ISD being disbanded								.877		
15.	Future of ISD in corporation								.837		
7.	Rotation of personnel									.845	
17.	Change of job responsibilities									.827	
27.	Undertaking risky projects										.729
35.	Investment in slow returns										.777
	Eigenvalue	8.485	3.557	2.251	1.828	1.723	1.544	1.459	1.338	1.213	1.146
	% of Variance	22.93	9.61	6.09	4.94	4.66	4.17	3.94	3.62	3.28	3.10
	Cumulative %	22.93	32.55	38.64	43.58	48.24	52.41	56.35	59.97	63.25	66.35

Factor Names

Factor 1 Company CASE Train ng Availability
Factor 2 Advocacy of CASE
Factor 3 Communication with External Sources
Factor 4 Top Management Support for IS
Factor 5 Performance Gap of the ISD
Factor 6 Functional Differentiation in the ISD
Factor 7 Knowledge of Structured Methodologies
Factor 8 Environmental Instability
Factor 9 Job Stability in the ISD
Factor 10 Risk Aversiveness of the Corp. Culture

Interpretation of Factors

This section discusses the logical meaning of each factor extracted in the factor analysis procedure. All ten factors were examined and given a representative name, as suggested by the general theme of items constituting each factor.

Items on company-supported CASE training, knowledge of CASE/CASE tool, training in structured methodologies/system design techniques and degree of CASE expertise loaded heavily on factor 1. This factor was named "Company CASE Training Availability". Thus in addition to the four items on training in CASE/structured methodologies, two other items on knowledge of CASE/CASE tools and degree of CASE expertise also loaded heavily on this factor. This factor explained 22.93% of the total variance of the independent variables.

Advocates of CASE technology, people pushing for CASE adoption and pressing for its usage and leaders for CASE adoption loaded heavily on factor 2, which was named "Advocacy of CASE".

Items on amount learned by programmer/analysts on CASE from different communication sources including CASE seminars/product shows, trade publications, vendors, video/audio tapes, text and reference books and

programmer/analysts in other companies loaded on factor 3. Factor 3 clearly represents "Communication with External Information Sources about CASE". The item "People in our ISD have learned a lot about CASE from consultants" did not load significantly on this factor. However, the loading was approaching significance on both factors 1 and 3 (.47 and .37 respectively). This makes intuitive sense as learning from consultants represents a form of CASE training that could be provided by the company in addition to representing a form of communication with an external information source.

Top management's approach to IS, their leadership for the IS function and IT innovations, and their vision of how IS will support corporate goals loaded heavily on factor 4. Hence, the factor was called "Top Management Support for IS".

Application development backlog, user-satisfaction with the ISD and application portfolio, and the need to improve performance of the ISD loaded on factor 5. This factor was thus called "Performance Gap of the ISD".

Specialized job roles, the existence of methodology, standards, testing, R&D, experimentation and other specialized technical groups loaded on factor 6. This factor was called "Functional Differentiation in the ISD". Programmer/analyst's knowledge of structured methodologies and structured development approaches loaded heavily on

factor 7, hence the factor was called " Knowledge of Structured Methodologies".

Factor 8 represents "Environmental Instability", since the two items, threat of the ISD being disbanded and future of the ISD in the corporation, loaded heavily on the factor. Rotation of personnel among different job roles and their changing job responsibilities loaded on factor 9, thus this factor was named "Job Stability within the ISD". Factor 10 was called "Risk Aversiveness of the Corporate Culture" as the items on the corporation undertaking risky projects, and investing in slow return projects loaded heavily on this factor.

The stunning agreement between this set of empirically-derived factors and the pro forma specification of the independent variables provides good confirmation of the construct validity of the questionnaire items. It is to be reiterated that the extracted factors are perfectly orthogonal and uncorrelated.

Reliabilities of Modified Scales

Two items, knowledge of CASE/CASE tools and degree of CASE expertise in the ISD, were initially thought to be part of the scale measuring "Knowledge of CASE/Structured Methodologies". However, these items loaded on factor 1

along with the other four items on training in CASE/ Structured Methodology. These six items were thus viewed as constituting factor 1, which was named "Company CASE Training Availability". The two items on knowledge of structured methodologies and structured development approaches loaded on factor 7. This factor was then called "Knowledge of Structured Methodologies". Thus these two scales were redefined after interpreting the orthogonal factor patterns. The internal consistencies of these modified scales along with the others are shown in Table 7 below.

Table 7
Reliabilities of Modified Scales after Factor Analysis (N=405)

Scale	Item Pool	Cronbach's Alpha
Environmental Instability	1,15	.746
Knowledge of Structured Methodologies[2]	32,41	.829
Company CASE Training[3]	4,8,10, 12,16,23	.855
Advocacy of CASE	19,26,38,43	.913
Communication with External Information Sources	5,11,14,18, 37,39,42	.834
Performance Gap of the ISD	2,9,25,40	.702
Functional Differentiation within the ISD	24,29,31,34	.648
Risk Aversiveness of the Corporate Culture	27,35	.484
Top Management Support for IS	6,20,21,33	.843
Job Stability within the ISD	7,17	.722

[2]This scale represents factor 7. Items 32 & 41 which loaded on this factor measure knowledge of structured development methodologies.

[3]In addition to the 4 items on CASE training, 2 items on CASE expertise loaded on factor 1.

Revision of Hypotheses

The interpretation of the factor analysis procedure led to the redefinition of two independent variables. As a consequence, certain changes were necessarily made to the hypotheses. The redefinition of the "Training of CASE/ Structured Methodology" scale to "Company CASE Training Availability" suggested that this factor be added to the hypothesized correlates of depth of CASE penetration. Thus, the following null hypothesis will also be tested:

Hypothesis (Depth, 9)

H_o	**There is no significant relationship between the degree of company CASE training availability and the depth of CASE penetration.**

Appropriate modifications were made to the two hypothesis which concerned the relationship between "Knowledge of CASE/ Structured Methodologies" and the depth as well as breadth of CASE. These hypotheses were initially stated in terms of "Knowledge of CASE/Structured Methodologies". As suggested by the results of the factor analysis procedure, the hypotheses were reworded to include only "Knowledge of Structured Methodologies". The corrected hypothesis along their hypotheses numbers are stated below.

Hypothesis (Depth, 2)

H_o	**There is no significant relationship between the degree of knowledge of structured methodologies in the ISD and the depth of CASE penetration.**

Hypothesis (Breadth, 2)

H_o	**There is no significant relationship between the degree of knowledge of structured methodologies in the ISD and the breadth of CASE penetration.**

Factor Scores

The complete estimation strategy was employed to compute factor scores. The factor scores were calculated using a linear combination of the standardized item scores and standardized scoring coefficients. No items were discarded while computing factor scores. As a result there was no "information loss", thereby leading to the best estimates of factor scores (Nie, Hull, Jenkins, Steinbrenner and Hall, 1975). The standardized scoring coefficients used were estimated using the multiple regression technique and are shown in Appendix 4.

Thus, the factor score for an ISD on a particular factor represents a weighted sum of the IS manager's responses on the items that comprise that factor. As common factor analysis had been performed, the true factor scores

have mean zero and variance one.

However, to get an idea of the relative positioning of variables in the study, the mean of the sum of items constituting each scale is shown in Table 8 below. Also shown are the range of possible values, and the maximum and minimum scores for each variable.

Table 8

Range and Mean Scores of Variables in Study[4]

	Range of Possible Scores	Lowest Score	Highest Score	Mean Score	Standard Deviation
DEPTH of CASE Usage	0-65	0	55	13.11	12.67
BREADTH of CASE Usage	0-65	0	48	9.22	9.17
Company CASE Tool Training Availability	6-42	6	40	17.07	7.97
Communication with External Sources	7-49	7	39	21.07	7.83
Advocacy for CASE	4-28	4	28	15.91	7.38
Top Management Support for IS	4-28	4	28	15.26	5.73
Performance Gap of the ISD	4-28	5	27	17.15	4.56
Functional Differentiation in the ISD	4-28	4	26	10.49	4.41
Knowledge of Structured Methodologies	2-14	2	14	7.98	3.14
Environmental Instability	2-14	2	14	4.67	2.89
Job Stability in the ISD	2-14	2	14	7.48	3.05
Risk Aversiveness of the Corporate Culture	2-14	2	13	6.66	2.60

[4]The mean scores have been computed using a summation of items that constituted a scale.

It is observed that the mean depth and breadth of CASE penetration have low values. Further, environmental instability has a low value suggesting that ISDs are fairly stable in their operating environment. The relatively high mean value for performance gap suggests that ISDs continue to be pressured to improve performance standards. Though the above are not actual factor scores, they have been included to provide an idea of the location and range of scores for the different variables in the study.

Stepwise Regression Analysis

Method

Stepwise regression was used to test the formulated hypotheses between the independent factors and depth and breadth of CASE penetration. The method chosen to run the stepwise regression was the stepwise selection technique. With this method, a variable has to meet the specified level of significance to enter into the model. Further, a variable that has entered the model can be removed if it no longer meets the specified level of significance required to remain in the model. The variables are entered into the model in the order of their significance. The level of significance specified to enter or stay in the model was

0.15.

The frequency count of the dependent variables indicated that there were 92 ISDs that had not acquired any CASE capability (depth = 0). As this represents a fairly large portion of the sample, it was decided to perform each regression analysis with both the full and reduced data sets. The reduced data set included ISDs with non-zero depth of CASE penetration[5]. Repeating the analysis using the two data sets would help identify any changes in the variables significantly related to depth and breadth after an ISD had acquired a CASE tool(s).

Multiple regression was also used to analyze both data sets. The multiple regression procedure differs from the stepwise, in that it includes all independent variables specified in the model. This analysis was specifically done to obtain the resulting signs of the insignificant variable coefficients. This enables comparison with the signs proposed by the literature.

No differences in the set of significant variables were identified using multiple instead of stepwise regression. This comes as no surprise as the 10 factors are orthogonal. Any small variations in the values of coefficients are because of the intercorrelations between the 10 orthogonal

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[5]Non-zero depth would imply that a CASE tool(s) is possessed by the ISD.

factors and size of the ISD.

The following sections describe the stepwise regression results for the two dependent variables using the full and reduced data sets. The multiple regression results have been included in Appendix 5 to 8.

Depth of CASE Penetration- Full Data Set

Stepwise regression results for the dependent variable depth of CASE penetration are shown in Table 9 below.

Table 9
Stepwise Regression Results For Dependent Variable-
Depth of CASE Penetration (Full Data Set)

The level of significance to enter the model is set to 0.15
The level of significance to stay in the model is set to 0.15

R SQUARE = 0.449 C(P) = 7.180

	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F	PROB>F
REGRESSION	7	29123.260	4160.465	46.19	0.0001
ERROR	397	35755.5149	90.064		
TOTAL	404	64878.775			

VARIABLE	VARIABLE (Short Name)	ESTIMATED VALUE OF ß	STANDARD ERROR	F	PROB>F
	INTERCEPT	10.335			
Environmental Instability	ENVU	-0.794	0.474	2.81	0.0945*[6]
Training	TRNG	5.699	0.497	131.47	0.0001
Communication	COMM	1.083	0.477	5.16	0.0237
Performance Gap	PERF	1.091	0.491	4.92	0.0271
Advocacy of CASE	SPON	4.435	0.502	77.90	0.0001
Functional Differentiation	FDIF	1.070	0.496	4.66	0.0315
Natural log of Size	Log(SIZE)	2.635	0.856	9.47	0.0022

No other variable met the level of significance for entry.[7]

[6]Did not meet the 0.05 level of significance.

[7]Risk Aversiveness of the corporate culture and knowledge of structured methodologies did not meet the necessary level of significance to enter the model.

Three variables namely Environmental Instability, Knowledge of Structured Methodologies and Risk Aversiveness of the corporate culture were not significant at $\alpha = 0.05$. The empirically derived equation for depth of CASE penetration is:

DPTH = 10.335 + 5.699*TRNG + 1.083*COMM + 1.091 * PERF
+ 4.435 * SPON + 1.070 * FDIF + 2.635 * LOG(SIZE)

The above model has an R-square of 0.45. Thus, 45% of the variation in depth of CASE penetration about its mean is explained by using the above equation. The results of the replicated multiple regression are shown in Appendix 5. The same factors were found to be significant with both approaches.

Depth of CASE Penetration - Reduced Data Set

The stepwise regression results using the reduced data set are shown in table 10 below. In addition to the three insignificant factors identified in the above analysis, Performance gap and Advocacy of CASE were found to be insignificant as well. The empirically derived equation for depth of CASE penetration in this case is :

DPTH = 12.43 + 5.11 * TRNG + 3.06 * SPON + 1.293 *FDIF
+ 3.00 * LOG(SIZE)

Table 10

Stepwise Regression Results[8] for Dependent Variable- Depth of CASE Penetration (Reduced Data Set)

The level of significance to enter the model is set to 0.15
The level of significance to stay in the model is set to 0.15

R SQUARE = 0.376 C(P) = 5.194

	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F	PROB>F
REGRESSION	4	16715.961	4148.990	46.48	0.0001
ERROR	308	27691.719	89.908		
TOTAL	312	44407.681			

VARIABLE	VARIABLE (Short Name)	ESTIMATED VALUE OF B	STANDARD ERROR	F	PROB>F
	Intercept	12.43			
Training	TRNG	5.11	0.53	92.87	0.0001
Advocacy of CASE	SPON	3.06	0.568	34.23	0.0001
Functional Differentiation	FDIF	1.293	0.561	5.31	0.0219
Natural Log of Size	Log(SIZE)	3.000	0.920	10.61	0.0013

No other variable met the 0.15 significance level for entry into the model.[9]

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[8]Only ISDs with dpth > 0 are included in this regression.

[9]Environmental Instability, Knowledge of Structured Methodologies, Risk Aversiveness of the Corporate Culture, Performance gap and Advocacy of CASE did not meet the necessary level of significance to enter the model.

Summary of Results - Depth of CASE Penetration

This section presents the summary of the variables found to relate significantly and insignificantly to depth of CASE penetration. Table 11 below summarizes the differences in the significant factors identified using the full and reduced data sets for depth of CASE penetration.

	Independent Variables	All Responses	Reduced Set of Responses[10]
Hypothesis (Depth, 1)	Environmental Instability	Insignificant	Insignificant
Hypothesis (Depth, 2)	Knowledge of Structured Methodologies	Insignificant	Insignificant
Hypothesis (Depth, 3)	Advocacy of CASE	Significant	Significant
Hypothesis (Depth, 4)	Size of ISD	Significant	Significant
Hypothesis (Depth, 5)	Communication with External Sources	Significant	Insignificant
Hypothesis (Depth, 6)	Performance Gap	Significant	Insignificant
Hypothesis (Depth, 7)	Functional Differentiation	Significant	Significant
Hypothesis (Depth, 8)	Risk Aversiveness of the Corporate Culture	Insignificant	Insignificant
Hypothesis (Depth, 9)	CASE Training Availability	Significant	Significant

Table 11: Comparison of Regression Results for Depth of CASE Penetration[11] - All ISDs versus ISDs with Depth > 0

[10] The 92 ISDs with depth = 0 were deleted from this data set.

[11] The shaded region implies that a variable is significant at a level of significance of 5%.

A detailed discussion of the implications of these results is presented in Chapter 5. The remaining part of this section summarizes whether each null hypothesis related to depth of CASE is accepted or rejected (at a level of significance of 5%). The null hypothesis will be rejected if the variable is found to be significant in the regression using the full data set (adopters and non-adopters). Any contradictions in results observed in the reduced data set provides additional insight into the innovation diffusion process within an ISD. A discussion of the implication of these differences is deferred to Chapter 5.

Hypothesis (Depth, 1)

The null hypothesis -- There is no significant relationship between the degree of environmental instability faced by an ISD and the depth of CASE penetration -- is accepted.

Hypothesis (Depth, 2)

The null hypothesis -- There is no significant relationship between the degree of knowledge of structured methodologies and the depth of CASE penetration -- is accepted.

Hypothesis (Depth, 3)

The null hypothesis -- There is no significant relationship between the degree of advocacy of CASE in an ISD and the depth of CASE penetration -- is rejected. The sign of the coefficient confirmed that a significant positive relationship exists between the degree of advocacy of CASE and the degree of sophistication of CASE possessed by an ISD.

Hypothesis (Depth , 4)

The null hypothesis -- There is no significant relationship between the natural logarithm of size of an ISD and the depth of CASE penetration -- is rejected. The sign of the coefficient confirmed that a significant positive relationship exists between the natural logarithm of size of an ISD and the degree of sophistication of CASE possessed by an ISD. This confirms that size of an ISD is positively related to the depth of CASE penetration up to a point after which the rate of increase diminishes.

Hypothesis (Depth, 5)

The null hypothesis -- There is no significant

relationship between the degree of communication with external information sources and the depth of CASE penetration -- is rejected. The sign of the coefficient confirmed the expectation that the relationship would be a positive one.

When the reduced data set was considered, degree of communication with external sources was found to be insignificant. Thus, communication was found to be a significant factor when in explaining differences in depth between adopters and non-adopters. However, it was not found to be significant in explaining differences in the depth of CASE penetration only among adopters.

Hypothesis (Depth, 6)

The null hypothesis -- There is no significant relationship between the performance gap of an ISD and the depth of CASE penetration -- is rejected. The sign of the coefficient confirmed that the relationship was positive.

When the reduced data set was considered, performance gap of the ISD was found to be insignificant. Thus, degree of performance gap was found to be a significant factor in explaining differences between the depth of CASE penetration of adopters and non-adopters. However, it was not a significant factor in explaining differences in the depth of

penetration only among adopters.

Hypothesis (Depth, 7)

The null hypothesis -- There is no significant relationship between the degree of functional differentiation within an ISD and the depth of CASE penetration -- is rejected. The sign of the coefficient confirmed that the relationship was positive.

Hypothesis (Depth, 8)

The null hypothesis -- There is no significant relationship between the degree of risk aversiveness of the corporate culture and the depth of CASE penetration -- was accepted.

Hypothesis (Depth, 9)

The null hypothesis -- There is no significant relationship between the degree of advocacy of CASE in the ISD and depth of CASE penetration -- is rejected. The coefficient had a positive sign confirming the expected positive relationship.

Breadth of CASE Penetration - Full Data Set

This section presents the regression analysis results for the the dependent variable, breadth of CASE penetration, using the full data set. These results using the stepwise analysis for the dependent variable breadth of CASE penetration are shown in Table 12. The analysis revealed that the only insignificant variable was environmental instability. All other factors were significant at α = 0.05. Thus, the empirically derived equation for breadth of CASE penetration is :

BRTH = 7.071 + 4.008*TRNG +1.179*KNOW + 2.56*SPON +
0.740*TMGT + 1.533*JSTB + 2.035*LOG(SIZE)

The above model has an R-square of 0.413. Thus, 41.3% of the variation in breadth of CASE penetration about its mean is explained by using the above equation.

The multiple regression results using the full data set are shown in Appendix 7. The same set of factors identified above were found to be significant. Any minor deviations in the values of coefficients is again due to the intercorrelations of the orthogonal factors with the size variable.

Table 12
Stepwise Regression Results for Dependent Variable-
Breadth of CASE Penetration (Full Data Set)

The level of significance to enter the model is set to 0.15
The level of significance to stay in the model is set to 0.15

R SQUARE = 0.413 C(P) = 8.00

	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F	PROB>F
REGRESSION	7	14022.169	2003.167	39.89	0.0001
ERROR	397	19938.709	50.223		
TOTAL	404	33960.879			

	VARIABLE	ESTIMATED VALUE OF β	STANDARD ERROR	F	PROB>F[12]
	INTERCEPT	7.071			
Environmental Instability	ENVU	-0.635	0.354	3.22	0.0733*
Training	TRNG	4.008	0.368	118.39	0.0001
Knowledge - Structured Methodologies	KNOW	1.179	0.353	11.17	0.0011
Advocacy of CASE	SPON	2.567	0.372	46.75	0.0001
Top Mgmt. Support for IS	TMGT	0.740	0.356	4.33	0.0383
Job/Role Rotation	JSTB	1.533	0.353	18.85	0.0001
Natural Log of Size	Log(SIZE)	2.035	0.588	11.96	0.0001

No other variable met the 0.15 significance level for entry.

[12] Environmental Instability was the only variable found to be insignificant at $\alpha = .05$.

Breadth of CASE Penetration - Reduced Data Set

This section presents the regression analysis results for the dependent variable, breadth of CASE penetration, using the reduced data set. The stepwise regression results for the reduced data set are shown in Table 13. The empirically derived equation for breadth of CASE penetration with the reduced data set is:

$$BRTH = 9.235 + 3.712*TRNG + 1.549*KNOW + 1.539*SPON + 1.252*TMGT + 1.687*JSTB + 1.699*LOG(SIZE)$$

Table 13

Stepwise Regression Results[13] for Dependent Variable- Breadth of CASE Penetration (Reduced Data Set)

The level of significance to enter the model is set to 0.15
The level of significance to stay in the model is set to 0.15

R SQUARE = 0.382 C(P) = 8.000

	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F	PROB>F
REGRESSION	7	9101.323	1300.19	26.89	0.0001
ERROR	305	14745.981	48.34		
TOTAL	312	23847.310			

	VARIABLE	ESTIMATED VALUE OF β	STANDARD ERROR	F	PROB>F
	Intercept	9.23			
Environmental Instability	ENVU	-0.813	0.413	3.88	0.0497
Training	TRNG	3.712	0.388	91.40	0.0001
Knowledge - Structured Methodology	KNOW	1.549	0.394	15.45	0.0001
Advocacy of CASE	SPON	1.539	0.414	13.80	0.0002
Top Mgmt. Support for IS	TMGT	1.252	0.402	9.68	0.0020
Job/Role Rotation	JSTB	1.687	0.393	18.42	0.0001
Natural Log of Size	Log(SIZE)	1.699	0.646	6.91	0.0090

No other variable satisfied α= 0.15 for entry into the model.

[13]Only ISDs with dpth > 0 were included in this regression.

Summary of Results - Breadth of CASE Penetration

This section presents a summary of the regression results for the dependent variable -- breadth of CASE penetration. This is followed by conclusions on the whether the null hypotheses, as specified for this dependent variable, are accepted or rejected.

A comparison of the list of significant factors obtained when the full and reduced data set were employed is shown in Table 14. Environmental instability emerged as insignificant in the first case but as significant in the second case. All other hypothesized variables were found to be significantly related to breadth and had the expected signs.

	Independent Variables	Using All Responses	Reduced Set of Responses[14]
Hypothesis (Breadth, 1)	Environmental Instability	Insignificant	Significant
Hypothesis (Breadth, 2)	Knowledge of Structured Methodologies	Significant	Significant
Hypothesis (Breadth, 3)	Advocacy of CASE	Significant	Significant
Hypothesis (Breadth, 4)	Size of ISD	Significant	Significant
Hypothesis (Breadth, 5)	Top Management Support for IS	Significant	Significant
Hypothesis (Breadth, 6)	CASE Training Availability	Significant	Significant
Hypothesis (Breadth, 7)	Job Stability in the ISD	Significant	Significant

Table 14

Comparison of Regression Results for Breadth of CASE Penetration[15] -All ISDs Versus ISDs with Non-zero Depth

A detailed discussion of the implications of these results is presented in Chapter 5. The remaining part of this section summarizes whether each null hypothesis related to breadth of CASE is accepted or rejected (at a level of significance of 5%). The null hypothesis will be rejected if the variable is found to be significant in the regression that used the full data set (adopters and non-adopters). As

[14] All ISDs with depth = 0 were deleted from this data set.

[15] The shaded region implies that the variable was significant at a level of significance of 5%.

with the regression results on depth, the implications of any differences in results, between the full and reduced data sets, is deferred to Chapter 5.

Hypothesis (Breadth, 1)

The null hypothesis -- There is no significant relationship between the degree of environmental instability faced by the ISD and the breadth of CASE penetration -- is accepted. However, environmental instability was found to be significantly related to breadth of CASE when the reduced data set was used. As expected, the coefficient had a negative sign.

Thus, environmental instability is not significant in explaining the differences in usage levels of CASE when both adopters and non-adopters are considered. However, it is a significant factor in explaining the differences in breadth among adopters of CASE.

Hypothesis (Breadth, 2)

The null hypothesis -- There is no significant relationship between the degree of knowledge of structured methodology in the ISD and breadth of CASE penetration -- is rejected. An examination of the sign confirmed the expected

positive relationship between these two variables.

Hypothesis (Breadth, 3)

The null hypothesis -- There is no significant relationship between the degree of advocacy of CASE in the ISD and the breadth of CASE penetration -- is rejected. The coefficient had a positive sign confirming the expected positive relationship between these variables.

Hypothesis (Breadth, 4)

The null hypothesis -- There is no significant relationship between the natural logarithm of size of an ISD and the breadth of CASE penetration -- is rejected. The sign of the coefficient confirmed that a significant positive relationship exists between the natural logarithm of size of an ISD and the degree of CASE usage by an ISD. This confirms that size of an ISD is positively related to breadth of penetration up to a point after which the rate of increase diminishes.

Hypothesis (Breadth, 5)

The null hypothesis -- There is no significant

relationship between the degree of top management support for IS and the breadth of CASE penetration -- is rejected. The sign of the coefficient confirms that this relationship is a positive one.

Hypothesis (Breadth, 6)

The null hypothesis -- There is no significant relationship between the degree of company CASE training availability and the breadth of CASE penetration -- is rejected. An examination of the coefficient sign confirmed that the direction of the relationship is positive, as expected.

Hypothesis (Breadth, 7)

The null hypothesis -- There is no significant relationship between the degree of job/role rotation and the breadth of CASE penetration -- is rejected. The sign of the coefficient confirms that the relationship between these two variables is positive.

Classification of ISDs

A two-way cross tabulation of all ISDs was done using the two dependent variables in the study. ISDs having depth (or breadth) scores greater than or equal to the mid-range were considered to have a "high" depth (or breadth) of CASE penetration. ISDs having a depth (or breadth) score less than the mid-range but greater than 0 were considered to have a "low" depth (or breadth) of CASE penetration. As the range of possible values on the scales for depth and breadth scales was 0 - 65, the mid-range on both these scales was 32.5.

		BREADTH			
		0	Low	High	Cumulative
DEPTH	0	92			92
	Low	6	269	2	277
	High	0	30	6	36
	Cumulative	98	299	8	405

Table 15: Classification[16] of ISDs By Depth & Breadth of CASE Penetration

Thus, the 92 ISDs (22.72%) with depth and breadth = 0 were in stage 0 of the proposed innovation model (no CASE

[16]The mid-range of depth and breadth scores is used as a cut-off point between HIGH and LOW. This is 32.5 out of a maximum of 65 in both cases.

adoption). The 305 ISDs (74.31%) with depth > 0 and breadth < 32.5 were in stage 1 (technology exploration). The remaining 8 ISDs (1.98%) with dpth > 0 and breadth > 32.5 were in stage 2 (implementation). However, within each stage it is observed that additional information is provided by considering the degree of sophistication of CASE i.e. depth.

A decomposition of the above aggregate classification by industry is included in Appendix 9. A summary of the industry-wise classification is reported in table 16 on the next page.

Table 16

Summary of CASE Penetration by Industry Classification

	Stage 0	Stage 1	Stage 2	Mean Depth	Mean Breadth
Manufacturing	43	139	5	12.42	8.91
Commercial Banking	4	9	0	15.54	9.62
Diversified Finance	5	14	0	17.00	10.74
Insurance	7	18	0	9.48	7.40
Retail	4	12	1	12.59	9.82
Transportation	0	8	0	15.63	11.63
Utilities	4	13	0	13.29	9.29
Education	3	23	0	11.88	8.19
Health Services	4	15	0	9.21	6.32
Federal Government	1	10	0	26.18	14.55
State Government	8	22	0	13.97	9.60
Local Government	8	22	2	14.72	11.44
Other	1	0	0	0	0

Correlation between Depth and Breadth of CASE Penetration

The Pearson's correlation between depth and breadth of CASE penetration was 0.738 (p=.0001). The reduced data set was used to compute the correlation as 92 ISDs with depth = 0 and breadth = 0 would bias the degree of correlation between the two dependent variables. This suggests a strong positive correlation between the degree of sophistication of CASE possessed by an ISD and the degree of usage of the technology.

CHAPTER 5

CONCLUSIONS

Overview

This chapter discusses the empirically derived results of the study. First, the extent of CASE penetration observed is discussed. An alternative four-stage classification of ISDs based on the degree of CASE penetration is presented. The degree of CASE tool(s) sophistication and usage for individual system functions is also presented.

The second part of the chapter discusses the observed relationships between the different organizational variables and depth/breadth of CASE penetration. The discussion highlights why some variables become significant/insignificant at certain points during the innovation process.

Finally, directions and challenging issues for IS researchers interested in implementation/innovation aspects of information technology and researchers in innovation theory in general are identified.

Extent of CASE Penetration

Stage Classifications

The present study classifies ISDs into three stages based on the depth and breadth of CASE penetration. A detailed discussion of the method of classification was provided in Chapter 4.

		BREADTH			
		0	Low	High	Cumulative
DEPTH	0	92			92
	Low	6	269	2	277
	High	0	30	6	36
	Cumulative	98	299	8	405

Table 17: Classification[1] of ISDs By Depth & Breadth of CASE Penetration

92 ISDs (22.72%) with depth and breadth = 0 were in stage 0 of the proposed innovation model (no CASE adoption). Six ISDs were observed to have some depth of CASE but had not initiated usage of the technology as yet. These six ISDs are in the technology acquisition phase and have not started any exploratory usage of the technology.

[1]The mid-range of depth and breadth scores is used as a cut-off point between HIGH and LOW. This is 32.5 out of a maximum of 65 in both cases.

There are 299 ISDs in various stages of experimentation. 30 of them are experimenting with quite sophisticated CASE tools, and the remaining 269 are experimenting at considerably lower degrees of CASE sophistication. For the present study, companies in technology acquisition and experimentation phase were combined into one broader category, which was called the technology exploration phase. This was done as most ISDs begin some form of experimentation activity very shortly after acquiring some degree of sophistication of the technology.

The remaining 8 ISDs (1.98%) with depth > 0 and breadth > 32.5 had high degrees of CASE usage. However, only six of these had high degrees of both depth and breadth and could be further classified as approaching "complete implementation" of CASE. Thus, only ISDs that acquire high degrees of sophistication and usage of a technology can consider to have fully implemented the complete range of capabilities offered by the innovation in question.

Differential Penetration of CASE Capabilities

An examination of CASE penetration at a finer level of detail reveals the differential penetration for different

system functions. Table 18 shows the mean sophistication and usage levels of the depth and breadth of CASE for all system functions considered along with their standard deviations. Figure 7 graphically compares the standardized mean of the degree of sophistication and usage for the thirteen system functions.

Presently the highest penetration in terms of both depth and breadth is observed for the system functions of project management, screen/report layout, diagramming and prototyping. There is some CASE penetration to support the system functions of requirements determination, data base code/schema generation, procedural code generation, test code generation and strategic systems planning.

The least CASE penetration has occurred for all three reverse engineering functions -- analysis of program structure, analysis of database structure and restructuring of program code.

Table 18

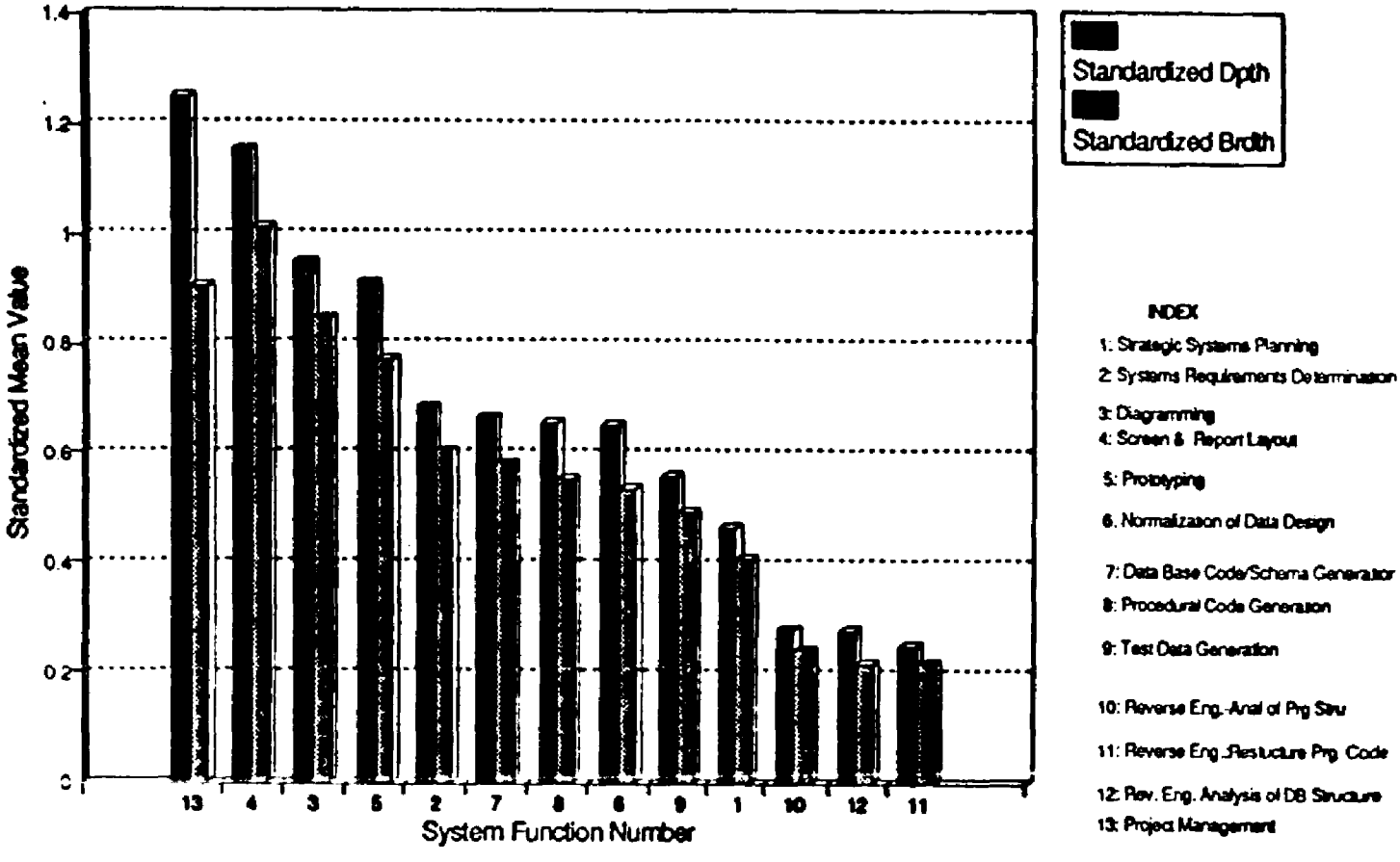
CASE Penetration for Different System Functions

SYSTEM FUNCTION AUTOMATED BY CASE TOOL	DEPTH		BREADTH	
	Mean[2]	Standard Deviation	Mean[3]	Standard Deviation
Strategic Systems Planning	0.58	1.25	0.33	.81
Systems Requirements Determination and Documentation	1.09	1.59	0.72	1.19
Diagramming (eg. Data Flow or Entity-Relationship Diagrams)	1.65	1.74	1.10	1.19
Screen and Report Layout	1.94	1.68	1.60	1.58
Prototyping	1.56	1.71	1.05	1.36
Normalization of Data Design	1.02	1.57	0.58	1.09
Data Base Code/Schema Generation	1.06	1.59	0.71	1.22
Procedural Code Generation	1.11	1.70	0.77	1.40
Test Data Generation	0.65	1.17	0.51	1.04
Reverse Engineering-Analysis of Program Structure	0.22	0.79	0.15	0.62
Reverse Engineering- Automatic Restructuring of Program Code	0.20	0.80	0.12	0.55
Reverse Engineering - Analysis of Data Base Structure	0.23	0.83	0.10	0.46
Project Management	2.0	1.60	1.44	1.59

[2]The depth scale ranges from 0 to 5.
0- no case tools; 1-very low sophistication, 2-low sophistication;
3-moderate sophistication; 4-high sophistication; 5-very high sophistication.

[3]The breadth scale ranges from 0-5.
0-no usage; 1- few people/projects experiment; 2-a few people/projects use regularly; 3-a lot of people/projects use regularly; 4- most people/projects use regularly; 5- used on a routine basis.

FIGURE 7
CASE Penetration for System Functions



Impact of Time on CASE Penetration

Though not a direct research question, respondents were asked to identify the time since their ISDs began initial CASE experimentation. Figure 8 shows a bar graph depicting the standardized mean depth and breadth of CASE for the different time categories.

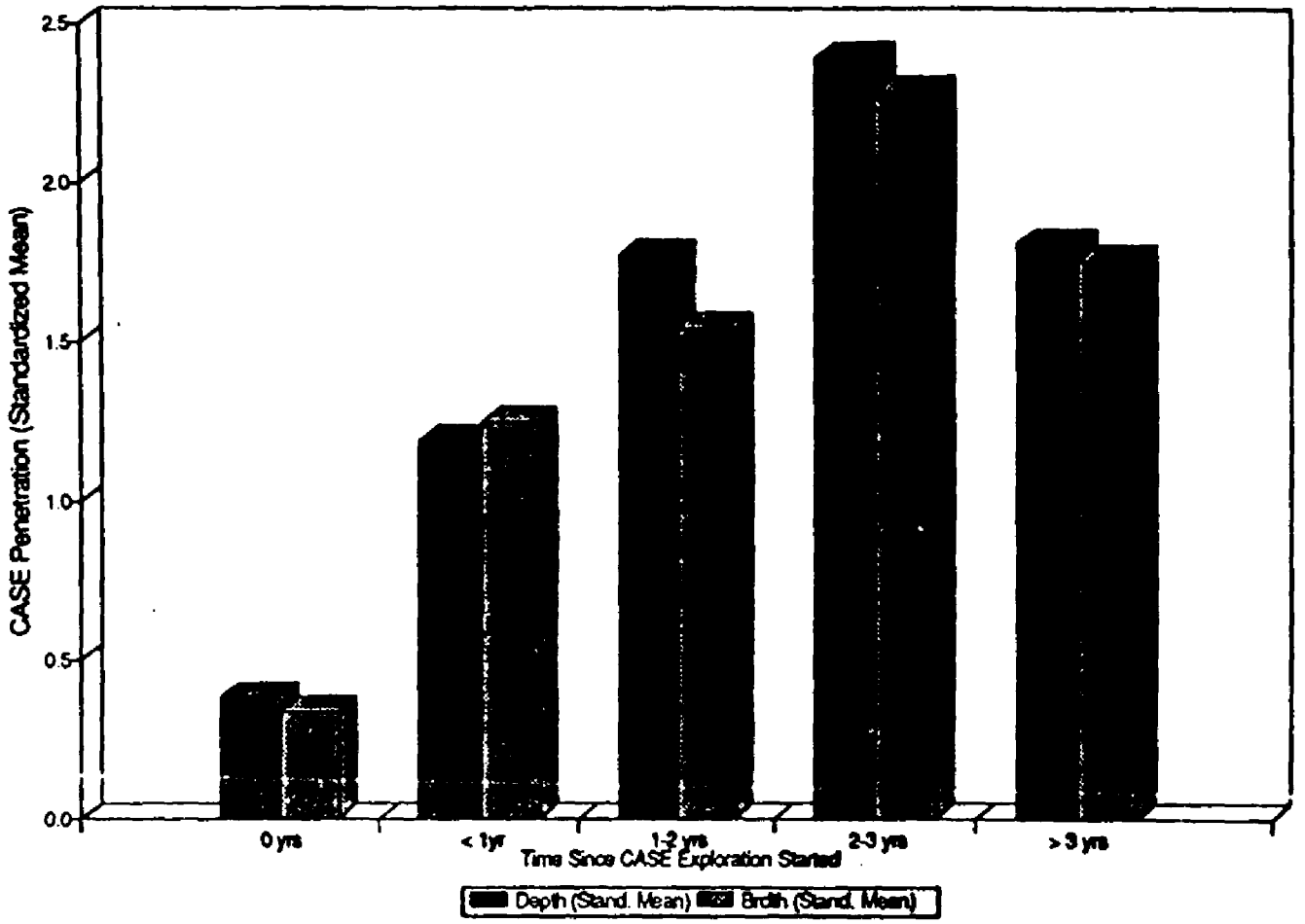
It is observed that category 1 ("not yet started") has a very low value for the standardized mean for depth and breadth. Ideally, the value should have been 0. However, a handful of IS managers whose ISDs had very low values of depth/breadth chose to classify themselves as not having commenced CASE experimentation. The graph reveals that, in general, ISDs who commenced experimentation efforts earlier had greater penetration levels. However, ISDs in the "> 3 years ago" category have standardized mean values less that the "2-3 years ago" category. Thus, the time since an ISD began CASE exploration does not have a continuous positive relationship with the degree of CASE penetration.

One possible reason for this is that some of the CASE tools which support logical and physical aspects of systems design are relatively later enhancements to CASE technology. Thus, ISDs who started experimenting about 3 years ago with the earlier CASE tools may not have continuously innovated and may not have acquired and diffused the use of the later

developments in the technology. This reinforces the importance of organizational factors in maintaining a climate of continuous innovation within organizational units.

However, the intent of the present study is not to look at time as a variable to explain differences in the extent of CASE penetration within an ISD but to understand the relationship and impact of organizational type variables on the penetration of CASE technology.

Figure 8
Relationship of Time & CASE Penetration



Discussion of Observed Empirical Relationships

Environmental Instability

The degree of environmental instability was not found to be significantly related to either the depth or breadth of CASE penetration when all ISDs were considered. In fact, the mean value for the degree of environmental instability was found to be 4.67 on a scale from 2-14 suggesting that the average instability faced by ISDs in organizations is low. This could be because organizations are becoming increasingly dependent on their ISDs for the functioning of their business, and the viability of the ISDs is thus assumed.

Thus, the empirical study did not confirm the expected results as suggested by the interview -- environmental instability would be a significant variable in deterring innovation adoption efforts. However, in all regression analyses, the coefficient of the degree of environmental instability did have a negative sign. This is in contradiction of the hypothesis derived from the literature but in agreement with the interviews.

Data analysis with the reduced data set revealed an interesting phenomenon. Environmental instability was found to be related to breadth of CASE penetration when the

reduced data set was considered. This implies that environmental instability will play a significant role in determining the extent of assimilation of a technology by an adopting unit. ISDs facing high degrees of environmental instability could face shortages in critical resources needed to diffuse the use of the technology in the ISD.

Training

The degree of company CASE training availability was found to influence the initial acquisition of the technology by the ISD -- it was significant in the regression when all ISDs were considered. Thus, it helped in explaining the difference between adopters and non-adopters.

Further, training availability played a significant part in explaining the differing degrees of sophistication possessed by ISDs who had adopted CASE. Thus, IS managers who want to initiate the use or enhance the degree of CASE sophistication should concentrate on initiating and improving training programs on the use of CASE and structured methodologies.

Training availability was found to positively influence the degree of usage of CASE by ISDs as well. ISDs which provided more training in the use of CASE/structured methodology were characterized by higher degrees of CASE

usage. The results suggest that managers who want to make the use of sophisticated CASE technology a part of standard systems development practice should concentrate on providing training, both, in the use of CASE and structured methodology to their programmer/analysts. This would facilitate initial adoption and subsequent diffusion of CASE in the ISD.

Advocacy of CASE

The degree of CASE Advocacy was a significant variable in explaining the depth and breadth of CASE penetration possessed by ISDs. It influences the degree of sophistication of CASE possessed and the degree of usage in ISDs. ISDs with high degrees of CASE advocacy were found to have higher degrees of usage of the technology than their counterparts who had no/lower degrees of CASE advocacy within the organization. The advocacy could stem from any level of management.

The degree of CASE advocacy was found to be a significant variable in all the regression models with depth and breadth of CASE penetration (reduced and full data sets). Thus, sponsorship of the technology is critical in initiating and in diffusing the technology. Further, it also plays a significant role in determining the

sophistication of the technology possessed by the adopting unit.

IS management must ensure that the innovation is championed to facilitate a "jump" to initiate CASE exploration by the ISD and to diffuse its use among programmer/analysts as well.

Knowledge of Structured Methodologies

Degree of knowledge of structured methodologies was not found to be significantly related to depth of CASE penetration. However, it was positively related to breadth of CASE penetration. This suggests that programmer/analysts who are aware of the importance of structured approaches for systems development will understand that CASE is a means to implement these approaches/techniques. Further, they will appreciate how the use of CASE could result in productivity gains and could ensure that a common structured standard is used in all systems work.

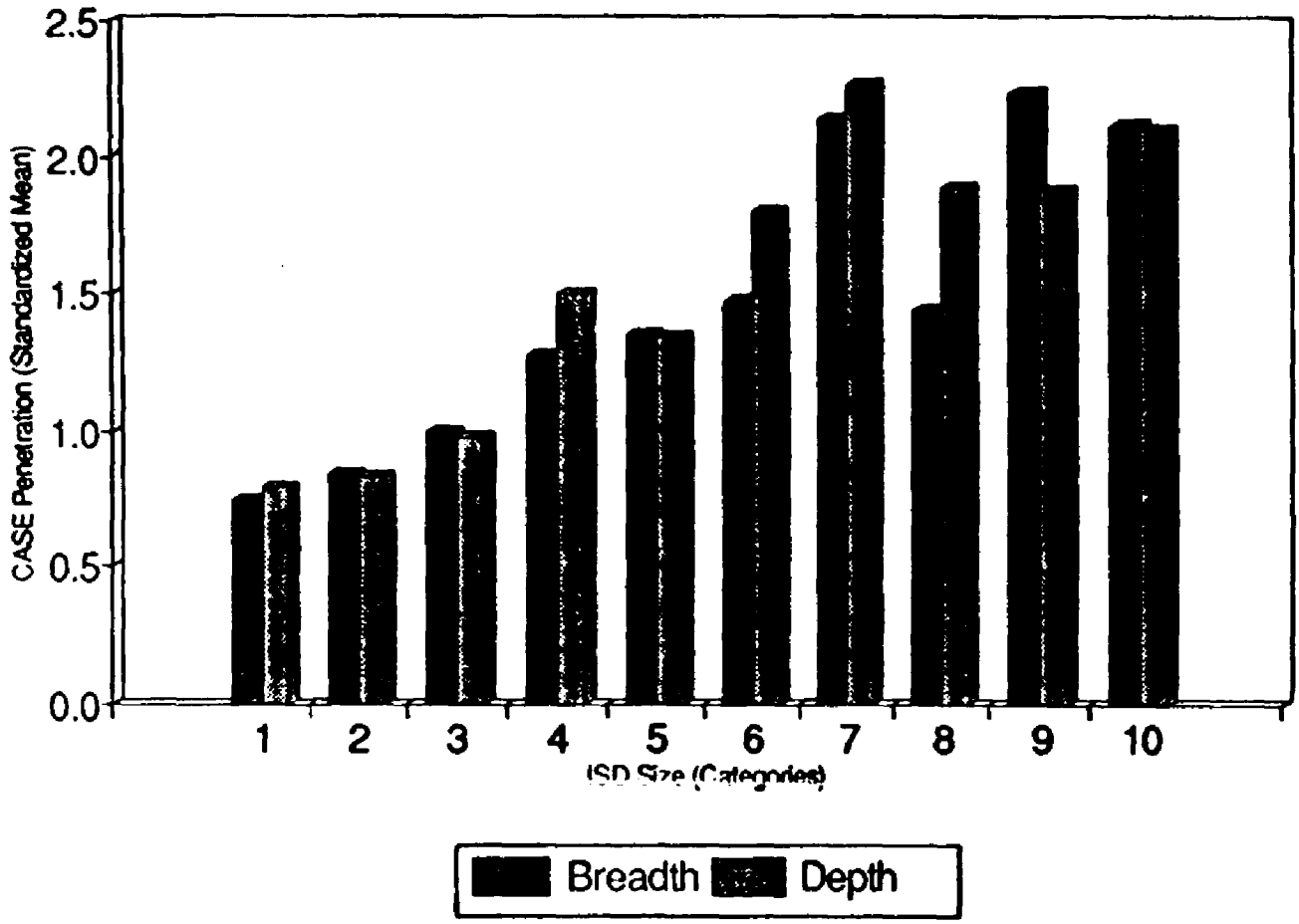
Organizational Size

Size of the ISD was found to be a significant factor in differentiating between adopters and non-adopters. Size was also a significant positive factor in explaining differences

in the degree of CASE sophistication possessed by adopting ISDs. Further, size of the ISD was also found to be positively related to degree of CASE usage. The statistical tests confirmed that the relationship was a logarithmic one.

Thus, the size of ISDs is positively related to the depth and breadth of CASE upto a point, after which the rate of increase diminishes. A bar graph illustrating this is shown below in Figure 9. This suggests that small ISDs might be constrained in their capability to explore and diffuse the use of powerful and expensive CASE products. Very large ISDs would have large parts of their budgets committed toward maintaining existing operations and systems. This automatically implies that fewer resources will be available for technology exploration activities. Thus, size seems to support the depth and breadth of CASE penetration up to a point after which diminishing returns set in.

Figure 9
Relationship of Size & CASE Penetration



Communication With External Sources

The degree of communication with external information sources about CASE technology was, as expected, found to be positively related to depth of CASE penetration possessed. However, when the reduced data set was considered, communication with external information sources was no longer significantly related to degree of sophistication possessed by ISDs. Thus, it was found to be significant factor in explaining differences in sophistication only when both adopters and non-adopters were considered. It was not significant in explaining differences in the depth of CASE penetration possessed by ISDs who had commenced CASE exploration.

IS managers should consider using different interface mechanisms with the external environment to initiate CASE exploration. Effective integration with external information sources will be most critical in creating the "awareness" which may lead to a decision to acquire some degree of sophistication in the technology. The interface mechanisms that could be adopted include trade publications, reference books, vendor representatives visiting the sites, video/audio tapes, informal contact with colleagues in other organizations, and external consultants.

Performance Gap

The degree of performance gap of the ISD was found to be a significant factor which differentiated between adopters and non-adopters of CASE. ISDs with high degrees of performance gap are more likely to explore a new technology such as CASE to possibly reduce some of their performance problems. On the contrary, ISDs with satisfactory performance levels will be less likely to experiment with a new systems development technology.

However, degree of performance gap was not found to be a significant variable in explaining the differences in CASE sophistication among adopters. Thus, high performance gaps initiate ISDs to make an initial commitment to CASE by exploring it.

Functional Differentiation

The degree of functional differentiation was found to be positively related to the depth of CASE penetration in ISDs. Functional differentiation was found to be a significant variable in differentiating between adopters and non-adopters. Further, the degree of functional differentiation was also found to be a significant variable in explaining the variation in the degree of sophistication

of CASE possessed by the adopting units.

IS managers interested in exploring CASE should set up technology exploration groups to examine the technology. Further, the existence of other groups to monitor and improve systems related work will help in initiating exploratory activities. These could include testing, methodology or standards groups.

Risk Aversiveness of the Corporate Culture

Risk aversiveness of the corporate culture was not found to be significantly related to depth of CASE penetration. However, the multiple regression results (Appendix 5 and 6) show that the estimated coefficient for this factor had a negative sign as expected. Thus, corporate culture toward payback periods and risky projects was not found to significantly influence the degree of sophistication of CASE.

A possible reason for this is that most companies tended to agree that their corporations were not supportive of risky projects and emphasized quick payback periods. Thus, the mean was relatively high (6.66 on a scale of 2-14) and the variability was relatively low compared to other factors (2.60 for the 2-14 range).

It is unlikely that many IS managers will have a

significant impact in altering corporate culture issues such as this. It is concluded that this variable may be hard to change in companies and IS departments today continue to be under pressure to demonstrate quick returns.

Top Management Support for IS

Top management support for IS was a significant factor in explaining differences in degrees of CASE usage when the set of adopters and non-adopters were considered, and also when only the set of adopters were considered. ISDs with higher degrees of top management support for IS had higher degrees of CASE usage. Top management's support for the IS function would encourage members of this organizational unit to implement new technologies to deliver effective systems that will support organizational processes and enhance effectiveness. The tie between information systems and organizational functions/processes is going to be greater in organizations where top management recognizes the importance of IS and identifies how it can support these functions/processes.

Thus, top management's support for the IS function appears to be instrumental in initiating new technology exploration by ISDs and in diffusing the use of acquired technologies such as CASE.

Job Stability within the ISD

The degree of job/role rotation within the ISD was found to be positively related to the degree of CASE usage. It helped in differentiating between ISDs who used CASE and those who did not. It was also a significant factor in explaining variations in degree of CASE usage in adopting units.

The importance of integrating logical and physical aspects of systems development work is the philosophy driving CASE technology. Thus, ISDs with blended job roles of programming/systems analysis or with personnel rotated between different roles should find it easier to implement a functionally integrative technology such as CASE.

IS managers wanting to implement CASE should work towards blending tasks or rotating personnel among different job roles. This would reduce resistance as the "skill-set" possessed by the members of the ISD will be greater. Thus, integrative technologies such as CASE would be viewed as potentially productivity enhancement technologies and not as a threat to their jobs.

Future Research

Most past research on innovation has been concerned

with social and scientific innovations. This stream of research applied to IS will develop a useful theoretical base in the information systems field. It is a challenge to researchers to develop models that will provide guidance to managers on how adoption of IT innovations can be stimulated.

Researchers in IS should replicate this study by considering other emerging technologies such as expert systems and neural computing. The present study dealt only with organizational factors. The present model should be expanded to include individual level factors as well.

It is important to understand that the list of significant factors changes at different points during the innovation process. The identification of these changes will provide guidance to managers on which factors to monitor and control during different stages of the innovation process. The present study does identify the factors that become significant/insignificant at different points during the CASE innovation process by replicating the analysis with two data sets namely the adopters and non-adopters of CASE and only the adopters of CASE . The replication of this approach in other social, scientific and IT related innovations will provide valuable guidance to innovation initiators and technology managers in different fields as well.

Another important issue that remains controversial and unanswered is the relationship between administrative and technological innovations. In other words, would it help if certain administrative changes are institutionalized before bringing about a technological change ? Or do administrative changes gradually fall in place while a technology diffuses through an organizational unit?

Thus, many unanswered questions remain in the gradual movement toward a comprehensive understanding and development of a unified theory of innovation. Researchers should work towards answering some of these questions. This should provide the much needed vision on the right ingredients that enhance innovative behavior by organizations. It is the idea of continuously innovating that will allow organizations to succeed in an era of global competition.

BIBLIOGRAPHY

Abernathy, W.J., & Utterback, J.M., "Patterns of Industrial Innovation," Technology Review, July 1978.

Ackoff, R.L., "Management Misinformation Systems," Management Science, Vol. 14, No. 4, December 1967, p. 147-156.

Aiken, M., & Hage, J., "The Organic Organization and Innovation," Sociology, No. 5, 1971, p. 563-583.

Andrews, D.C., "CASE Users find Implementation Trail Tough," MIS Week, February 6, 1989, p.48-49.

Armour, H.O., & Teece, D.J., "Vertical Integration and Technological Innovation," The Review of Economics and Statistics, Vol. 24, 1979, p. 200-219.

Bachman, C., "A CASE for Reverse Engineering," Datamation, July 1, 1988, p. 49-56.

Baker, N.R., Siegman, J., & Rubenstein, A.H., "The Effects of Perceived Needs on the Generation of Ideas for Industrial Research and Development Projects," IEEE Transactions for Engineering Management, Vol. EM-24, December 1967.

Bakos, J.Y., & Treacy, M.E., "Information Technology and Corporate Strategy: A Research Perspective," MIS Quarterly, January 1989.

Balridge, J.V., & Burnham, R.A., "Organizational Innovation: Individual, Organizational and Environmental Impacts," Administrative Sciences Quarterly, Vol. 20, 1975, p.165-176.

Barreyre, P.Y., "The Management of Innovation in Small and Medium Sized Industries," International Studies of Management and Organization, Vol. 7, 1978, p. 76-98.

Beyer, J.M, & Trice, H.M., Implementing Change: Alcoholism Policies in Work Organizations, New York:Free Press, 1978.

Biogness, W., & Perrault, W.D., "A Conceptual Paradigm and Approach for the Study of Innovation," Academy of Management Journal, Vol. 24, 1982, p. 68-82.

Blau, J.R., & McKinley, W., "Ideas, Complexity and Innovation," Administrative Sciences Quarterly, 1979, 24, p. 200-219.

Bourgeois, L.J., "Strategy and Environment: A Conceptual Integration," Academy of Management Review, November-December 1981, p. 29-40.

Boynton, A.C., & Zmud, R.W., "Technology Planning in the 1990's: Directions for Practice and Research," MIS Quarterly, March 1987, p. 59-70.

Burgelman, R.A., & Sayles, L.R., "Inside Corporate Innovation: Strategy, Structure and Managerial Skills," 1986, The Free Press, New York.

Burt, R.S., "The Differential Impact of Social Integration on Participation in the Diffusion of Innovations," Social Science Research, Vol. 2, 1973, p. 125-144.

Carter, C.F., & Williams, B.R., "The Characteristics of Technically Progressive Firms," Journal of Industrial Economics, Vol. 7, 1959, p. 87-104.

Cattell, R.B., "The Scientific Use of Factor Analysis in the Behavioral and Life Sciences," Multivariate Behavioral Research, April 1978, p. 245-276.

Chakrabarti, A.V., "The Role of the Champion in Product Innovation," California Management Review, Vol. 17, 1974, p. 58-69.

Chao, G., & Kozlowski, S., "Employee Perceptions on the Implementation of Robotic Manufacturing Technology," Journal of Applied Psychology, Vol. 17, No. 1, 1986, p. 70-76.

Coleman, J.S., Katz, E., & Menzel, H., Medical Innovation: A Diffusion Study, Bobbs Merril, Indianapolis, 1966.

Daft, R.L., & Becker, S.W., Innovation in Organizations, Elsevier, New York, 1978.

Daft, R.L., "Bureaucratic versus Non-Bureaucratic Structure and the Process of Innovation and Change," Research in the Sociology of Organizations, 1982, p. 129-166.

Daft, R.L., "A Dual Core Model of Organizational Innovation," Academy of Management Journal, Vol. 21, 1978, p. 193-210.

Delbecq, A.L. & Mills, P.K., "Managerial Practices that Enhance Innovation," Organizational Dynamics, Vol. 14, 1985, p.24-34.

Dewar, R.D., & Dutton, J.E., "The Adoption of Radical and Incremental Innovations: An Empirical Analysis," Management Science, Vol. 32, No. 11, 1986, p. 1422-1432.

Downs, G.W., & Mohr, L.B., "Conceptual Issues in the Study of Innovation," Administrative Science Quarterly, Vol. 21, 1976, p. 700-714.

Duncan, R.B., "The Ambidexterous Organization: Designing Dual Structures for Innovation," In R.H. Kilmann, L.R. Pondy and D.P. Slevin (Eds), The Management of Organization Design, Elsevier-North Holland, Amsterdam, The Netherlands,, 1977, p. 167-188.

Duschesneau, T.D., Cohn, S.E., & Dutton, J.E., A Study of Innovation in Manufacturing: Determinants, Processes and Methodological Issues, (Vols. 1 & 2), Orno, Maine: The Social Science Research Institute, University of Maine, January 1979 and December 1979.

Emery, J.C., "Management Information Systems: The Critical Strategic Resource," 1987, Oxford University Press, New York.

Ettlie, J.E., Bridges, W.P., & O'Keefe, R.D., "Organizational Strategy and Structural Differences for Radical versus Incremental Innovation," Management Science, 1984, p. 682-695.

Ettlie, J.E., & Bridges, W.P., "Environmental Uncertainty and Organizational Technology Policy," IEEE Transactions on Engineering Management, EM-29, 1982, p. 2-10.

Ettlie, J.E., & Vallenger, D.B., "The Adoption Time Period for some Transportation Innovations," Management Science, Vol. 25, 1979, p. 429-443.

Ettlie, J.E., "Organizational Policy and Innovation among Suppliers to the Food Processing Industry,' Vol. 26, No. 1, 1983, p. 27-44.

Evan, W.M. & Black, G., "Innovation in Business Organizations: Some Factors associated with Success or Failure of Staff Proposals," Journal of Business, 40, October 1967, p. 519-530.

Feuche, M., "Implementing CASE? Learn from the Users," MIS Week, September 18, 1989, p. 1 & 29.

Feuche, M., "Banker Standardizes on CASE Tool and Saves $1.2 million," MIS Week, September 25, 1989, p.15.

Gane, C., & Sarson, T., Structured Systems Analysis: Tools and Techniques, Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1979.

Glassman, E., "Managing Creativity: Back to Basics in R&D," R&D Management, Vol. 16, 1984, p. 175-183.

Globerman, S., "Technological Diffusion in the Canadian Carpet Industry," Research Policy, 1975, p. 129-148.

Gordon, G., Kimberly, J.R., & MacEachron, A., "Some Considerations in the Design of Problem-Solving Research on the Diffusion of Medical technology," In W.J. Abernathy, A.Scheldon & C.K.Prahalad (Eds)., The Management of Health Care, Cambridge, Mass:Ballinger, 1975, p. 29-61.

Gorwin, R.G., "Strategies for Organizational Innovations: An Empirical Comparison," American Sociological Review, 1972, p. 441-454.

Greer, A.L., "Medical Conservatism and Technological Acquisitiveness: The Paradox of Hospital Technology Adoptions," In J. Roth & S.Ruzek (Eds.), Research in the Sociology of Health Care, Vol. 4, 1986, p. 185-235.

Hackman, J.R., "A Normative Model of Work Team Effectiveness," Yale School of Organization and Management, New Haven, Conn., Research Program on Group Effectiveness, Technical Report #2, 1984.

Hage, J., & Dewar, R., "Elite Values versus Organizational Structure in Predicting Innovation," Administrative Sciences Quarterly, Vol. 18, 1973, p. 279-290.

Hage, J., & Aiken, M., "Program Change and Organizational Properties: A Comparative Analysis," American Journal of Sociology, Vol. 72, 1967, p. 503-519.

Hage, J., Theories of Organization, Wiley Interscience, New York, 1980.

Hall, R.H., Organizations: Structures, Processes and Outcomes, (4th ed.), Prentice-Hall, Englewood Cliffs, New Jersey, 1987.

Hannan, M.T., & Freeman, J.H., "Structural Inertia and Organizational Change," American Sociological Review, Vol. 49, 1984, p. 149-164.

Hedberg, B., Nystrom, P.C., & Starbuck, W.H., "Camping on Seesaws Prescriptions for a Self-Designing Organization," Administrative Sciences Quarterly, Vol. 21, March 1976, p.41-65.

Hlavacek, J.D., Dovey, B.H., & Biondo, J.J., "Tie Small Business Technology to Marketing Power," Harvard Business Review, Vol. 55, No. 1, 1977, p. 106-116.

Huber, G.P., "The Nature and Design of Post-Industrial Organizations," Management Science, Vol. 30, No. 8, 1984, p. 928-951.

Hyderbrand, W., Hospital Bureaucracy, Dunellen, New York, 1973.

Inmon, W.H., Information Engineering for the Practioner: Putting Theory into Practice, Yourdon Press, Englewood Cliffs, New Jersey, 1988.

Ives, B., & Learmonth, G.P., "The Information System as a Competitive Weapon," Communications of the ACM, December 1984, p. 1193-1201.

Kanter, R.M., The Change Masters: Innovation for Productivity in the American Corporation, Simon & Shuster, New York, 1983.

Kelly, P., & Kranzberg, M., Technological Innovations: A Critical Review of Current Knowledge, San Francisco:San Francisco University Press, 1978.

Keen, P.G., "Information Systems and Organizational Change," Communications of the ACM, Vol. 24, 1981, p. 24-33.

Kerlinger, F.N., "Foundations of Behavioral Research," The Dryden Press, New York, 3rd ed., 1986.

Kimberly, J.R., "Managerial Innovation," In P.C. Nystrom & W.H. Starbuck (Eds), Handbook of Organizational Design, Oxford University Press, New York, 1981, p. 84-104.

Kimberly, J.R., & Evanisko, M.J., "Organizational Innovation: The Influence of Individual, Organizational and Contextual Factors on Hospital Adoption of Technological and Administrative Innovations," Academy of Management Journal, Vol. 24, No. 4, 1981, p. 689-713.

Kimberly, J.R., "Hospital Adoption of Innovation: The Role of Integration into External Information Environments," Journal of Health and Social Behavior, Vol. 19, 1978, p. 361-373.

Kocher, M., & Deutsch, K.W., "Decentralization: Sketches Toward a Rational Theory, Gunn & Haen, Cambridge, MA, 1980.

Leavitt, H.J., "Applied Organizational Change in Industry: Structural, Technological & Humanistic Approaches," Chapter 27 in J.March (Ed.), Handbook of Organizations, Rand McNally, Chicago, 1965, p.1144-1170.

Lederer, A.L., & Mendelow, A.L., "Issues in Information System Planning," Information and Management, October 1986, p.245-254.

Lieberson, S., & O'Connor, J., "Leadership & Organizational Performance: A Study of Large Corporations," American Sociological Review, Vol. 37, 1972, p. 117-130.

Lockett, M., "Strategies for Managing End User Computing," In Micahel Earl's (Ed.), Information Management: The Strategic Dimension, Clarendon Press, Oxford, 1988, p. 211-229.

Lodahl, T., & Mitchell, S., "Drift in the Development of Innovative Organizations" In J. Kimberly and R. Miles (Eds.), The Organizational Life Cycle, Jossey-Boass, San Francisco, 1980.

Lovelace, R.F., "Stimulating Creativity Through Managerial Intervention," R&D Management, Vol. 16, 1986.

March, J., & Olsen, J., Ambiguity and Choice in Organizations, Universitetsforloget, Burgen, Norway, 1976.

March, J.G., & Simon, H.A, Organizations, Wiley, New York, 1958.

Martin, J., "Preventing the Application Development Revolution," PC Week, August 28, 1989, p. 70.

McFarlan, F.W., "Information Technology Changes the way you Compete," Harvard Business Review, May-June 1984, p. 98-103.

McWilliams, G., "Users see a CASE advance in Reverse Engineering Tools," Datamation, February 1988, p. 31-36.

Mealiea, L.W., "Learned Behavior: The Key to Understanding and Preventing Employee Resistance to Change," Group and Organizational Studies, June 1978, p. 211-223.

Melone, N.P., & Bayer, J., " The Effect of Communication Channel, Level of Sponsorship and Timing on Implementation," Working Paper # 88-89-32, GSIA, Carnegie Mellon University, 1990.

Meyer, A.D., & Goes, J.B., "Organizational Assimilation of Innovations: A Multi-level Contextual Analysis," Academy of Management Journal, Vol. 31, No. 4, 1988, p. 897-923.

Mintzberg, H., Raisinghani, D., & Theret, A., "The Structure of Unstructured Decision Processes," Administrative Sciences Quarterly, Vol. 21, p. 246-275.

Moad, J., "Navigating Cross-Functional IS Waters," Datamation, March 1989, p. 73-75.

Moch, M.K., & Morse, E.V., "Size, Centralization & Organizational Adoption of Innovations," American Sociological Review, Vol. 42, 1977, p. 716-725.

Mohr, L.B., "Determinants of Innovation in Organizations," American Political Science Review, Vol. 63, 1969, 111-120.

Mohr, L.B., Explaining Organizational Behavior: The Limits and Possibilities of Theory and Research, San Francisco:Jossey-Bass, 1982.

Myers, S., & Marquis, P.G., Successful Commercial Innovations, National Science Foundation, Washington:NSF, 1969.

Mytinger, R.E., Innovation in Local Health Services, Washington, D.C.: Government Printing Office, Public Health Service Publication, No. 1644-2, 1968.

Nilakanta, S., & Scamell, S., "The Effect of Information Sources and Communication Channels on the Diffusion of Innovation in a Data Base Environment," Management Science, January 1990, p. 24-40.

Ouchi, W., Theory Z, Addison-Wesley, Reading:Mass., 1981.

Owen, K., "Another Review of ICL," Computer Decisions, 1977, 9, p. 61-63.

Pascale, R. & Athos, A., The Art of Japanese Management, Warner Brooks, New York, 1981.

Pelz, D., & Munson, F., "Originality Level and the Innovating Process in Organizations," Human Systems Management, 1982, p. 183-187.

Peters, T.J. & Waterman, R.H., In Search of Excellence, Harper & Row, New York, 1982.

Pfeffer, J., & Davis-Blake, A., "Administrative Succession & Organizational Performance: How Administrator Experience Mediates the Succession Effect," Academy of Management Journal, Vol. 29, No. 1, 1983, p. 72-83.

Pfeffer, J., "Organizational Demography" In L.L. Cummings & B.M. Straw (Eds), Research in Organizational Behavior, JAI Press, Greenwich, CT, 1983.

Pierce, J.L., & Delbecq, A.L., "Organization Structure, Individual Attitudes, and Innovation," Academy of Management Review, March-April, 1977, p. 27-37.

Popper, W., The Implementation of Structured Methodologies as a Productivity Technique in Systems Development, M.S. Thesis, Massachusetts Institute of Technology, 1983.

Porter, M.E., & Millar, V.E., "How Information gives you Competitive Advantage," Harvard Business Review, July-August 1985, p. 149-160.

Porter, M., Competitive Advantage: Creating and Sustaining Superior Performance, The Free Press, New York, 1980.

Price, J.L., Organizational Effectiveness: An Inventory of Propositions, R.D. Irwin, Homewood, IL, 1968.

Roberts, N., "Transforming Leadership: Sources, Process, Consequences," presented at Academy of Management Conference, Boston, AUgust, 1984.

Rockart, J.F., "The Changing Role of the Information Systems Executive: A Critical Success Factors Perspective," Sloan Management Review, Fall 1982, p. 3-13.

Rogers, E., Diffusion of Innovations, (3rd ed.), New York:Free Press, 1983.

Runge, D.A., & Earl, M., "Gaining Competitive Advantage from Telecommunications," In Earl, M. (Ed.), Information Management: The Strategic Dimension, London, Clarendon, 1988.

Ruttan, V., & Hyami, "Toward a Theory of Induced Institutional Innovation," Journal of Development Studies, Vol. 20, No. 4, 1984, p. 203-223.

Salanick, G.R., & Pfeffer, J., "Constraints on Administration Discretion: The Limited Influence of Mayors on City Budgets," Urban Affairs Quarterly, Vol. 12, 1977, p. 475-498.

Sapolsky, H.M., Organizational Structure and Innovation, Journal of Business, 40, October 1976, p. 497-510.

Schien, E.H., Organizational Culture and Leadership, Jossey-Bass Publishers, San Francisco, 1985.

Schussel, G., "Application Development in the 5th Generation," Datamation, November 1987, p. 94-102.

Selznick, P., "Leadership in Administration," Harper and Row, New York, 1957.

Senn, J.A., "Information Systems in Management," Wadsworth Inc., 1990.

Shepard, H.A., "Innovation-Resisting and Innovation-Producing Organizations," Journal of Business, 40, October 1967, p. 470-477.

Simon, H.A., "Applying Information Technology to Organization Design," Public Administrative Review, May-June 1973, p. 268-278.

Stamps, D., "Cranking out Productivity," Datamation, July 1987, p. 55-58.

Stewart, D.W., "The Application and Misapplication of Factor Analysis in Marketing Research," Journal of Marketing Research, Vol. 18, February, 1981, p. 51-62.

Tomeski, E.A., "Building Human Factors into Computer Applications: The Computer Profession must Overcome a 'Jackass Fallacy'!", Management Datamatics, Vol. 4, August 1975, p.115-120.

Tornatzky, L.G., & Klein, K.J., "Innovation Charactersitics and Innovation Adoption Implementation: A Meta-Analysis of Findings," IEEE Transactions of Engineering Management, Vol. 29, 1983, p. 28-45.

Tornatzky, L.G., Eveland, J.D., Boylan, M.G., Hetzner, W.A., Johnson, E.C., Roitman, D., & Schneider, J., "Innovation Processes and their Management: A Conceptual, Empirical and Policy Review of Innovation Process Research," Washington D.C., National Science Foundation, 1983.

Tushman, M.L., "Special Boundary Roles in the Innovation Process," Administrative Science Quarterly, Vol. 22, No. 4, Decemeber 1977, p. 587-605.

Utterback, J., "Innovation in Industry and Diffusion of Technology," Science, 1974.

Utterback, J., "The Process of Technological Innovation within the Firm." Academy of Management Journal, Vol. 14, 1971, p.75-88.

Van de Ven, A.H. "Central Problems in the Management of Innovation," Management Science, 32, No. 5, May 1986, p. 590-607.

Whitten, J.L., & Bentley, L.D., Using Excelerator for Systems Analysis and Design, Mosby College Publishing, St. Louis, MO, 1987.

Witte, E., "Field Research on Complex Decision-Making Processes- The Phase Theorem," International Studies of Management and Organization, Vol. 2, No. 2, 1972, p. 156-182.

Zaltman, G., Duncan R., & Holbeck, J., Innovation and Organizations, New York:Wiley, 1973.

Zmud, R.W., "An Examination of Push-Pull Theory Applied to Process Innovation in Knowledge Work," Management Science, Vol. 30, 1984, p.727-738.

APPENDIX 1

QUESTIONNAIRE USED IN THE PILOT STUDY

STIMULATING CASE USAGE IN INFORMATION SYSTEM DEPARTMENTS

A NATIONAL SURVEY

FOR EACH LINE IN THIS CHART, CHECK ONE BOX THAT INDICATES THE DEGREE OF SOPHISTICATION OF CASE TOOLS POSSESSED BY YOUR INFORMATION SYSTEM DEPARTMENT.

Answer without regard for how much each CASE tool is actually used.

Most CASE tool products support several of the functions (lines) in the table—answer for each function separately.

SYSTEMS FUNCTION AUTOMATED BY CASE TOOL	We Do Not Possess This Tool	We Have Tools Of **Very Low** Sophistication	We Have Tools Of **Low** Sophistication	We Have Tools Of **Moderate** Sophistication	We Have Tools Of **High** Sophistication	We Have Tools Of **Very High** Sophistication
Strategic System Planning						
System Requirements Determination and Documentation						
Diagramming (eg. Data Flow or Entity-Relationship Diagrams)						
Screen and Report Layout						
Prototyping						
Normalization of Data Designs						
Data Base Code/ Schema (eg. IDMS Generation)						
Procedural (eg. COBOL) Code Generation						
Test Data Generation						
Reverse Engineering-Analysis of Program Structure						
Reverse Engineering-Automatic Restructuring of Program Code						
Reverse Engineering-Analysis of Data Base Structure						
Project Management						

FOR EACH LINE IN THIS CHART, CHECK ONE BOX THAT INDICATES THE DEGREE OF USE OF CASE TOOLS IN YOUR INFORMATION SYSTEM DEPARTMENT.

Most CASE tool products support several of the functions (lines) in the table--answer for each function separately.

SYSTEMS FUNCTION AUTOMATED BY CASE TOOL	Tool Not Used At All	A Few People/ Projects Experiment With Tool	A Few People/ Projects Use Tool Regularly	A Lot Of People/Projects Use Tool Regularly	Most People/ Projects Use Tool Regularly	Tool Used On A Routine Basis
Strategic System Planning						
System Requirements Determination and Documentation						
Diagramming (eg. Data Flow or Entity-Relationship Diagrams)						
Screen and Report Layout						
Prototyping						
Normalization of Data Designs						
Data Base Code/ Schema (eg. IDMS Generation)						
Procedural (eg. COBOL) Code Generation						
Test Data Generation						
Reverse Engineering-Analysis of Program Structure						
Reverse Engineering-Automatic Restructuring of Program Code						
Reverse Engineering-Analysis of Data Base Structure						
Project Management						

THE FOLLOWING ITEMS PERTAIN TO CHARACTERISTICS OF YOUR INFORMATION SYSTEM DEPARTMENT (ISD). CIRCLE THE CHOICE ON EACH SCALE THAT BEST REPRESENTS YOUR ISD.

Strongly Disagree	Disagree	Disagree Slightly	Neutral	Agree Somewhat	Agree	Strongly Agree
SD	D	DS	N	AS	A	SA

1. Our ISD is under a threat of being disbanded.

SD D DS N AS A SA

2. The system development backlog in our corporation/ organization is no problem.

SD D DS N AS A SA

3. A substantial fraction of our ISD budget is allocated for technology exploration and R&D.

SD D DS N AS A SA

4. Programmer/analysts here get almost no company-supported CASE training.

SD D DS N AS A SA

5. People in our ISD have learned a lot about CASE by attending off-site CASE seminars and product shows.

SD D DS N AS A SA

6. Top management here takes a hands-off approach to information systems and the ISD.

SD D DS N AS A SA

7. In our ISD we frequently rotate personnel among various positions and job roles.

SD D DS N AS A SA

8. Most of our programmer/analysts know a lot about CASE and CASE tools.

SD D DS N AS A SA

9. Our users and clients are well-satisfied with the performance of our ISD.

SD D DS N AS A SA

10. Very few formal training opportunities on structured methodology are made available to our programmer/analysts.

SD D DS N AS A SA

Strongly Disagree	Disagree	Disagree Slightly	Neutral	Agree Somewhat	Agree	Strongly Agree
SD	D	DS	N	AS	A	SA

		SD	D	DS	N	AS	A	SA
11.	People in our ISD have learned a lot about CASE from consultants.							
12.	Our programmer/analysts are given many formal opportunities to receive formal training in CASE and CASE tools.							
13.	Our ISD is under pressure to produce quick returns on investment.							
14.	People in our ISD have learned a lot about CASE from trade publications, such as Datamation.							
15.	The future of the ISD is uncertain in our corporation/organization.							
16.	Our programmer/analysts are given many opportunities to receive formal training on logical data modeling and other "new" system design techniques.							
17.	People hardly ever change job responsibilities in our ISD.							
18.	People in our ISD have learned a lot about CASE from vendor representatives who have visited our site.							
19.	CASE has no strong advocates here.							
20.	Our top corporate/organizational management provide strong and involved leadership when it comes to information systems.							

Strongly Disagree	Disagree	Disagree Slightly	Neutral	Agree Somewhat	Agree	Strongly Agree
SD	D	DS	N	AS	A	SA

21. Top corporate/organizational management champions innovations related to information technology when they have the potential to help the firm.

22. Our users generally do not employ outside contractors for their systems work.

23. We have no CASE experts in our ISD.

24. We have separate groups of programmer/ analysts with separate jobs, such as a methodology group, a testing group, a standards group etc.

25. "Chaos" is the word that best describes the state of our application system portfolio.

26. There are one or more people in our corporation/organization who are pushing for CASE very enthusiastically.

27. Our corporation/organization avoids risky projects.

28. People in our ISD are confident they will be able to remain in their same job roles for a long time, if they choose.

29. We do not have separate groups for programming, analysis, data administration etc. in our ISD.

30. End user computing is threatening the future of our ISD.

SD	D	DS	N	AS	A	SA

Strongly Disagree	Disagree	Disagree Slightly	Neutral	Agree Somewhat	Agree	Strongly Agree
SD	D	DS	N	AS	A	SA

		SD	D	DS	N	AS	A	SA
31.	Our ISD does not have people whose main job is R&D, experimentation, and technology exploration.							
32.	Almost none of our programmer/analysts are well-versed about structured development methodologies.							
33.	Top corporate/organizational management has established clear goals and a clear picture of how information systems support these goals.							
34.	Job roles in our ISD are blended rather than specialized.							
35.	Our corporation/organization has a "corporate culture" that is quite open to investing in projects with slow or uncertain returns.							
36.	Job stability is high within our ISD.							
37.	People in our ISD have learned a lot about CASE from video/audio tapes.							
38.	Nobody in our corporation/organization has taken the lead in pushing for adoption of CASE.							
39.	People in our ISD have learned a lot about CASE through their contacts with programmer/analysts in other organizations.							

Strongly Disagree	Disagree	Disagree Slightly	Neutral	Agree Somewhat	Agree	Strongly Agree
SD	D	DS	N	AS	A	SA

40. Our ISD is under pressure to improve its performance. SD D DS N AS A SA

41. Most of our programmer/analysts know a lot about structured system development methodology. SD D DS N AS A SA

42. People in our ISD have learned a lot about CASE from reading text and reference books. SD D DS N AS A SA

43. There are one or more people here who are pressing for CASE usage. SD D DS N AS A SA

THE LAST FEW QUESTIONS ARE NEEDED TO DEVELOP A DEMOGRAPHIC PROFILE OF THE ISDs SURVEYED

44. How many full-time employees are in your ISD (operations, development, etc.). *Circle the number corresponding to your answer.*

1. 1-10 people
2. 11-20
3. 21-50
4. 51-100
5. 101-150 people
6. 151-200
7. >200

45. When did your ISD begin experimentation with CASE tools? (Circle number.)

1. Not yet started
2. < 1 year ago
3. 1-2 years ago
4. 2-3 years ago
5. > 3 years ago

46. *Please name the CASE tools used in your ISD, in order of usage.*

1. _____
2. _____
3. _____
4. _____

47. What is your organization's primary business? (Circle one.)

01 Electric, electronic manufacturing and processing
02 Machinery, instruments, equipment manufacturing and processing
03 Chemicals, petroleum, coal manufacturing and processing
04 Other manufacturing and proceesing; Please specify _____
05 Public utilities
06 Banking and financial
07 Insurance
08 Engineeiring
09 Service - DP
10 Service - other than DP
11 Retail sales and distribution
12 Other; Please specify _____

IF YOU WOULD LIKE TO RECEIVE RESULTS OF THIS STUDY, PLEASE ATTACH A BUSINESS CARD OR WRITE YOUR NAME AND ADDRESS HERE. (YOUR ANONYMITY WILL BE PROTECTED.)

IN CASE OF ANY QUESTIONS, PLEASE CONTACT:

GEOFFRY S. HOWARD
or
ARUN RAI
Graduate School of Management
College of Business Administration
Kent, Ohio 44242
(216) 672-2750

APPENDIX 2

QUESTIONNAIRE USED IN THE NATIONAL STUDY

College of Business Admin.
Department of Administrative Sciences
Graduate School of Management
(216) 672-2750

Kent State University

xx/xx/xx

Mr. XYZ
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Dear MIS Manager,

We are university researchers with no product or service to sell. We would, however, like to entice you to fill out the enclosed CASE survey. In return, you'll quickly receive a summary of our results, which will provide you an up-to-date profile of how CASE is being used nationally. This will enable you to compare the nature of CASE use in your data center with national CASE norms.

The objectives of our study are to measure the extent to which CASE usage has penetrated into data centers, and to determine the factors that explain variations in CASE use. We hope you'll agree that these results could be useful in managing CASE innovations in your own shop.

Your name was randomly selected from a purchased mailing list of data center managers. The credibility of the results that we will feed back to the MIS industry greatly depends on the number of return questionnaires received. Please help us help you by taking the time to complete this short questionnaire. (Please fill out the questionnaire even if you are not presently using CASE.)

The questionnaire has been scientifically designed and carefully pretested. The apparent repetitiveness of some of the questions is intentional.

If you would like to receive a copy of the results, please **include a business card** or write your name and address on the front of the questionnaire. We will respond quickly.

Sincerely,

Geoffry S. Howard
Associate Professor
Information Systems

Arun Rai
Instructor
Information Systems

College of Business Admin.
Department of Administrative Sciences
Graduate School of Management
(216) 672-2750

xx/xx/xx

xxxxxxxxxxxxxxxxxxxx
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Dear MIS Manager,

I hope you received the questionnaire on CASE technology that was sent to you about three weeks ago. To date we have not received a response. I know that your time is precious, but would be most grateful if you could take a few minutes to complete the survey. (Please do so even if you are not presently using CASE for your application software development.)

In the event you do not develop any in-house application software, the survey might be inappropriate for you. However, we would appreciate your returning the questionnaire, stating the same.

Let me reiterate that we would like to thank you for participating by sending you the results of the survey.

If you would like to receive a copy of the results, please enclose your business card or write your name and address on the front page of the questionnaire. The results should help you in managing CASE innovations and learning what is being done with CASE in other firms. You can be fully assured that your anonymity will be protected.

Sincerely,

Arun Rai
Instructor
Information Systems

STIMULATING CASE USAGE IN INFORMATION SYSTEM DEPARTMENTS

A NATIONAL SURVEY

Geoffry S. Howard
Arun Rai
Graduate School of Management
College of Business Administration
Kent, Ohio 44242
(216) 672-2750

FOR EACH LINE IN THIS CHART, CHECK ONE BOX THAT INDICATES THE DEGREE OF SOPHISTICATION OF CASE TOOLS POSSESSED BY YOUR INFORMATION SYSTEM DEPARTMENT.

Answer without regard for how much each CASE tool is actually used.

Most CASE tool products support several of the functions (lines) in the table--answer for each function separately.

SYSTEMS FUNCTION AUTOMATED BY CASE TOOL	We Do Not Possess This Tool	We Have Tools Of **Very Low** Sophistication	We Have Tools Of **Low** Sophistication	We Have Tools Of **Moderate** Sophistication	We Have Tools Of **High** Sophistication	We Have Tools Of **Very High** Sophistication
Strategic System Planning						
System Requirements Determination and Documentation						
Diagramming (eg. Data Flow or Entity-Relationship Diagrams)						
Screen and Report Layout						
Prototyping						
Normalization of Data Designs						
Data Base Code/ Schema (eg. IDMS Generation)						
Procedural (eg. COBOL) Code Generation						
Test Data Generation						
Reverse Engineering- Analysis of Program Structure						
Reverse Engineering- Automatic Restructuring of Program Code						
Reverse Engineering- Analysis of Data Base Structure						
Project Management						

FOR EACH LINE IN THIS CHART, CHECK ONE BOX THAT INDICATES THE DEGREE OF USE OF CASE TOOLS IN YOUR INFORMATION SYSTEM DEPARTMENT.

Most CASE tool products support several of the functions (lines) in the table—answer for each function separately.

SYSTEMS FUNCTION AUTOMATED BY CASE TOOL	Tool Not Used At All	A Few People/ Projects Experiment With Tool	A Few People/ Projects Use Tool Regularly	A Lot Of People/Projects Use Tool Regularly	Most People/ Projects Use Tool Regularly	Tool Used On A Routine Basis
Strategic System Planning						
System Requirements Determination and Documentation						
Diagramming (eg. Data Flow or Entity-Relationship Diagrams)						
Screen and Report Layout						
Prototyping						
Normalization of Data Designs						
Data Base Code/ Schema (eg. IDMS Generation)						
Procedural (eg. COBOL) Code Generation						
Test Data Generation						
Reverse Engineering- Analysis of Program Structure						
Reverse Engineering- Automatic Restructuring of Program Code						
Reverse Engineering- Analysis of Data Base Structure						
Project Management						

THE FOLLOWING ITEMS PERTAIN TO CHARACTERISTICS OF YOUR INFORMATION SYSTEM DEPARTMENT (ISD). CIRCLE THE CHOICE ON EACH SCALE THAT BEST REPRESENTS YOUR ISD.

Strongly Disagree	Disagree	Disagree Slightly	Neutral	Agree Somewhat	Agree	Strongly Agree
SD	D	DS	N	AS	A	SA

1. Our ISD is under a threat of being disbanded.

SD D DS N AS A SA

2. The system development backlog in our corporation/ organization is no problem.

SD D DS N AS A SA

3. A substantial portion of our ISD budget is allocated for technology exploration and R&D.

SD D DS N AS A SA

4. Programmer/analysts here get almost no company-supported CASE training.

SD D DS N AS A SA

5. People in our ISD have learned a lot about CASE by attending off-site CASE seminars and product shows.

SD D DS N AS A SA

6. Top corporate/organizational management here takes a hands-off approach to information systems and the ISD.

SD D DS N AS A SA

7. In our ISD we frequently rotate personnel among various positions and job roles.

SD D DS N AS A SA

8. Most of our programmer/analysts know a lot about CASE and CASE tools.

SD D DS N AS A SA

9. Our users and clients are well-satisfied with the performance of our ISD.

SD D DS N AS A SA

10. Very few formal training opportunities on structured methodology are made available to our programmer/analysts.

SD D DS N AS A SA

Strongly Disagree	Disagree	Disagree Slightly	Neutral	Agree Somewhat	Agree	Strongly Agree
SD	D	DS	N	AS	A	SA

11. People in our ISD have learned a lot about CASE from consultants.

12. Our programmer/analysts are given many opportunities to receive formal training in CASE and CASE tools.

13. Our ISD is under pressure to produce quick returns on investment.

14. People in our ISD have learned a lot about CASE from trade publications, such as Datamation.

15. The future of the ISD is uncertain in our corporation/organization.

16. Our programmer/analysts are given many opportunities to receive formal training on logical data modeling and other "new" system design techniques.

17. People hardly ever change job responsibilities in our ISD.

18. People in our ISD have learned a lot about CASE from vendor representatives who have visited our site.

19. CASE has no strong advocates here.

20. Our top corporate/organizational management provide strong and involved leadership when it comes to information systems.

SD D DS N AS A SA

Strongly Disagree	Disagree	Disagree Slightly	Neutral	Agree Somewhat	Agree	Strongly Agree
SD	D	DS	N	AS	A	SA

		SD	D	DS	N	AS	A	SA
21.	Top corporate/organizational management champions innovations related to information technology when they have the potential to help the firm.							
22.	Our organization generally does not employ outside contractors for their systems work.							
23.	We have no CASE experts in our ISD.							
24.	We have separate groups of programmer/analysts with separate jobs, such as a methodology group, a testing group, a standards group etc.							
25.	Users here are generally dissatisfied with our application system portfolio.							
26.	There are one or more people in our corporation/organization who are pushing for CASE very enthusiastically.							
27.	Our corporation/organization avoids risky projects.							
28.	People in our ISD are confident they will be able to remain in their same job roles for a long time, if they choose.							
29.	Our programmer/analysts are not subdivided into specialized technical groups.							
30.	End user computing is threatening the future of our ISD.							

Strongly Disagree	Disagree	Disagree Slightly	Neutral	Agree Somewhat	Agree	Strongly Agree
SD	D	DS	N	AS	A	SA

31. Our ISD does not have people whose main job is R&D, experimentation, and technology exploration.

SD D DS N AS A SA

32. Almost none of our programmer/analysts are well versed about structured development methodologies.

SD D DS N AS A SA

33. Top corporate/organizational management has established clear goals and a clear picture of how information systems support these goals.

SD D DS N AS A SA

34. Job roles in our ISD are blended rather than specialized.

SD D DS N AS A SA

35. Our corporation/organization has a "corporate culture" that is quite open to investing in projects with slow or uncertain returns.

SD D DS N AS A SA

36. Stability of job roles is high in our ISD.

SD D DS N AS A SA

37. People in our ISD have learned a lot about CASE from video/audio tapes.

SD D DS N AS A SA

38. Nobody in our corporation/organization has taken the lead in pushing for adoption of CASE.

SD D DS N AS A SA

39. People in our ISD have learned a lot about CASE through their contacts with programmer/analysts in other organizations.

SD D DS N AS A SA

Strongly Disagree	Disagree	Disagree Slightly	Neutral	Agree Somewhat	Agree	Strongly Agree
SD	D	DS	N	AS	A	SA

40. Our ISD is under pressure to improve its performance.

41. Most of our programmer/analysts know a lot about structured system development methodology.

42. People in our ISD have learned a lot about CASE from reading text and reference books.

43. There are one or more people here who are pressing for CASE usage.

SD D DS N AS A SA

THE LAST FEW QUESTIONS ARE NEEDED TO DEVELOP A DEMOGRAPHIC PROFILE OF THE ISDs SURVEYED

44. How many full-time employees are in your ISD (operations, development, etc.)? Circle the number corresponding to your answer.

1. 1-10 people
2. 11-20
3. 21-50
4. 51-100
5. 101-150
6. 151-200 people
7. 201-250
8. 251-300
9. 301-350
10. > 350

45. When did your ISD begin experimentation with CASE tools? (Circle number.)

1. Not yet started
2. < 1 year ago
3. 1-2 years ago
4. 2-3 years ago
5. > 3 years ago

46. Please name the most-used CASE tools in your ISD, in order of usage.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

APPENDIX 3

FREQUENCY AND SUMMARY STATISTICS OF QUESTIONNAIRE ITEMS

Depth of Case Penetration

(N = 405)

Depth measures the degree of sophistication of CASE tools possessed for various system development functions without regard for actual usage.

SYSTEM FUNCTION AUTOMATED BY CASE TOOL	We Do Not Possess This Tool	We Have Tools of Very Low Sophistication	We Have Tools of Low Sophistication	We Have Tools of Moderate Sophistication	We Have Tools of High Sophistication	We Have Tools of Very High Sophistication	Mean[1]	Standard Deviation
Strategic Systems	319	17	20	23	21	5	0.58	1.25
Systems Requirements Determination and Documentation	256	20	26	54	37	12	1.09	1.59
Diagramming (eg. Data Flow or Entity-Relationship Diagrams)	180	31	45	75	44	30	1.65	1.74
Screen and Report Layout	137	34	58	88	65	23	1.96	1.68
Prototyping	191	28	40	80	43	23	1.56	1.71
Normalization of Data	265	18	34	39	34	15	1.02	1.57
Data Base Code/Schema	257	23	29	49	30	17	1.06	1.59
Procedural (eg. COBOL)	266	21	21	34	42	23	1.11	1.70
Test Data Generation	291	29	37	34	12	2	0.65	1.17
Reverse Engineering-Analysis of Program Structure	367	10	13	8	4	3	0.22	0.79
Reverse Engineering-Automatic Restructuring of Program Code	375	5	9	6	8	2	0.20	0.80
Reverse Engineering - Analysis of Data Base Structure	372	3	10	10	9	1	0.23	0.83
Project Management	153	37	43	110	51	11	2.0	1.60

[1] The depth scale ranges from 0 to 5.
0- no case tools; 1-very low sophistication; 2-low sophistication;
3-moderate sophistication; 4-high sophistication; 5-very high sophistication.

Breadth Of CASE Penetration

(N = 405)

Breadth measures the degree of usage of CASE tools for various system development functions.

SYSTEM FUNCTION AUTOMATED BY CASE TOOL	Tool Not Used At All	A Few People/ Projects Experiment With Tool	A Few People/ Projects Use Tool Regularly	A Lot of People/ Projects Use Tool Regularly	Most People/ Projects Use Tool Regularly	Tool Used On A Routine Basis	Mean[1]	Std. Deviation
Strategic Systems Planning	326	42	29	2	2	4	.33	.81
Systems Requirements Determination and Documentation	263	50	58	18	7	9	.72	1.19
Diagramming (eg. Data Flow or Entity-Relationship Diagrams)	193	62	98	29	13	10	1.10	1.30
Screen and Report Layout	156	45	88	62	27	27	1.60	1.58
Prototyping	207	69	69	32	14	14	1.05	1.36
Normalization of Data Design	285	50	46	10	6	8	0.58	1.09
Data Base Code/Schema (eg. IDMS Generation)	274	42	49	18	15	7	0.71	1.22
Procedural (eg. COBOL) Code Generation	283	36	34	19	16	17	0.77	1.40
Test Data Generation	306	36	34	16	11	2	0.51	1.04
Reverse Engineering- Analysis of Program Structure	372	19	7	3	1	3	0.15	0.62
Reverse Engineering - Automatic Restructuring of Program Code	378	15	6	3	1	2	0.12	0.55
Reverse Engineering - Analysis of Data Base Structure	379	16	7	0	3	0	0.10	0.46
Project Management	168	63	88	31	21	34	1.44	1.59

[1] Scores for each item vary from 0-5

Independent Variable Items

(N = 405)

	Item	Strongly Disagree	Disagree	Disagree Slightly	Neutral	Agree Somewhat	Agree	Strongly Agree	Mean	Standard Deviation
1.	Our ISD is under a threat of being disbanded.	253	86	15	15	18	11	7	1.81	1.43
2.	The system development backlog in our corporation/ organization is no problem.	73	153	70	24	34	39	12	2.89	1.68
3.	A substantial portion of our ISD budget is allocated for technology exploration and R&D.	153	152	32	21	33	9	5	2.20	1.42
4.	Programmer/analysts here get almost no company-supported CASE training.	28	43	34	27	33	113	127	5.08	2.00
5.	People in our ISD have learned a lot about CASE by attending off-site CASE seminars and product shows.	92	111	21	48	79	45	9	3.20	1.85
6.	Top corporate/organizational management here takes a hands-off approach to information systems and the ISD.	45	97	54	48	65	56	40	3.79	1.91
7.	In our ISD we frequently rotate personnel among various positions and job roles.	59	122	35	55	72	53	9	3.38	1.77
8.	Most of our programmer/analysts know a lot about CASE and CASE tools.	129	149	56	26	28	16	1	2.33	1.39
9.	Our users and clients are well-satisfied with the performance of our ISD.	9	50	66	42	113	115	10	4.44	1.52
10.	Very few formal training opportunities on structured methodology are made available to our programmer/analysts.	23	68	51	31	53	127	52	4.51	1.90

	Item	Strongly Disagree	Disagree	Disagree Slightly	Neutral	Agree Somewhat	Agree	Strongly Agree	Mean	Standard Deviation
11.	People in our ISD have learned a lot about CASE from consultants.	130	159	27	31	35	19	4	2.40	1.52
12.	Our programmer/analysts are given many opportunities to receive formal training in CASE and CASE tools.	117	152	46	30	38	16	6	2.49	1.53
13.	Our ISD is under pressure to produce quick returns on investment.	9	28	34	54	91	128	61	5.10	1.62
14.	People in our ISD have learned a lot about CASE from trade publications, such as Datamation.	46	66	34	84	120	50	5	3.82	1.78
15.	The future of the ISD is uncertain in our corporation/organization.	136	120	37	28	41	30	13	2.65	1.65
16.	Our programmer/analysts are given many opportunities to receive formal training on logical data modeling and other "new" system design techniques.	82	118	69	37	60	36	3	2.98	1.68
17.	People hardly ever change job responsibilities in our ISD.	20	82	100	29	78	81	15	3.90	1.65
18.	People have learned a lot about CASE from vendor representatives who have visited our site.	97	134	36	36	76	24	2	2.85	2.02
19.	CASE has no strong advocates here.	72	81	58	41	44	72	37	3.66	1.85
20.	Our top corporate/organizational management provides strong and involved leadership when it comes to information systems.	57	98	62	42	66	58	22	3.55	1.75
21.	Top corporate/organizational management champions innovations related to information technology when they have the potential to help the firm.	32	53	45	47	108	91	29	4.32	2.13

	Item	Strongly Disagree	Disagree	Disagree Slightly	Neutral	Agree Somewhat	Agree	Strongly Agree	Mean	Standard Deviation
22.	Our organization does not employ outside contractors for their systems work.	51	72	60	14	36	109	63	4.21	1.92
23.	We have no CASE experts in our ISD.	25	40	36	13	42	136	113	5.14	1.46
24.	We have separate groups of programmer/analysts with separate jobs, such as a methodology group, a testing group, a standards group etc.	162	163	20	13	25	16	6	2.13	1.65
25.	Users here are generally dissatisfied with our application system portfolio.	47	127	76	42	59	47	7	3.27	2.17
26.	There are one or more people in our corporation/organization who are pushing for CASE very enthusiastically.	77	90	21	30	64	65	58	3.84	1.79
28.	People in our ISD are confident they will be able to remain in their same job roles for a long time, if they choose.	34	73	69	45	77	82	25	4.71	1.65
29.	Our programmer/analysts are not subdivided into specialized technical groups.	17	41	42	51	75	149	30	4.86	1.79
30.	End user computing is threatening the future of our ISD.	13	58	44	19	49	168	54	2.36	1.41
31.	Our ISD does not have people whose main job is R&D, experimentation, and technology exploration.	120	167	41	23	42	9	3	5.45	1.76
32.	Almost none of our programmer/analysts are well versed about structured development methodologies.	18	27	34	11	26	165	124	3.84	1.79
33.	Top corporate/organizational management has established clear goals and a clear picture of how information systems support these goals.	28	102	72	24	84	74	21	3.17	1.73

	Item	Strongly Disagree	Disagree	Disagree Slightly	Neutral	Agree Somewhat	Agree	Strongly Agree	Mean	Standard Deviation
34.	Job roles in our ISD are blended rather than specialized.	72	112	67	45	62	31	16	5.33	1.29
35.	Our corporation/organization has a "corporate culture" that is quite open to investing in projects with slow or uncertain returns.	4	18	27	17	108	187	44	2.65	1.39
36.	Stability of job roles is high in our ISD.	80	157	65	44	45	13	1	4.92	1.46
37.	People in our ISD have learned a lot about CASE from video/audio tapes.	9	23	50	40	101	151	31	2.46	1.37
38.	Nobody in our corporation/organization has taken the lead in pushing for adoption of CASE.	111	150	47	46	44	7	0	4.30	2.03
39.	People in our ISD have learned a lot about CASE through their contacts with programmer/analysts in other organizations.	43	67	53	24	48	118	52	2.99	1.48
40.	Our ISD is under pressure to improve its performance.	60	141	47	74	67	14	2	5.22	1.45
41.	Most of our programmer/analysts know a lot about structured system development methodology.	5	26	30	23	118	135	68	3.82	1.61
42.	People in our ISD have learned a lot about CASE from reading text and reference books.	26	81	83	40	108	58	9	3.34	1.51
43.	There are one or more people here who are pressing for CASE usage.	43	107	72	70	83	27	3	4.04	2.06

		1-10	11-20	21-50	51-100	101-150	151-200	201-250	251-300	301-350	> 350	Mean[1]	Standard Deviation[2]
44.	Full-time Employees in the ISD	75	67	112	64	30	13	12	6	3	23	75.7	100.98

		Not Started	< 1 yr	1-2 yrs	2-3 yrs	>3 yrs
45.[3]	Time Since ISD began experimentation	106	147	79	30	43

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[1] $mean = \frac{\Sigma f_i * r_i}{\Sigma f_i}$ where r_i is the mid-range of each interval and f_i is the observed frequency for that interval.

$$std.deviation = \frac{\Sigma f_i * (M_i - \overline{X})^2}{n-1}$$

[2] where f_i is the frequency of a class and M_i is the mid-point

[3] This was not an independent variable item but was included to obtain additional information.

APPPENDIX 4

STANDARDIZED COEFFICIENTS USED TO COMPUTE
COMPOSITE FACTOR SCORES

Item Number	Variables	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor10
4.	Company CASE training	.274	.033	-.117	-.026	-.000	-.031	-.041	.003	-.086	-.012
8.	Knowledge of CASE & CASE tools	.206	.000	-.009	-.054	-.099	-.089	-.036	.069	.075	-.087
10.	Training -structured methodologies	.185	-.043	-.100	.040	* .061	.016	.196	.036	.131	.050
12.	Training -CASE & CASE tools	.304	-.053	-.067	-.045	-.019	-.033	-.038	.008	-.064	.003
16.	Training -system design techniques	.222	-.137	-.022	.025	.049	.005	.050	-.001	-.028	.023
23.	CASE experts in the ISD	.200	.083	-.109	-.013	-.036	-.005	-.076	.042	.054	-.028
5.	Learned from CASE seminars/ product shows	.033	.043	.150	-.044	-.029	-.023	-.148	-.027	-.061	.128
11.	Learned from CASE consultants	.159	-.095	.083	-.002	.074	.004	-.151	-.001	.095	-.095
14.	Learned from trade publications	-.128	-.057	.339	.014	.045	-.065	-.006	-.002	-.029	.061
18.	Learned from vendors	.092	-.037	.145	-.019	.008	.016	-.150	-.047	.020	-.027
37.	Learned from video/audio tapes	-.036	-.059	.250	-.019	-.028	.057	-.027	-.001	.004	.000
39.	Learned from programmer/ analysts-other companies	-.081	-.067	.337	-.008	-.060	-.003	.029	-.050	-.069	-.073
42.	Learned from text & reference books	-.111	-.003	.297	-.029	-.040	-.009	.074	.029	-.019	-.023
19.	Advocates of CASE technology	-.057	.278	-.019	-.013	-.047	-.057	-.002	.005	.044	-.005
26.	People pushing for CASE	-.057	.274	-.031	.013	.000	.010	.019	.013	-.066	-.030
38.	Leaders for CASE adoption	-.013	.273	-.092	.006	-.032	-.009	.019	.008	.001	-.021

Item Number	Variables	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor10
43.	People pressing for CASE usage	-.096	.299	-.009	.003	-.025	.004	.010	.014	-.039	.025
6.	Top mgmt approach to IS	-.061	.065	-.066	.387	.067	-.051	.095	.100	-.060	-.198
20.	IS leadership by top mgmt	-.022	-.020	-.007	.358	.021	.006	-.044	.006	-.031	-.042
21.	IT innovations and top mgmt	-.020	.022	-.009	.272	-.008	-.017	-.073	.044	-.002	.098
33.	IS and corporate goals	-.020	-.064	.034	.285	-.016	-.014	-.033	-.028	.034	-.020
2.	Development Backlog	-.003	.019	-.097	-.008	.320	-.016	.084	-.115	.048	.008
9.	User-satisfaction with the ISD	-.055	-.017	.013	-.024	.324	.045	.061	.019	-.022	.053
25.	Satisfaction with application portfolio	.102	-.195	.053	.048	.354	-.038	-.040	-.012	.023	-.131
40.	Need to improve performance	-.029	.023	-.034	.066	.326	-.049	.049	.037	.034	.081
24.	Methodology, standards group etc	.085	-.189	.016	-.007	.129	.326	-.018	-.049	.059	-.059
29.	Specialized technical groups	-.096	.031	-.007	-.026	-.071	.424	.011	.017	.041	-.058
31.	R&D, experimentation & other groups	.021	-.049	-.002	-.034	.025	.259	-.060	-.077	.068	.126
34.	Specialized job roles	-.091	.097	-.043	-.015	-.096	.388	.071	.102	-.130	.016
32.	Knowledge -methodologies	-.045	.026	-.057	-.046	.025	.020	.486	-.004	.007	.007
41.	Knowledge -structured development	-.083	-.033	.025	-.001	.046	-.006	.509	-.006	-.004	-.065
1.	Threat of ISD being disbanded	.055	.012	-.043	.056	-.029	.001	-.020	.543	.031	.010

Item Number	Variables	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor10
15.	Future of ISD in corporation	.000	.024	.001	.010	-.015	.017	.023	.507	-.019	.063
7.	Rotation of personnel	-.037	-.021	-.026	-.015	-.009	-.014	-.010	.081	.527	.021
17.	Change of job roles	-.038	-.012	-.041	-.100	.065	.038	-.006	-.077	.519	-.033
27.	Undertaking risky projects	-.063	.081	-.005	.021	-.057	-.082	-.016	.135	.038	.527
35.	Investment in slow returns	.001	-.062	-.001	-.101	.055	.057	-.025	-.055	-.041	.571

APPENDIX 5

MULTIPLE REGRESSION RESULTS FOR DEPTH OF CASE PENETRATION (FULL DATA SET)

R- SQUARE = .451 ADJUSTED R-SQUARE = .438

	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F	PROB>F
REGRESSION	9	29229.782	3247.754	35.986	0.0001
ERROR	395	35648.993	90.251		
TOTAL	404	64878.775			

VARIABLE	ESTIMATED VALUE OF β	STANDARD ERROR	T	PROB>|T|[1]
INTERCEPT	10.311			
Envu	-0.792	0.474	-1.67	0.0959*
Trng	5.700	0.497	11.44	0.0001
Know	0.413	0.473	0.873	0.383*
Comm	1.079	0.477	2.261	0.0243
Perf	1.083	0.492	2.199	0.0284
Ccul	-0.305	0.472	-0.647	0.518*
Spon	4.425	0.503	8.796	0.0001
Fdif	1.062	0.497	2.138	0.0331
Log(Size)	2.685	0.858	3.127	0.0019

[1]Environmental Instability, Knowledge of Structured Methodologies and Risk Aversiveness of the Corporate Culture did not meet the level of significance of 0.05.

APPENDIX 6

MULTIPLE REGRESSION RESULTS FOR DEPTH OF CASE PENETRATION (REDUCED DATA SET)

R-SQUARE = .387 ADJUSTED R-SQUARE = .369

	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F	PROB>F
REGRESSION	9	17182.641	1909.182	21.248	0.0001
ERROR	303	27225.037	89.850		
TOTAL	312	44407.680			

VARIABLE	ESTIMATED VALUE OF ß	STANDARD ERROR	T	PROB>|T|[3]
INTERCEPT	12.796			
Envu	-0.868	0.564	-1.537	0.0683*
Trng	5.216	0.538	9.69	0.0001
Know	0.580	0.538	1.07	0.3197*
Comm	0.416	0.553	0.752	0.2690*
Perf	0.746	0.597	1.248	0.0645*
Ccul	-0.285	0.546	-0.522	0.6376*
Spon	3.267	0.584	5.59	0.0001
Fdif	1.368	0.563	2.430	0.0036
Log(Size)	2.527	0.979	2.582	0.0103

[3]Environmental Instability, Knowledge of Structured methodologies, Advocacy of CASE, Performance gap, and Risk Aversiveness of the Corporate Culture did not meet the level of significance of 0.05.

APPENDIX 7

MULTIPLE REGRESSION RESULTS FOR BREADTH OF CASE PENETRATION (FULL DATA SET)

R-SQUARE = .413 ADJUSTED R-SQUARE = .403

	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F	PROB>F
REGRESSION	7	14022.16	2003.17	39.89	0.0001
ERROR	397	19938.71	50.22		
TOTAL	404	33960.88			

VARIABLE	ESTIMATED VALUE OF ß	STANDARD ERROR	T	PROB>|T|[2]
INTERCEPT	7.071			
Envu	-0.635	0.353	-1.79	0.0733*
Trng	4.01	0.368	10.88	0.0001
Know	1.18	0.353	3.34	0.0009
Spon	2.57	0.372	6.90	0.0001
Tmgt	1.53	0.353	4.34	0.0001
Jstb	1.50	0.366	4.089	0.0001
Log(Size)	2.04	0.589	3.46	0.0006

[2]Environmental Uncertainty and Top Management Support for IS did not meet the level of significance of 0.05.

APPENDIX 8

MULTIPLE REGRESSION RESULTS FOR BREADTH OF CASE PENETRATION (REDUCED DATA SET)

R-SQUARE = .383 ADJUSTED R-SQUARE = .368

	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F	PROB>F
REGRESSION	7	9101.328	1300.19	26.89	0.0001
ERROR	305	14745.981	48.35		
TOTAL	312	23847.309			

VARIABLE	ESTIMATED VALUE OF β	STANDARD ERROR	T	PROB>|T|[4]
INTERCEPT	9.234			
Envu	-0.812	0.817	-1.97	0.0497
Trng	3.712	0.388	9.56	0.0001
Know	1.549	0.394	3.931	0.0001
Spon	1.538	0.414	3.714	0.0002
Tmgt	1.252	0.402	3.111	0.0020
Jstb	1.687	0.393	4.292	0.0001
Log(Size)	1.699	0.646	2.629	0.0090

[4]Environmental instability did not meet the level of significance of 0.05.

APPENDIX 9

INDUSTRYWISE CLASSIFICATION OF ISDs BY DEPTH & BREADTH OF CASE PENETRATION

MANUFACTURING

DEPTH \ BREADTH	0	Low	High	Cumulative
0	43			
Low	2	124	2	128
High	0	13	3	16
Cumulative	45	137	5	187

COMMERCIAL BANKING

DEPTH \ BREADTH	0	Low	High	Cumulative
0	4			4
Low	0	7	0	7
High	0	2	0	2
Cumulative	4	9	0	13

DIVERSIFIED FINANCE

DEPTH \ BREADTH	0	Low	High	Cumulative
0	5			5
Low	0	10	0	10
High	0	4	0	0
Cumulative	5	14	0	19

INSURANCE

DEPTH \ BREADTH	0	Low	High	Cumulative
0	7			
Low	0	17	0	17
High	0	1	0	1
Cumulative	7	18	0	25

RETAIL

DEPTH \ BREADTH	0	Low	High	Cumulative
0	4			4
Low	0	0	0	0
High	0	12	0	12
Cumulative	4	12	1	16

TRANSPORTATION

DEPTH \ BREADTH	0	Low	High	Cumulative
0	0			0
Low	0	6	0	6
High	0	2	0	2
Cumulative	0	8	0	8

UTILITIES

DEPTH \ BREADTH	0	Low	High	Cumulative
0	4			
Low	1	11	0	12
High	0	1	0	1
Cumulative	5	12	0	17

EDUCATION

DEPTH \ BREADTH	0	Low	High	Cumulative
0	3			3
Low	1	22	0	23
High	0	0	0	0
Cumulative	4	22	0	26

HEALTH SERVICE

DEPTH \ BREADTH	0	Low	High	Cumulative
0	4			4
Low	1	0	0	1
High	0	14	0	14
Cumulative	5	0	0	5

GOVERNMENT

DEPTH	BREADTH			
	0	Low	High	Cumulative
0	17			17
Low	1	46		47
High	0	7	2	9
Cumulative	18	53	2	73