THE IMPLEMENTATION OF STRUCTURED METHODOLOGIES AS A PRODUCTIVITY TECHNIQUE IN SYSTEMS DEVELOPMENT

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ABSTRACT

A study of the implementation of structured systems development methodologies by analysts and programmer-analysts was conducted at three sites in a large industrial firm. A sample of 145 was selected and interviewed. A questionnaire was used to obtain information on the extent of use of the methodologies, and perceived advantages and disadvantages and the reasons for using alternative approaches. Data on the background, attitudes and perceptions of the analysts was gathered.

The results indicate that implementation of these methodologies is related to specific organizational, individual and opportunity factors. The degree to which supervisors and clients support use of the technique is related to the analyst's decision to implement it, for the structured analysis methodology but not for the structured programming methodology. Similar relationships were observed between analysts' attitudes and technical orientation and extent of use. Finally access to training, as an opportunity variable, was related to use of structured systems analysis.

Recommendations were made for the more effective implementation of the methodologies in the systems development organization. They included improving the measurement and monitoring of use and matching of access to training with expected extent of use.

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INTRODUCTION

Corporate management has become increasingly concerned in recent years with the implementation of productivity improvement techniques among professional and white collar workers. Because of the growing importance of information systems organizations in most large firms, and because of increasing costs of labor in this area, productivity improvement among systems analysts and programmers is of particular interest. This study is an examination of the use of structured systems development methodologies as a productivity improvement technique. The introductory chapter provides an overview of the study in four sections. The first section describes the problem of productivity in an information systems organization in general terms. In the second section, the purpose of the study is stated. Section three outlines the design of the study and sates the hypotheses to be tested. The final section defines the terminology used.

The Need for Productivity Improvement in Systems Development. Large corporations have been increasing their expenditures for electronic data processing steadily ever since the first electronic computing systems were installed. As expenditures have increased, both in absolute dollars and in proportion to other costs of doing business, corporate managers have become increasingly concerned about the efficiency of the information systems organizations within their firms. One result has been an increased interest on the part of information systems managers in establishing modern management practices to insure that the information system organizations for which they are responsible provide the most effective services for the least cost.

Several developments over the last fifteen years have resulted in a focus of these concerns in the area of labor productivity in information systems, a and in particular in the productivity of systems development professionals responsible for analyzing business problems and designing computer-based information systems to help solve these problems. These professionals are the systems analysts and programmer-analysts, the technical people who develop new software for a firm's computers and who design and implement improvements in existing software.

In large corporations, systems analysts generally work in the information systems group, providing services on request to other departments in the business. The latter are the end users of the systems, programs and applications packages developed by systems analysts. These end users or clients initiate requests for services, contract for these services and pay for the services provided. As the products and services of the information systems organization are ever more widely used within the firm, costs of information processing become more visible to management and concern with productivity in this area is more widely distributed.

Meanwhile technical developments have changed the distribution of costs within information systems. As computer hardware has become more inexpensive to manufacture the costs of processing time and memory have decreased relative to the cost of labor. Unit labor costs have simultaneously increased due to the shortage of trained technical workers and the higher level of training required to perform increasingly complicated tasks necessary to develop sophisticated systems. The result of these developments is that a manager concerned with the increase of productivity must look more closely at labor productivity to see whether the output per unit of labor input can be increased.

Another change underlying the increased concern with labor productivity is the gradual change over time in the content of systems development work from the development of entirely new systems to the enhancement and maintenance of existing systems. When computers were first introduced in business, all systems development work was in new development. As programs were implemented and software applications packages adopted end users returned to systems developers with requests for changes, improvements and supplements to previously developed systems. Analysts and programmers have been spending an increasing proportion of their time on this type of activity (Synnott and Gruber, 1981; Zmud, 1980). In the process, managers have become aware that some of the maintenance and enhancement work results from errors or oversights on the part of the systems developers who designed the original product. They attempt to improve the quality of work in the initial stages of development in hopes that the need for subsequent work will be reduced. Errors caught in initial development can avoid costly maintenance later in the life cycle of a system and thus improve overall productivity of the information systems operation.

One aspect of the problem which is particularly troublesome is the difficulty of measuring productivity in systems development. This is a common problem in managing white collar, technical and professional workers in general and knowledge workers in particular. The industrial approach to productivity measurement, to calculate a ratio of units of product output to units of factor inputs is difficult to apply to work in which the inputs and outputs are often intangible, unobservable or hard to quantify. The debate in systems development for years has been whether the one easily quantifiable output, lines of code in a program, is a legitimate measure of the product of the information systems worker. Without a meaningful, measurable output it is impossible to calculate a productivity ratio no matter how precisely the inputs of labor, machine time or other factors can be determined.

An alternative in this situation is to address the problem as one of improving effectiveness of the information systems operation rather than improving just its efficiency. The argument here is that what matters to the firm is the quality of services provided to clients, their timeliness and the degree to which they meet the needs of the client (Crawford, 1982). Effectiveness can be a particularly useful concept for long-lived, complex products in that it suggests multiple measures of output in the environment in which the product is used, potentially including measures across a range of uses and across the life of the product.

As information systems managers have addressed the related issues of productivity, efficiency and effectiveness they have necessarily focussed on the process of systems development and the role of individual analysts and other professionals in this process. Since the late 1960's the literature has provided evidence of concern with the most appropriate organization of the work process, project management, labor time and cost estimates and process innovations. Systems development has been described more frequently as a process in which work could be divided into well-defined stages, and methods have been tried for organizing and managing the work at each stage.

One set of innovative methods which has emerged is structured systems development. This methodology is based on the assumption that the effectiveness of analysts and programmers can be increased if the development process can be standardized and engineered to a greater degree, providing a common approach, language and graphical representation. Standardization and engineering, as well as language and graphics, are seen as helpful in improving communications both among analysts and between analysts and their clients. The methodology is also presented as improving the effectiveness of systems development management by providing managers with a framework within which to make estimates, assess progress, evaluate teams and individuals and compare inputs and results. In short, structured methodologies promise to address the productivity problem by improving information systems effectiveness while at the same time establishing a framework in which effectiveness can be analyzed and perhaps measured.

Purpose of the Study. Structured systems development methodologies have been adopted by information systems departments in a number of large organizations (Johnson, 1977; Goldstein, 1982). Reports of the development and adoption of these innovations appear in the information systems literature, along with descriptions of the advantages these methodologies offer over alternative approaches to productivity improvement. These reports are primarily case studies of adoption, describing the methodology and its benefits for the organization (e.g. Mendes, 1980). The reports analyze adoption as an event at the level of the organization, and discuss the implications of adoption for the organization. They do not specifically examine the role of individual analysts in the adoption decision or in the subsequent decisions regarding the use of newly adopted methodologies in the work of systems development (Goldstein, 1982). It is the purpose of the current study to complement previous reports by examining the individual analyst's decision to implement structured methodologies once the official adoption decision has been made at the policy level.

Information systems organizations employ a professional, highly educated staff and are characterized by substantial dispersion of decision making. Analysts make many of the decisions about the way in which they work, the tools and techniques they use, and the way in which their work is organized. In particular, in applying structured systems methodologies to the work of systems development, the analysts have a great deal of discretion in the extent of use of the methodology and the determination of the situations in which they will use an alternative instead. Even when official organizational guidelines specify a particular approach, analysts have a certain latitude in interpreting the guidelines, altering the situation or the definition of the tasks, and in other ways getting around official policy. In systems development as in other areas of professional work adoption of an innovation by the organization is only the first step in effective implementation of that innovation. It does not guarantee use. Effective implementation is of particular interest to management because it is crucial to the success of structured methodologies. If methodologies are formally adopted without being implemented, or if adopted methodologies generate effective resistance among analysts in their daily work, adoption will not result in the desired outcomes. An understanding of the implementation process at the level of the individual analyst is a necessary pre-requisite to effective management of this change in the information systems organization.

There is the possibility, too, that individual analysts will have some insight into the strengths and weaknesses of a particular structured methodology, arising from their experience with that methodology in their work, and this information might be useful to those responsible for the further refinement of the innovation and subsequent changes in the ways in which it is used by the organization. There is evidence (Mendes, 1980) that analysts experiences have been used intentionally by methodology development groups in some organizations in just this way.

This study is designed to provide understanding of the implementation of structured methodologies by analysts in order to help managers improve the effectiveness of systems development. The study is organized to achieve the following objectives: 1) to describe the micro-level implementation of a set of structured systems methodologies by systems analysts across a large information systems organization in a multi-national environment; 2) to analyze the relationships between selected organizational, personal and opportunity variables and the extent of use of these methodologies; 3) to summarize and analyze the reasons given by analysts for use of alternatives to these methodologies at various stages of the systems development life cycle; 4) to make recommendations for more effective implementation of structured systems methodologies in this and similar settings, with the goal of improving the overall effectiveness of information systems organizations in large firms.

The study is based on a number of assumptions related to the methodologies themselves, the users of these methodologies and the environments in which the methodologies are implemented. First, it assumes that the methodologies have the characteristics attributed to them by their developers and their users. The study is not an assessment of these techniques at a technical level but an examination of the decisions leading to their use and the factors in the environment related to their use. It is taken for granted that the methodologies are useful, at least in some situations and for some tasks, and that they function as described in the literature and as stated by participants in the study.

Secondly, it is assumed that the existence of official guidelines regarding the use of these methodologies in the organization was not in itself sufficient to guarantee full and effective use. The individuals who constitute the subjects in the study are assumed to have the opportunity to make decisions related to the application of the methodologies in specific work situations. It is further assumed that the subjects accurately responded to questions and that as experienced analysts they were in a position to comment on their own decisions and their own work as well as on their skill and previous technical training. The responses of analysts, while to some extent subjective, are a unique source of data related to the implementation process and assumed valuable in this regard.

Finally, it is assumed that the organization values these methodologies and that management intends to use them effectively. There is ample evidence of organizational support in the amount of resources devoted to the development, testing, revision and implementation of the methodologies over the past eight years. There is additional evidence in the resources devoted to the study in the form of the time of a large number of employees. Organizational support for individual analysts is assumed to take the form of assignment to training, upon the approval of the analysts immediate supervisor.

Further official support is evident in the mention of the methodologies in guidelines, memos and other written material.

Design and Hypotheses. This study is designed to describe the implementation of two structured systems development methodologies in a large organization and to asses the relationships between selected factors and the extent of use of these methodologies by individual analysts. Data on the use of the methodologies and on factors believed related to use are gathered from analysts. Data are analyzed in the framework of hypotheses suggesting relationships among organizational, individual and opportunity variables and extent of use of the methodologies.

The dependent variable in this study is use of two methodologies developed by the computer technology group in a large industrial firm for use by the applications development analysts in that firm. The methodologies are similar in that they are both process innovations in the organization and in that they are based on a common philosphical approach to the need for a more structured, more engineered work process. They differ, however, in that each is appropriate for use at a different stage in the sequence of systems development tasks. Methodology 1 is a technique for improving the productivity of analysts in the early stage of development, when the initial exploration of the business operation leads to an assessment of alternative solutions to the problem posed by the client. At this stage communication with the client and accurate representation of the problem are central concerns of the analyst. Methodology 2 is a technique for improving productivity toward the end of the development sequence, at a stage at which analysts and programmers design, code and document the computer program. At this stage the use of common logic and notation and the clarity of relationships among the many components of a complex program are central concerns.

The methodologies, while used as self-contained techniques, are conceived of as two parts of a system of techniques intended by the firm to structure the entire development process. The other components of the system (for example, a structured logical data base design methodology and an on-line computerized design tool) will not be addressed in the present study.

These two methodologies taken together comprise a process innovation officially adopted by the firm but implemented at the discretion of individual analysts and programmer analysts and their supervisors. These analysts are the universe of subjects to be sampled in the study.

Implementation is assumed in this model to be influenced by three major clusters of variables: organizational, individual and opportunity variables. Within each cluster a few representative measures have been selected for this study to represent the whole cluster. The measures were selcted on the basis of extensive open-ended conversations with the developers of the methodologies and with analysts who use the methodologies. They were chosen according to two criteria: 1) the degree to which each represented a variable thought to be strongly related to extent of use and 2) the degree to which analysts were thought to have the necessary information. The organizational, individual and opportunity clusters are discussed briefly below. The selcted measures are explained in more detail in Chapter 3.

Organizational factors represent the influence of the environment on the implementation of the methodologies. In particular, the attitudes and values of key people in the organization as well as the specific resources provided by the organization are included here. With respect to systems analysts, the key people in the organization are those for whom these analysts regularly perform tasks and those who are the users of the applications products the analysts produce. These are supervisors and clients. The resources provided by the organization are those training, consulting and support activites which together comprise the organization's efforts to disseminate the methodologies and encourage their use by analysts. One tangible resource, evidence of organizational support, is the written guidelines for the use of systems development methodologies and techniques, in which both of the structured methodologies are included.

Individual factors which may be related to use of the methodologies are grouped in the model as attitude and ability variables. Attitude variables include the attitude of individual analysts toward their jobs, toward the idea of structured analysis and programming methodologies in general, and toward Methodology 1 and Methodology 2 in particular. Ability variables include measures of past training and experience in systems development, skills in various systems development techniques and orientation to technical or non-technical careers.

Opportunity factors, in this model, are those which characterize the type of tasks analysts are engaged in as well as the implied need for productivity improving methodologies inherent in the organization of these tasks. These factors are an attempt to explore the fit between task-related needs and the capabilities of the two methodologies, and to test the assumption that decisions to use a methodology are related to the strength of the need for that methodology.

The hypotheses are stated and explained below.

1. Extent of use is related to organizational support.

1.1 Client attitudes favorable to the use of the methodologies will be associated with greater extent of use. Analysts perform their work, individually or as members of work teams, for the ultimate goal of providing a service to a client. In the context of the organization, the client contracts with the information systems organization for a specific product or service, generally an applications package, and receives and uses the end product. Analysts, just like any professionals, are sensitive to the needs and desires of their clients and will modify their behavior in accordance with the perceived attitudes of the clients.

1.2 Supervisor attitudes favorable to the use of the methodologies will be associated with greater extent of use. The relationship of supervisor to analyst is direct and the consequences of supervisor preferences are likely to include changes in the expressed preferences and in the behavior of analysts.

1.3 General organizational attitudes consistent with the use of the methodologies are likely to be associated with more extensive use. The perceived favorable attitudes of work group peers as well as of the upper level managers of the systems development organization are predicted to be positively related to extent of use of methodologies.

2. Extent of use is related to individual attitudes about systems development work and structured systems methodologies.

2.1 Analysts whose attitudes are consistent with the use of structured methodologies in general will be more extensive users of these methodologies.

2.2 Analysts whose attitudes toward these particular methodologies are favorable will be more extensive users of these methodologies.

3. Extent of use is related to personal ability, experience and career orientation in systems development work.

3.1 There is a relationship between skill in each methodology and extent of use of that methodology. It is possible here that the greater the analyst's skill, the less the cost of using the methodologies and therefor the more likely that use will increase productivity. Analysts who want to be more effective will use their skills. On the other hand the relationship may work in reverse. Supervisors may insist on use of the methodology, and individuals may subsequently develop skills as a result of extensive use.

3.2 Analysts who are skilled in other programming and systems development techniques will be less likely to use the methodologies. These analysts are those who are relatively effective in using other programming and analysis techniques . They will not perceive a need for a new method which promises to increase their effectiveness. It is likely too that supervisors of more technically skilled analysts will not push them to use the methodologies to improve their performance.

The more skilled analysts may also be resistant to learning new methodologies which threaten to make their present skills obsolete. They may, as a result, use the innovation less extensively.

3.3 Technical work experience and technical orientation of the analysts will be related to extent of use. The more experience in the field of systems development and the greater the degree of commitment to pursuing a technical career, the more likely that an analyst will use the methodologies. In addition, analysts with a technical, computer science degree will be more likely to use the methodologies.Among people with a strong technical education it is likely that the appeal of using the methodologies will arise from an appreciation of the structured approach to systems development work as a "state of the art" technique.

4. Extent of use is related to the implied opportunity for increased productivity in the analyst's work.

4.1 The type of task to which analysts are assigned and in which they spend major portions of their time will be related to their extent of use of these methodologies. The methodologies will more likely be used on new applications development tasks than on applications maintenance tasks. In the latter tasks, the applications will have been developed in many cases at a time before the methodologies were available and for this reasons an alternative approach will have been used. The perceived costs of employing the methodologies in this situation due to the need to modify or replicate previous work may be sufficiently high to discourage extensive use.

4.2 The size of the work group to which an analyst is assigned as well as the length of the project the analyst is working on will both be positively related to extent of use. Large jobs and long projects are characterized by relatively complex communications. The methodologies are designed to improve analysts' efficiency by improving communications. The more complex the communications, the more likely that an opportunity exists for productivity improvement due to use of the methodologies.

Definitions. A number of terms will be used in the context of this study with specific meanings. These terms are defined below.

Implementation: Implementation is the stage of innovation at which a new product of process, having been developed and formally adopted by the organization, is incorporated into the work of the organization. Students of innovation and organizational change generally agree that innovation is a sequential process in which a new idea is first developed into a recognizable product or process, then more or less formally adopted through some decision-making process and finally put into practice by one or more end users. The number of stages varies, according to the situation and the researcher's ability to make fine distinctions. For the purposes of the present study the number matters less than the sequence off the stages. We are examining here a process innovation which has clearly gone through numerous development, testing and revision cycles so that it can safely be stated that the development stage is complete. The fact that the methodologies under study are described in guidelines published by the organization for its analysts indicates that the innovation has also gone through the adoption stage. It is implementation of the methodologies by individual analysts, in the context of their every day work assignments, which will be the focus of this study.

Structured methodologies: procedures used in systems development work to provide a common approach, terminology, sequence of activities, set of graphics and logical structure for undertaking the full range of applications development, from scoping of new projects through design, coding and documentation of programs. The structured methodologies whose implementation is examined in this study were developed by a computer technology development group in a large multi-national firm for use by analysts employed by the firm. The methodologies are seen as a step toward improved analyst and programmer productivity. Subsequent steps include the development of automated tools to support the methodologies, essentially computer-aided systems and analysis and design tools. Two specific methodologies are the focus of the current study; they are described briefly below, under slightly altered names.

Meth1: The first methodology is used early in the process of systems development, when analysts are involved in scoping and exploration, understanding the business operations and selecting an appropriate applications development approach.

Meth2: The second methodology is used toward the end of the systems development process, when programmer-analysts are conducting program design, coding and documentation tasks.

Analyst: the professional employees of the organization who have the responsibility for the entire range of systems development tasks, from analysis through coding and including maintenance and support. Analysts, for the purposes of the study, include some employees in supervisory positions in the information systems departments of the organization working, for example, as project leaders or group leaders with responsibility for several projects on which other analysts are working. They include, too, employees who in o other organizations might have the title of programmer.

Client: end user of the applications packages or software developed in the information systems organization. In general, in this organization, all systems development work is undertaken upon the request of a client in one of the other functional areas in the organization (i.e. corporate headquarters, finance, marketing, engineering). The two parties agree on a time frame and a budget for the work, and the client is billed for the service.

REVIEW OF THE LITERATURE

The process of implementing a technical innovation in an organizational setting is a complex one involving interactions among organizational, individual and tecnological variables. The relevant literature for a study of this type is in two areas. First, among numerous studies of innovation and organizational behavior, there are those which address the issues specifically related to the behavior of individuals in organizational settings. This work is only a small part of the research on innovation, most of the rest being devoted to the decisions and actions at the organizational management and policy level. The topic of individual decision-making in relation to innovation in an organizational context, a phenomenon D. Anderson (1981) refers to as micro-level innovation, is of particular interest in the current study because the policy in the organization is one of decentralized decision-making, allowing and even encouraging individuals to use approaches and methodologies of their own choosing from among a set of such approaches identified as acceptable by the organization. It is of interest also because the analysts whose decisions and behavior are analyzed here are college educated professionals, a group generally given a relatively high degree of responsibility for decision-making and relatively more autonomy on the job than the employee who is not as well educated. These are people who have been trained to think and act for themselves and who tend to be expected by the organization to do so.Thus the focus of the review, in this area, will be on implementation by the individual, in the environment of the organization.

The second area in which a review of previous work will be helpful is the use of new technology in improving productivity among white collar workers in general, and systems development employees in particular. These studies may help in identifying micro-implementation issues. In particular, studies of structured systems methodologies as productivity tools will help frame both the hypotheses and the analyses of the current study. Information systems and structured methodologies are relatively recent arrivals in the workplace and are limited to the largest work organizations. They have been little studied to date. In the latter area, studies are limited primarily to case descriptions written by individuals directly involved in the work being described (Goldstein, 1982). For this reason, it is advisable to include in the review some studies of more general interest though they may be lacking in specific relevance to the systems development process. Studies in the area of white collar productivity will be reviewed to understand the need for productivity improvement and the issues related to definition and measurement, with specific attention once again to the factors related to micro-implementation. These are the human factors (Keene, 1982) about which there has been increasing concern among management as information technology changes the ways work is conducted. In a sense, the current study complements the major thrust of previous work in productivity implementation. Previous studies emphasize the specific attributes of new technologies and explore the relationships between these attributes and the outcomes that result from the adoption and use of the innovation. The current study is concerned with the conditions under which adoption can be effective, in particular the factors related to an individual's decision to implement. Of course, an understanding of both areas is necessary to develop a complete analysis of the process.

In the framework of innovation research, the question is one of emphasis on different stages of innovation and different levels of implementation. Most theoretical and empirical studies in the field postulate a sequence of stages in the process of innovation. Early studies (Rogers, 1962) noted the importance of the time dimension in describing the process of innovation and diffusion. Reviews of subsequent work (Zaltman, et al., 1973) make it clear that some sort of developmental or sequential stage theory is explicit in most work in field. The number of stages varies according to the the situation and personal preference of the author, but even in a simple two stage model there is a common sequence, initiation or invention coming first, implementation or adoption later. The differences are important in that different organizational, individual and technological factors appear to facilitate effectiveness at different stages (Rowe and Boise, 1974; Downs and Mohr, 1976). Most studies to date of productivity improvement in information systems development focus on outcomes subsequent to implementation of a new technology. The present study, in contrast, explores the implementation process and the factors related to the decision to implement. This focus on a particular sequential stage in the life cycle of the organizational innovation, however, is not intended to limit the study to a narrow range of individual behaviors in relation to use of the methodologies. At the individual level, the entire process repeats itself as the individual conducts his or her own intitiation or search activities prior to the decision to implement a new technology (Anderson, 1981).

The review which follows is divided into three sections. First the literature on individual implementation in and organizational setting is reviewed for suggestion of applicable organizational and individual factors which may be found to relate to the use of the methodologies. Second recent studies on the need for and results of productivity improvement in knowledge work in general and in information systems work in particular are summarized and implications for micro-level implementation identified. Third, work on the characteristics and use of structured systems methodology is reviewed.

<u>Individual Implementation.</u> A number of early studies of organizational behavior, while not directly in the mainstream of the innovation literature, establish a theoretical framework which is applicable in a situation in which the decisions and actions of individuals are the outcomes under examination. March and Simon (1958) base their theory on the assumption than individuals act rationally, given their own understanding of their situation, to solve the problems they perceive in their work. The theory emphasizes individual cognition and in particular the individual's perception of organizational environments. This suggests that in explaining individual

decision-making it is those aspects of the organization experienced by and perceived by the individual which are important, and that using the individual as the source of data about an organization is justified. It is after all the individual's perception of the organization, as much as the reality of the organization, which will influence decisions and ultimately behavior. This work suggests further that individual cognition, including skills and frame of reference, will interact with perceptions to influence behavioral outcomes.

Organizational issues are likely to become more important in situations in which the organizational goals are not entirely clear (March, 1981) in that the individual is forced search more actively for the relevant environmental factors necessary for the completion of the rational decision process. This may be the case if the organization is highly decentralized (Pierce and Delbecq, 1977) or if political considerations are an important element in decision-making (Markus, 1981) or the intended implementors do not have the clear authority to implement (Knight, 1967). In each case one would expect that otherwise rational decisions might be complicated, delayed or avoided due to uncertainty on the part of the individual. And in each case the individual will respond to uncertainty by attending more closely to organizational issues. If, for example, the goals of supervisors, managers, clients and work group members are not internally consistent the individual may experience the goals of the organization as confusing. In this situation one might expect both increased attention by the individual to organizational cues and a reluctance to implement an innovation which is perceived to have mixed backing on the part of significant organization members.

In addition to the goals of the organization, the individual perceives the extent to which organizational resources are allocated to a particular innovation and may in fact be the direct recipient or such resources. In the case of a process innovation, the resources may be training time, or access to consultants who are experts in the process, or an opportunity to be involved in the development of guidelines for process implementation of even to be involved in the development and modification of the process. The concept of organizational slack (Cyert and March, 1963; Downs and Mohr, 1976) is one which captures metaphorically the significance of spare resources in the innovation process. It is generally found that slack is most important at the front end of the process, in connection with initiation and experimentation. However it is possible that slack is necessary at later stages as well. As an individual is deciding whether to implement a new technology, the likelihood of a positive decision is increased when the organizational resources are sufficient to support initial use. The resources available for implementation will be a factor worth considering (Mohr, 1969) and the incentives to implement are likely to make a difference as well (Kerr, 1975).

Several studies suggest that the values and orientation of organization members can affect the implementation process, particularly when they are directly related to the innovation or its intended outcome. Research on the size and degree of specialization of organizations suggest that with specialization and expert knowledge in a unit of an organization, the attitude of professionals is more likely to be an important factor in innovation (Moch, 1976; Moch and Morse, 1977). In general, the norms of the relevant community will be important (Rogers, 1962) as well as the type and degree of access of an individual to the members of that community. For example, one would expect a systems analyst to care more than a programmer about what the client says, since the analyst's job puts him in closer, more frequent and more intensive contact with the client than does the job of the programmer. On the other hand, both will be influenced by their perceptions of the attitudes, opinions and desires of their supervisor.

The organizational factors which emerge from the research described above are contextual variables in the implementation process at the micro-level. Equally important are the individual factors, for it is the individual whose perceptions of reality we are taking for reality. Individual factors have been categorized in numerous ways. For the sake of simplicity a two category scheme suggested by Knight (1967) and adopted by D. Anderson (1981) is used in this study. Individuals' perceptions are assumed to be influenced by their motivations and their cognition.

Motivation to implement an innovation may be assumed in situations in which the organizational incentives are clear, consistent and directly related to the relevant behaviors. Even in the best of circumstances from the point of view of the organization wishing to encourage innovation, however, the effect of incentives is mediated by the personal motivation of individuals (Locke, 1977; Locke et al., 1978). Unless an individual's goals are consistent with those of the organization, or unless that individual desires to obtain the incentives offered, the outcome may not be exactly as desired. Early theorists call attention to the significance of the general frame of reference of the individual which may influence motivation. Blau (1963) discusses status and Rogers (1962) explores the importance of attitude, ideology and extent of cosmopolitan orientation of individuals. In the current work, one can conceive of an individual analyst's orientation and previous experience as a systems development professional influencing his or her motivation to use new technologies. If the motivation is to become a better professional by using the most modern methods, and if the methodologies are perceived as modern, then the likelihood of use will increase. On the other hand if the methodologies are seen as limiting the analyst's opportunities for professional accomplishment, for example by reducing the level of professional skill and creativity required in the job (Kraft, 1977) then a lower level of use is the more likely outcome.

Another way in which motivation may influence implementation is as a result of contact with or communications from others. In a study of homeowners' decisions to use solar energy devices, Leonard-Barton (1979) found that knowing another solar owner was the strongest predictor of use. Similarly, in a study of professionals in public health agencies Mohr (1969) found that his subjects' attitudes toward change, and even more strongly their motivation to change, were related to the extent of implementation. In this case a cosmopolitan, professional orientation was found to be an important contributing factor. Others have found that communications from respected professionals in the field influenced the degree of use of new technology (Hage and Aiken, 1970; Hage and Dewar, 1973). And in the present study, McErlean (1983) found a significant relationship between contact with a local advocate of the methodologies and extent of use, and Leonard-Barton (1983) found that informal organizational influences were a significant factor in relation to extent of use. In these examples it is not clear whether communications resulted in an increase in motivation, an increase in skill or both. This distinction may be worth exploring in future research.

Individual cognitive factors related to implementation include, but are not limited to, awareness of and skills in the use of the new process. Knight (1967) argues that when individuals are engaged in innovation as a problem solving process they can be expected to implement new solutions to not only to the extent they are skilled in the use of those solutions, but also to the extent they are knowledgeable about the problem to be solved. D. Anderson (1981) postulates the effects of expertise at two levels. First, in search activities (i.e. at the level of initiation of innovation) expertise in specific solutions as well as general awareness of relevant principles is seen as important. Involvement, or close-in expertise, and detachment, or far-out expertise, can each contribute to the search process. Second, expertise will be a factor at the level of implementation in that individuals who understand a new technology and appreciate the need and potential uses are more likely to use that technology. Similarly Pelz and Andrews (1966) in a study of innovation among scientists show that specialization for short periods can be positively related to the extent of use of new technology, suggesting that the positive effects of specialized skills can be limited when individuals become so skilled that they are not open to new ways of approaching a problem. A similar result was obtained in a study of manufacturing engineers (Bigoness and Perreault, 1981).

The interaction of motivational and cognitive factors has been suggested in work on expectancy theory. Some motivation researchers have explored the ways in which an individuals skills and past experience shape the expectation of future behavioral outcomes and thus set boundaries for those outcomes (Campbell, et al., 1970). Specifically, expectations of success in innovation can influence motivation to succeed (Porter and Lawler, 1968). From another perspective, the definition of need and the assessment of a new technology in relation to that need are constructs the individual develops in light of past experience. An implementation, just like any change in behavior, will be evaluated in relation to the effectiveness of known alternatives (Knight, 1967; Cyert and March, 1963).

Information Systems Productivity Improvement Methodologies. The type of innovation studied and the context in which implementation takes place, as well as the stage in the innovation cycle, will affect the degree to which various organizational and individual factors are related to the extent of use of a new technology. An understanding of general issues related to productivity improvement among white collar or knowledge workers will be helpful in identifying issues specifically related to the implementation and use of structured methodologies. In this section, the need for productivity improvement in systems development will be summarized and some issues related to the measurement of productivity reviewed. The importance of human factors, including motivation and overcoming resistance, will be addressed briefly.

There is general agreement among social scientists and policy makers that over the past thirty years productivity increases in professional, technical and office work have lagged those in other areas (Strassman, 1982; Thurow, 1982). As the number of employees in this category has increased, managers have become increasingly concerned about controlling costs, monitoring and coordinating work and measuring output (Gremillion and Pyburn, 1983; Martin, 1982).

The interest in productivity improvement in systems development is a special case. The need in this area is highlighted by the extremely rapid growth of employment coupled with the drastic changes in technology which have taken place over a relatively short period, with the result than in many large systems development groups there are only elementary management systems in place (Zmud, 1980).

The noticeable increase in the cost of developing new software and maintaining and enhancing applications which are now in operation is one aspect of the problem. Costs of analysis and programming, relative to the cost of hardware for computing power and memory, have increased substantially and are expected to continue to do so (Yourdan, 1976; Mendes, 1980; Mcgowan, 1975; Benjamin, 1982; Brooks, 1975). In addition the demand for software has increased, as evidenced by the ever growing backlog of work in most systems organizations. In part the demand is a result of previous successes, in that users of applications previously developed begin to find new uses for information and request minor or major changes in the programs (Synnott and Gruber, 1981; Johnson, 1977). At the same time that both relative and total development costs are increasing, the availabilty of labor to perform this work is problematic (Synnott and Gruber, 1981). The field has expanded more rapidly than the capacity of training institutions so that it is at times difficult for a firm to find enough skilled employees or to hold current employees on the job. Turnover is high, frequently more than 25 per cent annually, and the costs of orientation and training for new personnel can be significant (McLaughlin, 1977). These problems apply less to the programmers, who perform relatively less skilled jobs, than to the analysts. The latter, while not always highly skilled in programming, are the professionals in systems development, the people who must accurately model the information flow of an entire business operation and represent it in an understandable and workable plan which will become the framework for the design of the program.

What magnifies the difficulty is that the analysis and related activities occuring at the front end of the development process are the most important with respect to quality, dependability and long run effectiveness of the product. Analysts, even the most skilled and the most tenured in a job, face a great deal of uncertainty due to the amount of information, the complexity of information flows, the changing nature of the business they are modelling, the changes in the technology on which the applications will be run. To the extent that they postpone decisions or make incorrect decisions based on insufficient information their recommendations will decrease the effectiveness of the application. Coming early in a complex process, their decisions will affect the work of many others, over a long time if the project is a large one, and most likely in ways which are difficult to detect until the program is installed. At that point what errors or inefficiencies there are will lead to requests for more work (maintenance). The result is a lower quality product at a higher cost than might otherwise have been the case (Zmud, 1980).

Given the cost and quality problems, managers are understandably concerned with finding ways to establish more effective controls. They would like to have an analysis and design sequence which is predictable in cost and time, observable by supervisory personnel at each level, and standardized to the degree necessary to allow new personnel to pick up where previous employees left. They would like a sequence which results in a higher quality, more maintainable product. It is the combination of reliability and cost reduction, along with the possibility of improved management effectiveness, which generated interest in structured systems development methodologies in the middle 1970's and resulted, eventually, in the use of such methodologies (McGowan and Kelly, 1975; Mendes, 1980; Nolan, 1977 and 1979).

To comment on the effectiveness of any new technology in increasing productivity it is necessary to have a starting point, some standard measuring unit, and a desired outcome or at least a well defined dimension on which productivity will be measured. The economic concept of productivity suggests measurement along two dimensions, inputs and outputs. And in some early and even a number of present efforts to measure programmer productivity such measures are used (Johnson, 1977). The input is generally taken as units of programmer working time, or some variation. The output is lines of code, or source code, or some other unit of this sort.

The need for a system of measurement is frequently stated in the journals (Keene, 1982; Hammer, 1981). But convincing measures are missing from most studies and appear to be unavailable to management in most organizations (Khalil, 1980; Strassman, 1982). The problem appears directly related to the difficulties in defining and managing the work of systems development, particularly at the early, less structured stages of analysis (Parikh, 1981). One approach which may be applicable has been used in assessing the impact of technology on office work (Crawford, 1982). Crawford (1982) describes the introduction of electronic mail in a large industrial firm, addressing the productivity issue in two parts. First he uses quantifiable measures of input and output as an extremely rough basis for calculating efficiency improvements. Then he addresses the improvement of effectiveness using qualitative data.

Human factors in implementation of new technology are recognized as important in many of the ways described above. The findings of interest here are those suggesting management changes which can be made to increase the extent of use of the technology, as well as those about which additional data can be gathered in the current study. This data may have implications for selection and job assignment (McGowan, 1976), for reducing job turnover (Goldstein, 1982), for job training (Strassman, 1982; Campbell, 1971; Yourdan, 1976) and for incentives and rewards (Campbell, et al. 1970).

Structured systems development methodologies were developed to improve the effectiveness and efficiency of systems development personnel, in large part in response to the problems already described. They were intended to improve productivity, and at the same time to improve the ability of managers to control the systems development process (McGowan, 1976; Yourdan, 1976; Mendes, 1980).

Studies of these methodologies ascribe numerous benefits to their use. Some studies describe methodologies used early in the development process. Mendes (1980) discusses how these techniques improve product quality, increase the effectiveness of programmers and analysts, improve the accuracy of time estimates and the amount of time needed for projects. She describes a methodology which approaches analysis from the point of view of the business operation rather than from the data processing perspective and as a result improves analyst communication with the client. The methodology is presented, in addition, as a component of project management. C. M. Anderson (1981) argues that this same methodology has potential not just as a communications, productivity or management technique but also as a way of involving the client more integrally in the development process. He argues that both because of increased participation and due to the increased accuracy of the outcome, client acceptance and use of the end product will increase.

Other studies focus on structured methodologies for programming activites, those which take place toward the end of the development process. In a paper on one structured programming technique, Menard (1980) includes as benefits resulting from use the increase of productivity, the reduction of maintenance costs and the improvement of communications both in development and in maintenance due to improved documentation. She notes that this methodology takes more time in design work than would an alternative approach, but argues that the time is made up in subsequent development steps. In addition, maintenance time is reduced due to the presence of fewer errors, more In an automated version of the methodology, time required for its use is expected to be reduced still further.

Other studies reinforce these findings. Synnott and Gruber (1981) see advantages in the potential for integrating the stages of development, improving overall design and reducing the number and seriousness of errors, improving maintainability and readability of programs, and improving the effectiveness of project management. Holton

(1977) argues more generally for improved quality, maintainability and productivity resulting from introduction of the structured methodologies. He warns, as does Yourdan (1976), against expecting all programmers to benefit since significant skill is required to learn and use these techniques correctly, and not all programmers and analysts are sufficiently talented. These studies suggest that selection, training and assignment to tasks on which the methodologies are to be used may be more important than is generally admitted.

Yourdan goes further in discussing the potential problems with implementation. First, the methodologies may conflict with classic design and programming methods so that personnel who use them may be forced to unlearn old ways of working. For analysts with extensive technical training or many years of work experience, this situation may result in resistance to the use of the newer techniques (Holton, 1977). Secondly according to Yourdan the methodologies, being time consuming to set up, may not be appropriate for use in small projects and may be of only limited use in projects of medium size, those requiring the time of a few programmers for a few months. Finally Yourdan suggests that use of these techniques may expose some organizational issues related to the lack of focus and specific expectations for analysts and program designers. Yourdan expects that management will discover that the responsibility for design is not clearly delegated, and he even suggests that use of the methodologies may lead to the creation of new job categories to correct the problem.

Structured methodologies have been described as techniques which will improve the effectiveness of analysts. As such they would be appealing to those analysts who see themselves as professionals having a responsibility to use the most modern techniques available. These methodologies have alternately been presented as techniques which will increase management control over analysts. As such they may be resisted by analysts, especially those whose current skill level is adequate for the job. Given the possibility of these two ways in which the methodologies may be perceived, it is likely that the decision to implement will be made on more than just technical criteria. Analysts' attitudes as well as analysts' perceptions of organizational support may both influence the decision and may be related to extent of use.

METHODS

Systems development is a complex process in which professionals with expertise in computers and computer programming create models of information use and information flow in a business. These models are the framework for the design of applications programs which will support the business operation. A study of the systems development process is necessarily complicated by the need, first, to grasp the basics of the technology itself and, second, to understand the organizational relationships among the developers and between developers and end users of the systems they develop. A study of innovation, in this setting, is similarly complicated.

The current study was designed and conducted by a team of researchers, under the supervision of a university faculty member and with the cooperation of members of the computer science staff in the organization in which the research was undertaken. It was designed under the assumption that the people in the best position to comment on the extent of use of the innovation were those responsible for implementing that innovation, the analysts.

In this chapter the methods used in the study will be presented. In the first section, a description of the subject population will be given, along with summary characteristics of the sample and an explanation of how the sample was chosen. The second section will describe the questionnaire, highlight the sections relevant for the current study and describe the pilot. The third section provides a description of the interview used to gather the data. In the fourth section the methods used for analyzing the data are presented. This section includes a description of the dependent variables and a summary of the independent variables, as well as a definition of the opportunity variables used to specify the subset of the sample considered eligible users.

Population. The universe of subjects for this study was the population of systems analysts, programmer-analysts and other systems development professionals employed by a large multinational corporation with a long standing and large scale computer science and information processing organization. All the subjects of the study will be referred to hereafter as analysts although they held more than a dozen official job titles in the organization. These analysts were responsible for applications development and related systems development and consulting work, in support of clients in other functional areas of the organization. The population included analysts who worked in supervisory positions, some several levels up from the personnel who wrote computer program code or documentation. The population did not, however, include any senior level managers or any of the computer technology development team which had been responsible for developing, testing and revising the methodologies under study. Nor did the sample include any personnel outside the information systems organization.

The sample was chosen from a total population of more than 1000 in two steps. First three locations were selected to provide a range of organizational environments for the study. Each location had a minimum of thirty analysts in the organization and a minimum of three years experience with the structured programming methodologies. In addition, each site was in the process of considering the installation of computerized tools for these methodologies, although at none of the sites was that version widely available.

Location 1 was the corporate applications development group, located in a large corporate complex physically close to, but organizationally distinct from, the computer technology group which had designed and developed the methodologies. There were some working relationships between the two groups and there had been some exchange of personnel, most notably at the management level. There was also at Location 1 proximity to the upper level corporate management of the information organization. It should be noted, too, that at Location 1 the applications group had only limited internal consultation and had to rely on the technology development group for this support. In the other locations, in contrast, the applications groups had their own internal technical consultation staff members.

Location 2 was an international affiliate, selected for its relative independence from the American corporate headquarters and the difference in the background of the analysts. Differences were not extreme, since the site was in Canada, but it was clearly important in the corporate culture that this site maintain itself as a firm with management distinctly separated from that of the corporate parent. For example, this affiliate used its own name rather than that of the parent.

Location 3 was an American affiliate far removed geographically from the other two locations. There had been some transfers in past years from the Location 1 applications group, but these were limited in number. Location 3, like the other two sites, had officially approved the methodologies as part of a set of systems development techniques recommended for use.

The sample size was targeted between 120 and 150. With the help of the corporate technology development group, information systems management at each site was contacted and the purpose and scope of the study explained. Each manager was asked to participate in the study by selecting a random sample of employees below the senior management level as potential subjects. The target size, by location, was 30 at Location 1 and 60 each at Locations 2 and 3. The sample was to be drawn by selecting every Nth name from a list of all personnel, where N was determined by dividing the number of analysts employed at the location by the target sample size for that location. These employees were then asked if they would be willing to participate in a one hour interview and written questionnaire session as part of the study. Almost all agreed to participate, and of these almost all completed the interview. Schedules were arranged by administrative support staff in the firm, and gaps were filled with back-up respondents drawn from the same personnel lists.

The sample was relatively balanced by sex and relatively young and well educated. Of a total of 145 subjects, 60 per cent were male and 40 per cent were female. Slightly more than half were in their twenties and 87 per cent were less than forty years old. All but 5 of the sample had attained a level of education of college or beyond (Table 1).

The sample can be characterized by type of education, previous work experience and expressed interest in a technical career path. Table 1 shows that 42 per cent had a bachelor's or master's degree in computer science. Seventy eight per cent had worked in systems development for more than two years (Table 2). In describing their career plans, however, subjects indicated that they were not all committed to permanent jobs in systems development. While 36 per cent intended to pursue a technical career, 64 per cent were planning a career in management (Table 3). Asked to project their plans over the next five years, only 15 per cent expected to be in non-managerial jobs in systems development at the end of that time. In contrast, 49 per cent expected to be in general management positions. The background data suggest that analysts in this sample are young, well educated, technically oriented in the field of systems development, and experienced in the field. They suggest further that these subjects are looking forward to a time, not too far in the future, when they will be in management positions. A majority expect that they will be general managers rather than systems development managers.

Table 1

Demographics

Sex	Male		Female		Missing	Total	
	n	%	n	%	n	n	%[a]
	87	60	57	40	1	145	100

Age

20-29		30-39		40-49		50-59		60 or over		Missing	Total	
n	%	n	%	n	%	n	%	n	%	n	n	%
77	53	49	34	13	9	4	3	1	1	1	145	100

Education

Technical				Nontechnical					
Bachelor's		Master's		Bachelor's		Master's		Other	
N	%	N	%	N	%	N	%	N	%
46	32	14	10	43	30	29	20	12	8

[a]Missing is not included in percentage data.

Table 2

Work Experience

Years	Years in Systems Development		Years at the Firm	
	Number	Percent	Number	Percent
Under 1	4	3	10	7
1.0 to 1.5	17	12	20	14
1.6 to 2.0	11	8	19	13
2.1 to 3.0	20	14	26	18
3.1 to 4.0	13	9	9	6
4.1 to 5.0	8	6	8	5
5.1 to 7.0	20	14	13	9
7.1 to 10.0	15	11	10	7
10.1 to 13.0	15	11	11	7
13.1 to 16.0	11	8	7	5
More Than 16.0	9	7	12	8
Missing[a]	6	-	0	-
Total	145	100	145	100

[a]Missing is not included in percentage data.

Table 3

Career Orientation

	Number	Percent
Managerial	89	64
Technical	51	36
Missing[a]	5	-
Total	145	100

Career Path

What type of work do you see youself doing in _____ years?

	In 1 Year		In 3 Years		In 5 Years	
	N	%	N	%	N	%
Systems Development	103	75	47	35	20	15
Technical Management	23	17	49	37	36	28
General Management	3	2	26	19	64	49
Other	8	6	12	9	10	8
Missing	8		11		15	
Total[a]	145	100	145	100	145	100

[a]Missing is not included in percentage data.

The sample can be further characterized according to the level and type of work performed in the context of the organization. This information is of interest because the extent of use of the methodologies under study here is thought to relate to the individual analyst's need for a particular methodology in his or her work. The work of an analyst is not easy to observe, let alone categorize, so an attempt was made in this study to identify several key descriptive categories within each of three dimensions of systems development work: the function which the application software will perform for the client, the type of application or system on which the analyst worked, and the level in the development cycle at which the work was performed. The distribution of working time within each of these dimensions is summarized in Table 4 and described briefly here.

In the functional dimension, the mean time worked is largest on applications which will be used in financial or other business applications. The mean is only 14 per cent for those products whose end use will be in engineering, and 15 per cent for products to be used in such other areas as personnel, text processing or technical support within the systems development organization. In reporting the split of their time among different types of systems, analysts indicated that operational or transanctions systems comprise the bulk of their work, with a mean of 57 per cent of time in this systems type. Finally analysts report that on average they spend substantial time on work that is related to existing systems, relative to work on new systems. The mean per cent of time on maintenance and enhancement, taken together,

Table 4

Distribution of Working Time By Functional Area, Systems Type and Project Level: Summary Statistics

	Mean Percent of Time Worked in this Category
Functional Area	
Engineering	14
Finance	34
Business Logistics	34
Other	15
Systems Type	
Operational, Transactions	57
Stewardship, Reporting	20
Planning, Analysis, Decision Support	17
Other	4
Project Level	
Scoping, Exploration	17
Systems Development, Acquisition	35
Major Enhancement	15
Application or User Support, Maintenance	27
Other	5

account for more than 40 per cent of total time.

Another way in which subjects were asked to break down their working time was according to the specific tasks defined for the purposes of the study as comprising the work of programmer-analysts (Table 5). This breakdown is of interest in defining an opportunity variable for the study. Prior to examining extent of use of the methodologies, it was necessary to define the subset of the sample which had the opportunity to use each of the two methodologies. Since each methodology is considered appropriate for use in performing only certain tasks, only those analysts who spent time on those tasks were considered eligible users. Specifically, analysts were included in the subset of eligible users for each methodology if they reported spending 5 per cent or more of their time on at least one of the tasks for which that methodology is considered appropriate.

For the purpose of this study, ten tasks to which analysts and programmers are assigned in this organization were identified. Among these tasks, the first three (understand business operation, define client needs, recommend solution) are those for which Methodology 1 is considered an appropriate method. These tasks comprise the work of systems analysis in the organization. A large majority of analysts reported that they spent more than 5 per cent of their time on these tasks. It is analysts in this group who were considered to have had the opportunity to use Methodology 1. Similarly three other tasks (design program, code program, document program) comprise the work of a programmer in the organization. It is these tasks for which

Table 5

Proportion of Time Spent on System Development Task

	Proportion of Time Less than 5% Frequency	Percent	5% or More Frequency	Percent
1. Understand Business Operation[a]	30	21	115	79
2. Define Client Needs[a]	30	21	115	79
3. Recommend Solution[a]	38	26	107	74
4. Document Solution	52	36	93	64
5. Produce Data Base Design	106	73	39	27
6. Analyze role of Information	76	52	69	48
7. Design Program[b]	40	28	105	72
8. Code Program[b]	40	28	105	72
9. Document Program[b]	71	49	74	51
10. Provide User Support	50	35	95	65

[a]Tasks for which M1 is an appropriate methodology.

[b]Tasks for which M2 is an appropriate methodology.

Mehthodology 2 is considered appropriate. A smaller, but still substantial proportion of respondents reported having spent 5 per cent or more of their time on each of these tasks. It is this subset of the sample who were considered to have had the opportunity to use Methodology 2. A third methodology exits in the organization and is considered appropriate for use in tasks four through six. Use of that methodology will not be considered in this study. Finally, no specific methodology is considered applicable to task ten.

A final set of descriptive variables for the sample population gives an indication of the relationship of the respondents to the organization in which they work on dimensions of level of responsibility, time in the organization, type of client and size of project.

Most respondents in the sample worked at the level of programmer or analyst in the organization, rather than at a management level. Seventy two per cent of respondents were classified with variations of these titles and only 27 per cent were in supervisory or specialist jobs.

Respondents typically had spent relatively little time in the organization and in their current jobs at the time of the study. More than half of the sample had been in the organization three years or fewer. Only one fifth had been there more than ten years. This distribution is not surprising, given the relatively recent emergence of systems development as an area of employment in most organizations. It is related, too, with relatively low age distribution in the sample. Tenure in the current work group is even shorter, with 61 per cent of respondents having worked with their current group for two years or fewer. Tenure in the current job is similarly relatively short.

Questionnaire. During the two month period prior to the pilot study, members of the research team and members of the technology development group which had developed the methodologies met twice to identify issues which were to be addressed in the study. Based on the results of these sessions and on conversations and open-ended interviews with individual applications development group members representative of the population to be sampled, the team wrote an initial version of an interview protocol to be used in the pilot. This protocol was revised after the pilot and finalized as a twenty-two page questionnaire (see Appendix A).

The questionnaire was designed for two purposes. First, it was intended to structure the gathering of relatively large amounts of specific data on independent and dependent variables under investigation by the team. Since four team members were each planning to research a different aspect of the problem, the topics covered were broad and the number of questions large. To the extent that the data could be obtained in the form of short answer, written responses the data gathering process would be less time consuming. For some aspects of the problem, however, both the complexity of the implementation process and the lack of well-defined measures suggested that open ended questions would provide more valuable data. Thus the second purpose of the questionnaire was to provide a format for recording responses to these questions. The format was self-explanatory so that each respondent could complete all questions in writing. However in practice, team members generally found that an interactive interview, with the researcher writing notes in the appropriate spaces, was most effective on these open-ended questions.

The questionnaire was organized to minimize the difficulty of resistance on the part of respondents to a long and demanding data gathering process by ordering questions so that easy-to-answer questions came first, challenging and potentially threatening questions in the middle sections and necessary but perhaps less interesting demographic questions at the end. The early questions dealt with recent experiences at work, asking for descriptions and categorizations of analysts' responsibilities over the preceding twelve months. These questions were factual and could be answered without analysis or evaluation on the part of the respondents. The middle sections contained the more complex, more analytic or judgemental questions which might require some time or mental effort and which might be difficult for respondents not accustomed to reflecting on their experiences. It was in these sections that most of the researchers found that some interaction, probing questions, supportive comments and in some cases interviewing were necessary. The questionnaire continued with several pages of short answer attitudinal questions and ended with a page of demographic data.

The questionnaire included eight sections. The first focussed on job title and responsibilities as well as project characteristics for work to which the respondent had been assigned over the previous year. Included in this section were questions about the way each analyst's time had been spent, categorized by type of end use for which applications had been developed, level of development task and type of system developed. In the second section respondents reported on the extent to which they used the methodologies, the alternative approaches they used when they did not use the methodologies and their reasons for selecting these alternatives. The third section requested analysts' perceptions of factors important in their own work and in the organization's assessment of their work. In the fourth section analysts listed advantages and disadvantages of the methodologies and gave each methodology an overall rating. Fifth they assessed their own skills in using various development techniques, including the methodologies. The sixth section covered sources of instruction, extent and level of satisfaction with training, and sources and extent of communication in the organization relative to the methodologies. In the seventh section were several sets of scaled response items on values in the organization, attitudes and perceptions related to structured methodologies, analysts' self-perceptions of learning styles and analysts' job satisfaction. The final section requested such demographic data as age, education level and work experience.

The questionnaire was pilot tested at Location 1 by the research team, in interview sessions with twenty applications development analysts. Each respondent was asked to read and complete the questionnaire. The team member then reviewed questions with respondents with respect to clarity of the question, agreement on the meaning of certain terminology, sequence and length of the protocol, unintended or misplaced emphasis and omissions. The team members then individually and as a group reviewed the results of these sessions and modified the instrument. In particular, several questions which had until this time remained open-ended were rewritten in a structured form, using pilot session data for generation of multiple responses categories. For these and other structured response questions the format was altered to include a category for "other" responses.

To insure that the terminology used was applicable across locations, the questionnaire was further tested prior to the data gathering visits to Locations 2 and 3 by sending it for review and conducting a telephone conference with a representative of the applications development group at the site. For both locations, on the suggestion of local personnel, the questionnaire was slightly modified to reflect local terms and titles.

Interviews. The questionnaire was administered to each respondent in a face to face interview scheduled to last one hour. Respondents' participation was voluntary. Their time at the session was part of the regular working their involvement had the prior approval of management. Upon arriving at the interview, each respondent was given a brief oral summary of the project, its purpose and its scope as well as a letter from the team leader once again stating that participation was voluntary.

All coded responses were transferred from the questionnaires to a data file for processing within two weeks of completion of the interviews.

Plan for Data Analysis. Data gathered in the course of the study was analyzed in papers prepared separately by each of the four team members. Each study addressed a different aspect of the problem. The studies shared a common definition of the dependent variable, Extent of Use. Independent variables were selected and defined according to the design of each author.

In this section the definition of the dependent variable will be given and the method of calculating it will be explained. The independent variables will be defined. Finally, the reasoning used in selecting from the sample those analysts considered to be eligible to use the methodologies will be explained.

There were two dependent variables in this study, each representing the extent of use of one structured systems methodology. Methodology 1, the technique for increasing systems analysis work early in the development sequence, was measured by M1. This methodology was considered by the organization to be appropriate for any one or more of three tasks which comprise the work of systems analysis: understanding the business operation, defining client needs and recommending a solution. An analyst was given a score on M1 based on the amount of time he or she had spent on the tasks for which the methodology could potentially be used and on the self-report of the extent of use of the methodology. If a respondent reported having spent 5 per cent or more of working time in any one of the three tasks, that analyst was considered eligible to be a user. The score calculated for that respondent was an average of the reported extent of use across the three tasks, where extent of use was measured on a five point scale representing "Never" to "Always". The calculated scores were then grouped, for analysis, into two categories roughly equal in size, representing low and high use.

Similarly, a dependent variable for extent of use of Methodology 2, the structured programming technique, was calculated based on the time spent on the three tasks for which that method was said to be appropriate: designing, coding and documenting the program.

Independent variables were developed for each part of each of the hypotheses. In some cases the variable is the response to a single question. In others it is a scale combining the responses to several related questions. The independent variables are given below, in the order of the hypotheses which they which they are used to test.

Hypothesis 1: Organizational Factors

1.1 Client Attitude, measured with two agree-disagree questions: a)"My client users want maintainability more than efficiency in code." b)"If and when I use the new system development technologies...my client users appreciate my work more."

1.2 Supervisor Attitude, measured with two agree-disagree questions, one for each methodology: a) "My supervisor (over the past year) would have liked me to use M1." b) "My supervisor (over the past year) would have liked me to use M2."

1.3 Organization Attitude, measured with a scale comprising five agree-disagree items, reliability tested at the alpha = .58 level (Questionnaire items 38.1,13,15,20,28; see Appendix A).

Hypothesis 2: Individual Attitudes

2.1 General Attitude toward Structured Methodologies, measured with a scale comprising five agree-disagree items, reliability tested at the alpha = .56 level (Questionnaire items 38.2,11,19,21,24).

2.2 Attitude toward Local Methodologies, measured with a scale comprising six agree-disagree items, reliability tested at the alpha =

Hypothesis 3: Individual Technical Ability, Experience and Orientation

3.1 Skill in Systems Development, measured with a five point self-rating on skill in programming in Fortran and PL1.

3.2 Skill in Methodologies, measured with a five point self-rating on skill in M1 and M2.

3.3 Technical Experience and Orientation, measured for each factor as follows: a) education as a dichotomous variable representing technical or nontechnical college degree, b) experience as years of experience in systems development, c) orientation as dichotomous variable representing responses to the question "In general do you see yourself pursuing a managerial or technical career path?".

Hypothesis 4: Opportunity for Increased Productivity

4.1 Type of Task, measured by per cent of time spent on tasks at each of four levels of systems development.

4.2 Complexity of Communications, measured by size of work group and length of current project.

The independent variables summarized above are thought to be related to the dependent variable. It is the purpose of this study to explore that relationship. However, before any tests of statistical significance are used it is necessary to examine more closely the logic of the situation in which the respondents were working to determine whether the entire sample or a subset is the relevant group. It is possible that not all the analysts had the opportunity to use these methodologies. In this event, it would be of interest to find out what distinguished those who had the opportunity from those who did not. In analyzing relationships of other factors to extent of use of methodologies, it would be advisable to limit the analysis to analysts who had a meaningful opportunity.

There are two variables which determine the opportunity of analysts to use the methodologies. One is access to training, or to some other source of skill development in the technique. An analyst who is not either trained or skilled in the methodology will not be a user, although it is likely that skill will be further developed through use on the job. The other opportunity variable is time spent on a task for which the methodologies are appropriate. These two variables are necessary conditions for the use of the methodologies. In this organization, however, they are factors over which the individual analyst has little control. Skill is most commonly acquired in a formal training program conducted by the firm. Since the methodologies are proprietary, there is no opportunity to get training outside the firm. And access to training is primarily, if not solely, dependent on assignment or approval by a supervisor. Similarly, the systems development tasks for which an individual is responsible are closely related to the job assignment and this is largely an organizational rather than a personal decision. (The analyst does exercise some control in the process, for example by turning down an opportunity to attend training sessions. Several respondents reported that when their turn to attend training came they were "too busy" to go.)

There is evidence that a substantial proportion of the sample have not had training in the methodologies (Table 7). For M1, 38 per cent of respondents report having had a day or less of training. Even for M2, which has been in use for four years or more, 19 per cent have had no training or only one day of training. There are, of course, some respondents who have not had training but have developed skills on their own or learned informally from others. These have been included in the group having opportunity to use the methodologies, on the training criterion.

Table 7

Training in Methodologies

Methodology	Days Training	Number of Cases	Percent[a]
M1	None	51	36
	1	3	2
	3	10	7
	4	42	30
	5	35	25
	Missing	4	-
	Total	145	100
M2	None	24	17
	1	3	2
	2	11	8
	3	64	46
	4	20	14
	5	17	12
	10	1	1
	Missing	5	-
	Total	145	100

[a]Percent of Non-Missing Data Only

To distinguish between opportunity and no-opportunity groups, with respect to training, a variable was created which was based on the amount of training as well as the self-reported skill in the use of each methodology. A respondent was considered to have opportunity if that individual met at least one of the following conditions: a) the analyst reported having had at least one day of training, or b) the analyst reported being skilled at a level of at least four on a five point scale. An analyst who met this test in regard to M1 was included in the subset of the sample used in exploring M1 use. The same approach was used for M2. While this approach may exclude some analysts who were offered training and did not attend, it has the advantage of being conservative in defining opportunity. It assures that if any relationships between in defining opportunity. By controlling for training/skill, it assures that those analysts for whom extent of use is measured had at least a familiarity with the methodologies as a basis for the decision to use or not to use them.

The other opportunity variable, time on tasks for which the methodologies are appropriate, is taken into account in the definition of the dependent variable. It is assumed that anyone who reported working on one or more of the tasks for 5 per cent or more of the time had the opportunity to use the methodology in question.

The following chapters make use of the dependent, independent and opportunity variables discussed here to analyze the data and report findings.

IMPLEMENTATION

The use of structured systems development methodologies by analysts at various stages in the systems development process is described in this chapter in four parts. The first section presents results describing the extent of use of M1 and M2 in the tasks for which they are appropriate and discusses the logical grounds for the creation of a single variable to measure the extent of use of each methodology. The second section describes analysts' access to training and explores factors which may be related to the amount of training an analyst receives. In third and fourth sections the analysts' perceptions regarding the benefits and disadvantages of each of the methodologies are presented and the stated reasons for using alternative methods, when M1 and M2 are not used, are summarized and discussed.

The results presented in this chapter are primarily descriptive of the aspects of implementation about which data were gathered in the study. The descriptions of extent of use, access to training, benefits and disadvantages and reasons for using an alternative provide the background necessary for understanding the relationships of various factors to implementation. In Chapter 5 a more analytic approach is taken in identifying specific factors thought to be associated with the extent of use.

Extent of Use. Each of the two methodologies was described in the guidelines for systems development in the organization as applicable for use in three specific tasks. In describing the extent of use of M1 and M2 we would like to know, first, whether analysts worked on these tasks. If they worked on one or more task and therefor were eligible to use the methodology, we are interested in whether they did in fact use it, and to what extent. Further, it will be important to find out whether the extent of use differed across tasks or whether analysts who were users on one task in a set tended to be users on all three tasks in a set. In the latter case, it will be possible and logically justifiable to create a single extent of use variable for M1 and another for M2 averaging the extent of use measures across the three tasks for which each methodology is appropriate.

Extent of use is given separately for each methodology on Table 8 These data show responses to a question on extent of use, condensing a five point scale into three groups. Several patterns stand out. For both sets of tasks, the large majority of respondents were eligible users as judged by the amount of time they had spent on the task (5 per cent or more). For each of the M1 tasks, more than 85 per cent of the sample were eligible users. For each of the M2 tasks, more than 70 per cent of the sample were eligible, by this criterion.

Table 8

Extent of Use, by Task

M1 Task[a]

Extent of Use	Understand The Business Number	Understand The Business Percent[b]	Define Client Needs Number	Define Client Needs Percent[b]	Evaluate Alternative Number	Evaluate Alternative Percent[b]
Always or frequently	44	34	32	25	22	17
Sometimes or infrequently	28	22	29	23	35	27
Never	56	44	66	52	67	52
Not Applicable[c] or Missing Data	17	-	18	-	21	-
TOTAL	145	100	145	100	145	100

M2 Task[d]

Extent of Use	Design Program		Code Program		Document Program	
	Number	Percentb	Number	Percentb	Number	Percentb
Always or Frequently	47	41	33	30	42	40
Sometimes or Infrequently	26	23	26	24	21	20
Never	41	36	51	46	42	40
Not Applicable[c] or Missing Data	31	-	35	-	40	-
Total	145	100	145	100	145	100

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[a] Tasks listed are those for which M1 may be appropriate.

[b] Percentages are based on adjusted totals, not including "Not Applicable" or Missing Data.

[c] Not Applicable: respondent spent less than five percent of working time on this task.

[d] Tasks listed are those for which M2 may be appropriate.

However, given membership in the population of eligible users, a relatively large proportion of analysts reported that they never use the methodologies: almost 50 per cent of eligible M1 users and approximately 40 per cent of eligible M2 users were in this category. It is possible that M1 is little used by some analysts because it has been approved for use relativly recently. M2 has been available and approved by the organization for a number of years, however, so other factors are likely to be important.

Extent of use appears to be relatively consistent across tasks within each grouping. For example, the proportion of respondents who never use M1 on the task "Understanding the Business" is similar to the proportion who never use M1 on "Define Client Needs". To test this relationship, Pearson Correlations were computed within each cluster of tasks. The result indicates a strong relationship among responses within each cluster, with a correlation of .7 or higher at the .01 level of significance. Analysts who are heavy of M1 on any one task are generally heavy users on the other two tasks; those who are not users on one task are likely not to be users on the other tasks. This is consistent with the impression given by analysts in the interviews that the tasks within each cluster are closely associated. Analysts in their work integrate their understanding of the business, defining of client needs and evaluating of alternatives. The time spent on the tasks is not spent in discrete blocks. Work in one area weaves among the other two, and techniques used in one task tend also to be those used in the other two. Based both on the high Pearson Correlations and on the logic of the situation, it makes sense to average the reported extent of use of M1 across the M1 tasks, and likewise to average the extent of use of M2.

Since many analysts were eligible, on the time-on-task criterion, to use both M1 and M2 there was a possibility that analysts had common patterns of use across the two clusters of tasks. In other words, analysts might be either high or low users, regardless of the particular methodology. Once again the Pearson statistic was used to test the relationship. Using the averaged measure of extent of use for each methodology, a Pearson Correlation of there is a significant relationship between use of M1 and use of M2, given eligibility to use both. Some analysts are high users of structured systems methodologies in general, while others tend to be lower level users or non-users. The relationship here appears to be not as strong as the relationship within a task cluster, however.

Access to Training. Formal training sessions conducted by the organization are the primary source of skill acquisition for M1 and M2. In Chapter 3, Table 7, the frequency distribution of training in each of the two methodologies was given. It indicated that the majority of analysts had two to five days of training in M1 (62 per cent) and similarly in M2 (80 per cent). There was, however, a significant minortiy who had not received training, particularly in M1 (38 per cent with one day or less).

In another study conducted as part of this project, McErlean (1983) has explored in detail the relationship of both formal training and informal access to consulting and advocate support to the extent of use of the methodologies, finding significant relationships between training and support on the one hand and extent of use on the other. It was further argued, in the previous chapter of this study, that access to training should be considered an opportunity variable in that an analyst without skill in M1 could not be expected to use M1, and likewise for M2. From both points of view, training is an important aspect of the implementation process. Access to training is likely to be related to the effectiveness of the innovation and an understanding of which analysts get training may be useful in interpreting analysts' assessment of the benefits of the methodologies. To provide some understanding of which analysts received training, and of how training and skill in the methodologies are related, this section will explore the relationships between level of training and a number of factors characterizing the analysts.

It is conceivable that access to training may be related to organizational factors such as location, respondent's position in the organizational hierarchy or attitude of the respondent's supervisor regarding the methodologies. It is possible, too, that access to training may be related to individual variables such as the analyst's educational background (technical or nontechnical) or career orientation, or the analyst's age. These possibilities were explored and the results are reported below.

The relationship between access to training, measured in days of training, and several organizational factors was tested using the Pearson Correlation Coefficient. For M1 training, no relationship was found between level of training and location. However, the relationship with Job Title (a seven point scale representing the hierarchical job level within the organization) gave an r of .32 at the .00 level. The more senior level analysts were more likely to have received training. This result may be due, in part, to the fact that analysts in senior positions tend to be older (Pearson r of .53, at the .00 level, for the relationship between age and Title) and therefor to have been in the organization longer and more exposed to the opportunity of training. On the other hand, it may be that the organization trains its higher level analysts to a greater extent than it trains those at lower levels.

Another organizational factor related to training was the degree to which the supervisor wanted the respondent to use M1. This finding is consistent with the reasoning that it is the supervisor who is a key decision maker in the process of allocating training resources among the analysts.

An exploration of the relationships between these same organizational factors and M2 did not result in similar findings. M2 training was found to vary to a small degree according to location (McErlean, 1983) but to have no significant relationship to Job Title or to the attitude of the supervisor to the use of M2. These findings must be interpreted in light of the fact that the great majority of analysts had training in M2 at more than the minimum level. The organization, through policy or at the level of an individual supervisor's decisions, is likely to influence the initial access to training, but almost all analysts have that access to M2 training. Beyond initial access, variation in the number of days of training may be influenced more by other factors than by the organizational factors measured here.

Two other organizational factors were examined and found to have no relationship to either M1 or M2 training. They are the size of the work group and the length of the project. Analysts in large groups, working on long projects, were thought to have potentially more use for a methodology designed to improve communications and to allow more effective coordination across individuals and through time. If this were true, one would expect the organization to encourage use of the methodology in order to increase productivity. One way to encourage use in these situations would be to attempt to provide training to analysts in methodologies appropriate here. The fact that training is not related to these factors suggests that either the organization does not currently act in this way or that other variables mask the results of such actions. For example, suppose an analyst had an assignment to work on a long project. If the thrust of that project were to maintain or enhance an existing application on which M1 and M2 were not used initially, the use of M1 or M2 now might not be appropriate. In that case, a rational supervisor might decide not to send an analyst to training.

Access to training may be related to an individual's background or technical orientation. For both M1 and M2 training, possible relationships with age, technical education and career orientation were tested. Age was found to be significantly related to M1 training ($r = .21$ at the .01 level) but not to M2 training. Technical education was found to be negatively related to M1 training but not related to M2 training. Those analysts who have a bachelor's or a master's degree in computer science are less likely to have had M1 training than those with non-technical degrees (Table 9). It is possible that these analysts do not feel the need to acquire skills in M1, or that they are concerned that their previously learned skills will become obsolete if they learn M1 and are therefor resistant to change. On the other hand, if it is the organization which is making decisions about access to training it is likely that supervisors are assessing the need of technically skilled analysts for M1 as being relatively low and are therefore not assigning these analysts to training.

The final individual factor explored in relation to training was career orientation. In this case no significant relationship was found with either M1 or M2 training; i.e. analysts oriented toward a technical career are no more likely to have received training than those oriented toward a career in management.

One aspect of training worth investigating further is the relationship of training level with skill level for M1 and M2. Table 10 shows that as expected the relationship is strong and positive for M1, but contrary to expectations it is not nearly as strong for M2. It is

Table 9

Access to Training, by Education

		M1 Training				M2 Training			
		0 Days		1+ Days		0 Days		1+ Days	
		N	%	N	%	N	%	N	%
Education	Nontechnical[a]	17	35	53	65	10	48	59	55
	Technical[b]	31	65	28	35	11	52	48	45
	Total	48	100	81	100	21	100	107	100

M1 Statistics	M2 Statistics
N = 129	N = 128
Missing Cases = 16	Missing Cases = 17
Chi Square = 9.8	Chi Square = 0.2
Significance = 0.00	Significance = 0.7

[a]Bachelor's or Master's, other than Systems Development.

[b]B.S. or M.S., Systems Development.

Table 10
Skill Level by Training

		Days of Training							
		M1				M2			
		0		1+		0		1+	
		n	%	n	%	n	%	n	%
Skill	Low	49	96	65	72	18	75	69	60
Level[a]	High	2	4	25	28	6	25	46	40
	Total	51	100	90	100	24	100	115	100

Statistics	M1	M2
N	141	139
Missing, N/A	4	6
Chi Square	12.6	2.1
Significance	0.00	0.35

[a]Skill Level based on self-rating on a 5-point scale, 1 to 3 low, 4 to 5 high.

[b]Missing, N/A includes respondents not answering this item.

particularly striking that a large number of respondents (65 for M1 and 31 for M2) report that they are trained but not skilled in the methodologies. In part this finding is due to the fact that the measure of training used here was relatively liberal (one day or more), compared to the company standard for the M1 training of 4 days. Among these analysts, however, are likely some for whom either training was not effective or training took place so long ago that the skills developed in training have deteriorated. This latter phenomenon was reported in a number of interviews by analysts who explained that the training was given at a time when there was no immediate opportunity to apply the skills learned, so that the skills were eventually forgotten. In addition, several respondents commented that the training program itself would benefit from the introduction of more practical examples in the curriculum and from a closer integration of M1 or M2 techniques with the work in which trainees were currently engaged.

Also of interest in these data are the respondents who are skilled but not trained. These analysts (2 for M1 and 19 for M2) are living proof that the methodologies can be learned outside the formal training program, especially when the methodology has been in use over a number of years as is the case with M2. The existence of analysts in this category suggests that those in the organization concerned with more effective implementation of the methodologies, and in particular with more effective ways to increase the level of skills, might plan to increase their use of the non-formal training, support and communications systems through which some analysts are currently getting skill development. The use of consultants, local advocates, on-line tutorials and other support techniques may help, in particular, in providing skill-refresher activities which may address the problem of the deterioration over time of the effects of formal training.

Benefits of the Methodologies. One of the assumptions underlying this study is that individual analysts, acting rationally within the boundaries set by the organzation and the constraints imposed by their own abilities and their work-related opportunities, will assess the value of each of the methodologies and the potential of each to improve analyst effectiveness. This section reports the benefits and disadvantages of the methodologies, as perceived by the analysts. These results are compared with the claims made for each methodology by the computer technology development group which is responsible for their creation and dissemination. The results are also compared across methodologies to find common advantages and disadvantages and to identify those benefits which are specific to M1 and M2. Finally those benefits not frequently chosen will be reviewed and the implications for the implementation process discussed.

On Table 11 the four most heavily weighted advantages of M1 and M2, as perceived by respondents, are given. Three of the four advantages listed for M1 are benefits related to the central tasks of the early stages of systems development. Understanding the client's business, accurately defining the requirements of the system and communicating effectively are all necessary parts of the analysts work. As indicated

Table 11

Principal Advantages of the Methodologies According to the Survey Respondents (N = 145)

M1 Advantages	Weighted Ranking[a]	M2 Advantages	Weighted Ranking[a]
1. Helps me understand clients' business	3.7	1. Provides structured design	3.8
2. Structured approach	4.7	2. Structured approach	4.9
3. Improves requirement definition	4.8	3. Application more maintainable	4.9
4. Provides improved communication	5.6	4. Provides better documentation	5.1

[a]Respondents were asked to select and record in ranked order, the three most important advantages of each of these methodologies. Responses were weighted by their rank order (e.g., third ranked = 3); responses not selected were arbitrarily assigned the average ranking of 8 on the assumption that responses not selected, if ranked, would be randomly distributed among all possible remaining rankings (i.e., 4 to 13); the rankings were then aggregated and averaged. The smaller the number recorded here, the higher the rank, on average, given to this response. Range 1 - 8.

on Table 12, the developers of M1 agree with this assessment of the advantages of the methodology. The fourth advantage given by analysts, "structured approach", is more descriptive of the methodology itself than suggestive of the benefits it brings to analysis. It is worth noting, however, that structure is seen as an advantage by respondents rather than an irrelevant factor or a disadvantage. The implication is that the general orientation of analysts is favorable to a more structured approach to the early stages of systems development: M1 is clearly a structured approach, and respondents see that characteristic as an advantage. The developers do not list structure as an advantage of M1, most likely in that they take for granted that structure is an advantage since it is the central characteristic of both of the methodologies.

Advantages given for M2 are similar to those given for M1 in that both structure and two more specific advantages are heavily weighted. The implications of the listing of "structure" as an advantage are the same as above. The other items address specific desired outcomes of the design, coding and documentation sequence of work which takes place at the later stages of systems development. The mention of maintainability is interesting in that we know that this feature is a major concern of managers attempting to improve systems development productivity, yet it is not a characteristic which is easily observed, described or measured. An application or a system can be demonstrably maintainable only in the long run. While it would be relatively easy to observe "better documentation", and thus to know whether M2 contributes to a better

Table 12

Principle Advantages and Disadvantages of the Methodologies According to Their Developers

M1 Advantages	M2 Advantages
1. Provides improved communications	1. Application more maintainable
2. Helps me understand client's business	2. Provides better documentation
3. Improves requirement definition	3. Provides structured design

M1 Disadvantages	M2 Disadvantages
1. Time Consuming to use	1. Time cosuming to use
2. Too expensive for client (time or budget)	2. Incompatible with programming language I use[a]
3. Unfamiliar	3. Not oriented to my application[a]

[a]In these cases, the developers chose as disadvantages, ones that actually ranked quite low on the respondents' lists, and left out ones the respondents felt were important.

documented product, it may be difficult to demonstrate a similar relationship between the use of M2 and the maintainability of a product. It is a fact that M2 is intended to provide this benefit. The developers make the claim here (Table 12). It may even be that over the several years during which M2 has been in use increased maintainability has been observed. However, of all the advantages given, this one appears less likely to be grounded in the immediate experience of the respondents and more likely a restatement of generally accepted opinion.

The two most important disadvantages perceived by analysts, with respect to both M1 and M2, are their lack of familiarity with the methodologies and the time it takes to use these techniques (Table 13). Time is a central concern here, in that it requires time to become familiar with a new approach and to develop skill in applying it. The analyst is aware of the importance of time in that one of the primary criteria used in performance evaluation is the extent to which the work is completed on time and within the budget. (Budget, itself, translates into time in this field since it is the labor cost of analysts and programmers which constitute the largest proportion of variable costs of any project.) The issue of familiarity was addressed in the previous section in regard to access to training and the need to schedule training in a way more closely coordinated with use of the methodologies on a project. Here analysts are reporting directly that they recognize that their own lack of familiarity with the methodologies as well as the time demands of use both cause problems. For M1, in addition, there is concern for the fact that the client will be required to bear the

Table 13

Principal Disadvantages of the Methodologies According to the Survey Respondents (N = 145)

M1 Disadvantages	Weighted Ranking[a]	M2 Disadvantages	Weighted Ranking[a]
1. Unfamiliar	2.2	1. Time consuming to use	3.8
2. Time consuming to use	3.0	2. Unfamiliar	4.0
3. Too expensive for client (time or budget)	5.6	3. Not useful for maintenance	5.3
4. Not oriented to my application	5.8	4. Restrictive (inhibits creativity)	5.7
5. Not useful for maintenance	5.9		

[a]Respondents were asked to select and record in ranked order, the three most important disadvantages of each of these methodologies. Responses were weighted by their rank order (e.g., third ranked = 3); responses not selected were arbitrarily assigned the average ranking of 7 on the assumption that responses not selected, if ranked, would be randomly distributed among all possible remaining rankings (i.e., 4 to 11); the rankings were then aggregated and averaged. The smaller the number recorded here, the higher the rank, on average, given to this response. Range 1 - 7.

increased expense due to use of the methodology.

Another disadvantage which analysts mention in relation to both methodologies is the perception that neither M1 nor M2 are useful for maintenance. Analysts reported in the interviews that on projects which are building onto previously developed systems, whether to correct errors or to enhance the systems, M1 and M2 cannot in general be used unless they were use in the original design of the system without undertaking an excessive amount of extra work. The cost of the work necessary to retrofit an existing system with M1 or M2 is seen as prohibitive, even for relatively large and somewhat self-contained components newly designed to augment systems currently in operation. In this area there appears to be significant latitude for individuals or project leaders to make the decision to use or not to use the methodologies, and most individuals, at least, are reluctant to commit themselves to the added costs of use.

It is clear that the developers disagree with the analysts on this point. The item "not useful for maintenance" is noticeably missing from their list of disadvantages. While their other listed disadvantages for M1 and one of their disadvantages for M2 are the same as those of the analysts, they do not share the perspective of the analysts on the issue of maintenance. There may be a correct perspective here, or a reasonable compromise between the two positions, but to find it is beyond the scope of this study. In practice, we know that use of M1 and M2 in the context of a maintenance project is a judgement call. Those making the judgement are the analysts. Their assessment, in this case, is the one which is the most directly related to behavior (extent of use of the methodologies) and is for that reason worth noting.

Underlying the assessment of advantages and disadvantages of the methodologies is a set of questions about costs and benefits. One of the missing pieces in this puzzle is the actual cost of using M1 and M2, and the actual advantages of using each. This is the productivity improvement measurement issue. While no specific measures are suggested here, there is in these findings a suggestion of a possible next step in developing such a measure. The step is to make a distinction between long and short term costs, and similarly long and short term benefits.

Analysts are concerned about the costs of using M1 and M2, and these concerns may well reduce their extent of use. The costs they are considering are short term costs, essentially the charges to the client on an applications development or systems development project. This is not surprising, since analysts are on the whole given incentives based on their short term production. They recognize the benefits of the structured methodologies and will most likely use the methodologies when the perceived benefits are greater than the perceived costs. However a number of the benefits identified, as well as some noted by the developers but not weighted heavily by analysts, are long term benefits. To the extent that these long term advantages are defined, operationalized and measured, a modified incentive structure for analysts can be developed. The balance between advantages and disadvantages, perceived by the analysts, can be altered and the extent of use of the methodologies can be increased.

Reasons for Using Alternatives. Analysts were asked their reasons for using alternative approaches, in those cases in which they did not use the structured methodologies. Their responses are summarized on Tables 14 and 15. For M1 the most frequently mentioned reason, by far, was the lack of training, skill and experience in the use of the methodology. Respondents often expressed in the interviews the feeling that they did not have the time to learn M1 properly or to practice it when they had been trained. The high rank of this reason for use of alternative approaches underscores the seriousness of this difficulty in implementation process. This finding suggests that perhaps M1 is more difficult to learn or to use than the organization is aware or is willing to pay for in the form of additional "overhead" time on projects. Analysts believe there is an experience curve, a potential for increasingl their skill level with additional experience and decreasing the time required for effective use of M1. They are dependent on the organization, however, to cover the cost of what is thought of, in effect, as on the job training necessary for them to get that experience.

The next two reasons, in order of relative frequency, are related to the fit between M1 and the analysts' work. M1 is seen as too formal or too detailed for use on the tasks for which they are responsible. It is not perceived to be justifiable for use on relatively small projects. In both cases the underlying concern seems once again to be one of cost, in that the analyst must spend extra time to use M1 in relation to the

Table 14

Reasons for Using Alternative to M1

Reasons	Task[a]					
	Understand Business		Define Client Needs		Evaluate Alternatives	
	Number	Percent[b]	Number	Percent[b]	Number	Percent[b]
Respondent not sufficiently trained/ skilled/experienced in M1	39	38	28	26	38	37
M1 too formal/detailed	19	19	29	28	15	15
Project too small to justify M1	12	12	13	13	14	13
Precedent set earlier in project	15	15	8	8	7	7
M1 not suitable/compatiablewith hardware or software	4	4	9	9	16	15
Alternative saves time	6	6	7	7	7	7
Other	7	7	12	12	7	7
Not Applicable[c] or Missing Data	43	-	39	-	41	-
Total	145	100	145	100	145	100

[a]Tasks listed are those for which M1 may be appropriate.

[b]Percentages calculated on the basis of adjusted totals, not including "Not Applicable" or Missing Data.

[c]Not Applicable: Respondent spent less than 5% of working tiome on this task.

Table 15

Reasons for Using an Alternative to M2

Reasons	Task[a]					
	Design Program		Code Program		Document Program	
	Number	Percent[b]	Number	Percent[b]	Number	Percent[b]
M2 not suitable/compatible with hardware or software	17	23	17	22	13	19
Respondent not sufficiently trained/ skilled/experienced in M2	17	23	17	22	11	16
Alternative saves time	10	13	12	15	9	13
Project too small to justify M2	12	16	8	10	9	13
M2 too formal/detailed	5	7	7	9	11	16
Precedent set earlier in project	9	12	7	9	4	6
Other	4	5	11	14	12	18
Not Applicable[c] or Missing Data	70	-	66	-	76	-
Total	145	100	145	100	145	100

[a]Tasks listed are those for which M2 may be appropriate.

[b]Percentages based on adjusted totals not including "Not Applicable" or Missing Data.

[c]Not Applicable: respondent spent less than five percent of working time on this task.

alternative approach, time which is apparently not seen as justifiable given the requirements of the project ("too formal") or the size of the project ("project too small"). The analyst is held responsible for cost, and this responsibility provides the frame of reference within which he or she makes decisions regarding the use of M1 or an alternative. The reasons for using alternatives do not indicate that other approaches offer better solutions to the underlying problems: communications, definition of requirements, understanding of the client's business, and so forth. In these areas we must assume that M1 remains a favored approach. The potential benefits attributed to M1 in these areas, however, are not observable in the short run and are not outcomes for which analysts will be rewarded. In other words, in choosing between M1 and the available alternatives analysts are acting according to short term incentives, although they recognize that were they to use M1 more extensively they might contribute to an increase in the effectiveness of systems development in the long run.

In the case of M2, incompatibility with applications software or with the hardware environment in which the application is being developed replaces lack of training as the most commonly sighted reason for use of an alternative approach. However training is a close second in rank, a surprising result in that such a large proportion of analysts is trained in M2. Once again it appears that either the training is too distant in time from the implementation or the job does not provide the chance to practice and gain experience in using the M2 skills learned. The other reasons are similar to those for M1, and the interpretation above appears to apply here too.

In gathering the data for this section, questions were left relatively unstructured in hopes of allowing for more open expression of concerns on the part of analysts and in an attempt to shed light on a complicated decision making process. The value of this data, more qualitative and less suitable to statistical analysis, is in the insight it may provide into the implementation process. The data indicate that analysts are making decisions about both M1 and M2 on the basis of a number of criteria related primarily to cost, including time and dollars, and compatibility. To the extent that these are the real reasons for choices of alternatives, and we have little if any evidence to indicate that they are not, it is likely that appropriate changes in the management of this implementation will result in an increase in the extent of use of the methodologies.

FACTORS RELATED TO EXTENT OF USE

The implementation of change at the level of an individual analyst is related to various organizational, individual and opportunity factors. In this study, four hypotheses were tested using selected variables to represent each of these factors. In this chapter the results of the tests are reported and discussed. The first section reports relationships found between the attitudes of clients, supervisors and the organization and the extent of use of the methodologies. In the second section, relationships between analysts' attitudes and extent of use are reported. The third section reports and discusses the ways in which analysts' abilities, education, experience and career orientation are associated with use. The final section presents data on two selected opportunity variables, type of task and complexity of project, in relation to use of structured methodologies. In each case, discussion of the findings is included with the report of results.

Hypothesis 1: Organizational Support. There is a strong indication that the level of organizational support perceived by an analyst in the form of favorable attitudes of clients, supervisors and the organization in general toward M1 is associated with more extensive use of M1. The same relationship appears to be present for M2 only in the case of perceived supervisor support. Client and general organizational support are not significantly associated with more extensive use. (See Chapter 2 for explanation of attitude variables.)

1.1 Client attitudes favorable to the use of the methodologies will be associated with greater extent of use. Tables 16 and 17 indicate that the extent of use of M1 is significantly greater when the client is seen as appreciating structured methodologies and when the client is perceived as preferring maintainability of an application over efficiency of the code. No similar relationships are found between these client attitude measures and the extent of use of M2.

Discussion: It is analysts engaged in the early stages of systems development work who have the most frequent and most intensive contact with clients. The analyst and the client are dependent on each other in the process of representing the business accurately, defining the needs of the business and recommending a solution in the form of an applications software package, an information system or some other product. In this close working relationship the analyst is likely to develop respect for the attitudes of the client. More important, perhaps, the analyst is dependent on the client's satisfaction with the relationship in keeping his or her own supervisor happy. It is likely that the analyst is willing to act on the client's preferences for certain product characteristics, if there is a way to do so. In this case, M1 is a technique which promises to deliver the product with the attributes the client wants.

Table 16
Extent of Use by Client's Appreciation

		Extent of Use[a]							
		M1				M2			
		Moderate		High		Moderate		High	
		n	%	n	%	n	%	n	%
Client's	Low	28	66	7	23	23	54	8	26
Appreciation[b]	High	14	33	24	77	20	46	23	74
	Total	42	100	31	100	43	100	31	100

Statistics	M1	M2
N[c]	74	74
Missing, N/A	71	71
Chi Square	14.7	4.6
Significance	0.00	0.03

[a]Extent of Use based on 5-point scale, 1 to 3 moderate, 4 to 5 high.

[b]Client's Appreciation based on responses to an agree-disagree question with a 5-point response scale, grouped 1 to 3 low, 4 to 5 high.

[c]N includes only those respondents with 1 or more days training or methodology skill level of 4 or 5, on a 5-point scale.

Table 17

Extent of Use by Client's Preference

for Maintainability Over Efficiency

		Extent of Use[a]							
		M1				M2			
		Moderate		High		Moderate		High	
		n	%	n	%	n	%	n	%
Client's	Low	23	54	8	26	24	44	11	46
Preference[b]	High	20	46	23	74	30	56	13	54
	Total	43	100	31	100	54	100	24	100

Statistics	M1	M2
N[c]	74	78
Missing, N/A	71	67
Chi Square	4.6	0.0
Significance	0.03	1.00

[a]Extent of Use based on 5-point scale, 1 to 3 moderate, 4 to 5 high.

[b]Based on responses to an agree-disagree question with a 5-point response scale, grouped 1 to 3 low, 4 to 5 high.

[c]N includes only those respondents with 1 or more days training or methodology skill level of 4 or 5, on a 5-point scale.

For analysts who work at later stages of development, the programming stages, contact with the client and interdependence between analyst and client are less intense. What the client wants may be less important than how well the program works. Technical and cost considerations may be relatively more important, in part because they are more easily observed at this stage. For these reasons, the clients' attitudes may matter less.

(It is possible that the association may work the other way. In this hypothesis and test there is no proof of causation. Perhaps it is analysts who are extensive users of M1 who influence their clients' attitudes, resulting in the association discussed above. It is understood that this possibility is present in all the relationships explored here, although it will not be explicitly mentioned in each.)

1.2 Supervisor attitudes favorable to the use of the methodologies will be associated with more extensive use. The relationship found between supervisor's attitude and use of both M1 and M2 was positive and highly significant. When the supervisor did not support use of the methodologies, hardly any analysts used the methodologies. When the supervisor was seen as wanting analysts to use M1 or M2 the extent of use of each, respectively, was higher. There were still a substantial number of analysts who were not heavy users in spite of what their supervisors wanted (Table 18).

Table 18

Extent of Use by Supervisor's Orientation

		Extent of Use[a]							
		M1				M2			
		Moderate		High		Moderate		High	
		n	%	n	%	n	%	n	%
Supervisor's	Low	25	58	4	13	28	52	4	17
Orientation[b]	High	18	42	27	87	26	48	20	83
	Total	43	100	31	100	54	100	24	100

Statistics	M1	M2
N[c]	74	78
Missing, N/A	71	67
Chi Square	13.6	7.1
Significance	0.00	0.01

[a]Extent of Use based on 5-point scale, 1 to 3 moderate, 4 to 5 high.

[b]Based on responses to an agree-disagree question with a 5-point response scale, grouped 1 to 3 low, 4 to 5 high.

[c]N includes only those respondents with 1 or more days training or methodology skill level of 4 or 5, on a 5-point scale.

Discussion: The supervisor is the single most influenital point of contact most analysts have with the organization. It is through the supervisor that the individual receives incentives and communications about what is expected. There is little surprise in the finding that supervisors' attitudes are associated with extent of implementation. The fact that both M1 and M2 are affected is evidence of the strength of supervisor influence relative to the influence of other variables. Very few of the factors tested here showed a statistically significant relationship with M2.

1.3 General organizational attitudes consistent with the use of the methodologies are likely to be associated with more extensive use. The finding reported in Table 19 is that organizational values consistent with the methodologies are associated with extensive use of M1 but are not significantly associated with use of M2. In the case of M1, even if the organization is perceived as supportive of the methodologies, 31 per cent of respondents make little or no use of the methodology.

Discussion: The influence of perceived organizational values on the decision of an analyst to use a particular technique is difficult to attribute to any particular individual or to isolate in a specific event. The perception of dominant values or beliefs in the environment can be associated with behavior, however, and the association may be strengthened if the clarity and internal consistency of the values is increased. If management were able to establish, in this case, the commitment to improving long run productivity by improving maintainability, or client-analyst communications, and if the structured

Table 19

Extent of Use by Organization Values

		Extent of Use[a]							
		M1				M2			
		Moderate		High		Moderate		High	
		n	%	n	%	n	%	n	%
Organization Values Consistency With Methodology[b]	Low	26	61	9	29	29	54	10	42
	High	17	39	22	71	25	46	14	58
	Total	43	100	31	100	54	100	24	100

Statistics	M1	M2
N[c]	74	78
Missing, N/A	71	67
Chi Square	5.9	0.5
Significance	0.01	0.46

[a]Extent of Use based on 5-point scale, 1 to 3 moderate, 4 to 5 high.

[b]Based on responses to a scaled set of agree-disagree questions, reliability tested at alpha .55)

[c]N includes only those respondents with 1 or more days training or methodology skill level of 4 or 5, on a 5-point scale.

methodologygies were perceived as useful in achieving these ends, then use of the methodologies might well increase.

Hypothesis 2: Individual Attitudes. The attitudes of the individual analyst, both toward structured methodologies in general and toward the local versions of structured methodologies, were positively related to extent of use of M1 but were not related to extent of use of M2. (For explanation of attitude variables, see Chapter 2, above.)

2.1 Analysts whose attitudes are consistent with the use of structured methodologies in general will be more extensive users of M1 and M2. It was found that this statement was true at the .01 level of significance for M1 using the Chi Square test. Analysts who are favorably inclined toward structured methodologies in general will tend to use M1 more extensively (Table 20). The relationship does not hold for M2.

2.2 Analysts whose attitude toward the local versions of structured methodologies are favorable will be more extnesive users. It was found that favorable attitudes were once again associated with significantly greater extent of use. In this case, the direction of the association was present in M2 as well as in M1, but the relationship was significant only in the latter (Table 21).

Discussion: The respondent's attitude to the methodologies influences, and is influenced by, use of the methodologies. The fact that the relationship is not stronger in the case of M2 is surprising, although this result fits the pattern noted above that many factors

Table 20

Extent of Use by Respondent's Attitude

Toward Structured Methodologies

		Extent of Use[a]							
		M1				M2			
		Moderate		High		Moderate		High	
		n	%	n	%	n	%	n	%
Respondent's Favorable Attitude[b]	Low	31	72	10	32	37	69	13	54
	High	12	28	21	68	17	31	11	46
	Total	43	100	31	100	54	100	24	100

Statistics	M1	M2
N[c]	74	78
Missing, N/A	71	67
Chi Square	10.0	0.9
Significance	0.00	0.34

---

[a]Extent of Use based on 5-point scale, 1 to 3 moderate, 4 to 5 high.

[b]Based on responses to a scaled set of agree-disagree questions, reliability tested at alpha .55)

[c]N includes only those respondents with 1 or more days training <u>or</u> methodology skill level of 4 or 5, on a 5-point scale.

Table 21

Extent of Use by Respondent's Attitude

Toward M1 and M2

		Extent of Use[a]							
		M1				M2			
		Moderate		High		Moderate		High	
		n	%	n	%	n	%	n	%
Respondent's	Low	23	54	5	16	28	52	8	33
Favorable	High	20	46	26	84	26	18	16	67
Attitude[b]	Total	43	100	31	100	54	100	24	100

Statistics	M1	M2
N[c]	74	78
Missing, N/A	71	67
Chi Square	9.2	1.6
Significance	0.00	0.20

---

[a]Extent of Use based on 5-point scale, 1 to 3 moderate, 4 to 5 high.

[b]Based on responses to a scaled set of agree-disagree questions, reliability tested at alpha .55)

[c]N includes only those respondents with 1 or more days training <u>or</u> methodology skill level of 4 or 5, on a 5-point scale.

associated are associated more strongly with M1 than with M2. It is interesting that for neither methodology does the presence of a favorable attitude assure heavy use. In both cases among analysts with a favorable attitude there are more users in the "none to moderate" category than there are heavy users.

3. Personal Ability, Experience and Career Orientation. There were statistically significant but complex relationships demonstrated as a result of testing this hypothesis. Skill in programming appeared to be at times positively and at times negatively related to use of the methodologies. Years of experience was found to be related positively to use, but only in the case of M1. And orientation of education was not found to be related to use of either methodology.

3.1 There is a relationship between skill in each methodology and extent of use of that methodology. The results given in Table 22 are consistent with this hypothesis for both M1 and M2. For the former, analysts with low to moderate skills are low level users of the methodology by a ratio of more that four to one, while analysts who are highly skilled are found mostly among the high users. The same pattern is found for M2. The results are tested with the Chi Square statistic and found highly significant.

3.2 Analysts who are skilled in other programming and systems development techniques will be less likely to use the methodologies. The hypothesis was tested for four skills: Fortran, PL1, Cobol and Nomad/Ramis. No statistically significant relationships were found for

Table 22

Extent of Use by Skill in M1 and M2

		Extent of Use[a]							
		M1				M2			
		Moderate		High		Moderate		High	
		n	%	n	%	n	%	n	%
Level	Low	34	81	14	45	43	80	4	17
of	High	8	19	17	55	11	20	20	83
Skill[a]	Total	42	100	31	100	54	100	24	100

Statistics	M1	M2
N[c]	73	78
Missing, N/A	72	67
Chi Square	10.9	24.9
Significance	0.00	0.00

---

[a]Extent of Use based on 5-point scale, 1 to 3 moderate, 4 to 5 high.

[c]N includes only those respondents with 1 or more days training <u>or</u> methodology skill level of 4 or 5, on a 5-point scale.

the latter two. For PL1 no relationship was found with use of M1. However a significant positive association was found with use of M2 (Table 23). And finally, for Fortran, a positive and significant relationship was found for M1 and a negative and significant relationship for M2 (Table 24). Given these contradictory results, the hypothesis can neither be confirmed nor denied.

Discussion: The relationship between technical skill level and use of the methodologies cannot be explained simply. One possibility is that technical skills have specific effects on use of each methodology due to commonalities or differences. For example, PL1 is a relatively structured programming language, possibly similar in orientation to M2. An analyst skilled in PL1 might be more willing to use M2 due to familiarity with the approach. Another possibility is that the skills investigated here may themselves be strongly associated with an underlying variable. This idea was tested with both age and technical educational background, and significant associations were found. Both Fortran and PL1 skills are negatively related to the age of the analyst; i.e. younger analysts are more likely to be skilled in these two programming languages than older analysts. Similarly, for both languages analysts with a technical degree are more likely to be skilled than those with a nontechnical degree. No significant relationships were found between age and education, on the one hand, and skill in Cobol or Focus/Ramis. So certain patterns of skill distribution may represent patterns of distribution of age or of education. But the relationship to the contradictory associations found in the study

Table 23

Extent of Use by Skill in P1

		Extent of Use[a]							
		M1				M2			
		Moderate		High		Moderate		High	
		n	%	n	%	n	%	n	%
Level	Low	23	55	18	58	33	61	7	29
of	High	19	45	13	42	21	39	17	71
Skill[a]		Total		42	100	31	100	54	100
24	100								

Statistics	M1	M2
N[c]	73	78
Missing, N/A	74	67
Chi Square	0.8	5.6
Significance	0.67	0.02

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[a]Extent of Use based on 5-point scale, 1 to 3 moderate, 4 to 5 high.

[c]N includes only those respondents with 1 or more days training <u>or</u> methodology skill level of 4 or 5, on a 5-point scale.

Table 24

Extent of Use by Skill in Fortran

		Extent of Use[a]							
		M1				M2			
		Moderate		High		Moderate		High	
		n	%	n	%	n	%	n	%
Level	Low	27	66	23	74	28	53	19	79
of	High	14	34	8	26	25	47	5	21
Skill[a]		Total		41	100	31	100	53	100
24	100								

Statistics	M1	M2
N[c]	72	78
Missing, N/A	73	67
Chi Square	2.1	5.3
Significance	0.36	0.07

[a]Extent of Use based on 5-point scale, 1 to 3 moderate, 4 to 5 high.

[c]N includes only those respondents with 1 or more days training <u>or</u> methodology skill level of 4 or 5, on a 5-point scale.

remains unclear.

3.3 Technical work experience of the analysts will be related to extent of use. The relationship was tested using years of experience in the field of systems development and technical as compared to nontechnical education (Tables 25 and 26). Years of experience was found to be related to use of M1, with Chi Square equal to 5.7 at the .02 level of significance. Analysts with longer experience in systems development tend to be more extensive users. There were no other statistically significant relationships under this hypothesis.

Discussion: While technical orientation, as measured by technical degree from college is apparently related to access to training in M1 and M2 it is not related to use of the methodologies among analysts already skilled or trained. An analyst with a technical background is no more or less likely to use the methodologies than one with a nontechnical background. This suggests that the technical orientation of an analyst is not in itself a factor in determining extent of use, but may be indirectly involved in the sequence of events through which the patterns of use are established in the organization. If, for example, supervisors are instrumental in assigning analysts to training, and if the supervisors act on the assumption that analysts with a technical background do not need training in M1 and M2, the analysts in this group will receive less training in the methodologies and will for that reason appear to be less extensive users.

Table 25

Extent of Use by Experience in Systems Development

			Extent of Use[a]							
			M1				M2			
			Moderate		High		Moderate		High	
			n	%	n	%	n	%	n	%
Years	0-3	Low	13	31	8	26	35	66	14	58
of	3+	High	29	69	23	74	18	34	10	42
Experience		Total	42	100	31	100	53	100	24	100

Statistics	M1	M2
N[c]	73	77
Missing, N/A	72	68
Chi Square	0.0	0.2
Significance	0.83	0.69

---

[a]Extent of Use based on 5-point scale, 1 to 3 moderate, 4 to 5 high.

[c]N includes only those respondents with 1 or more days training _or_ methodology skill level of 4 or 5, on a 5-point scale.

Table 26

Extent of Use by Education

		Extent of Use[a]							
		M1				M2			
		Moderate		High		Moderate		High	
		n	%	n	%	n	%	n	%
Nontechnical	Low	28	70	19	70	24	47	12	55
Technical[b]	High	12	30	8	30	27	53	10	45
	Total	40	100	27	100	51	100	22	100

Statistics	M1	M2
N[c]	67	73
Missing, N/A	78	72
Chi Square	0.0	0.1
Significance	1.0	0.7

---

[a]Extent of Use based on 5-point scale, 1 to 3 moderate, 4 to 5 high.

[b]Nontechnical includes bachelor's or master's in fields other than computer science. Technical includes bachelor's or master's in computer science.

[c]N includes only those respondents with 1 or more days training or methodology skill level of 4 or 5, on a 5-point scale.

4. Opportunity Factors. Results obtained in testing this hypothesis indicate that opportunity factors of two types may be related to use of structured methodologies. The task to which an analyst is assigned as well as the amount of time spent on that task can be associated with use. And the size of the project on which the analyst is working may be similarly related to use.

4.1 The type of task to which analysts are assigned and in which they spend major portions of their time will be related to their extent of use of the methodologies. This relationship was tested by comparing the proportion of the analyst's time spent on Scoping, Development/Acquisition, Enhancement and Maintenance to the extent of use of both M1 and M2. The results for Scoping and Maintenance are given in Tables 27 and 28. They show more time spent in Scoping is related to more use of M1 and less use of M2. Scoping is an activity which takes place early in the development cycle and is appropriate for the use of M1. They further show that more time spent in Maintenance is related to less use of both methodologies, although the relationship is not statistically significant for M2. In maintnenance work the system being modified has frequently been in use for many years and is unlikely to have been developed with either methodology originally. To begin to use the methodologies now may not be as easy as using them on an entirely new system and this may be a factor in the relatively low level of use.

Table 27

Extent of Use by Time on Scoping Tasks

		Extent of Use[a]							
		M1				M2			
		Moderate		High		Moderate		High	
		n	%	n	%	n	%	n	%
Percent Time	0	18	42	7	23	30	56	8	33
on Scaping	100	25	58	24	77	24	44	16	67
	Total	43	100	31	100	54	100	24	100

Statistics	M1	M2
N[c]	74	78
Missing, N/A	71	67
Chi Square	0.9	0.7
Significance	1.63	0.8

[a]Extent of Use based on 5-point scale, 1 to 3 moderate, 4 to 5 high.

[c]N includes only those respondents with 1 or more days training or methodology skill level of 4 or 5, on a 5-point scale.

Table 28

Extent of Use by Time on Maintenance

		Extent of Use[a]							
		M1				M2			
		Moderate		High		Moderate		High	
		n	%	n	%	n	%	n	%
Percent Time on Maintenance	0	18	42	14	45	13	24	10	42
	1-49	10	23	14	45	23	43	10	42
	50+	15	35	3	10	18	33	4	16
	Total	43	100	31	100	54	100	24	100

Statistics	M1	M2
N[c]	74	78
Missing, N/A	71	67
Chi Square	7.4	3.4
Significance	0.02	0.18

---

[a]Extent of Use based on 5-point scale, 1 to 3 moderate, 4 to 5 high.

[c]N includes only those respondents with 1 or more days training or methodology skill level of 4 or 5, on a 5-point scale.

4.2 The size of the work group to which the analyst is assigned as well as the length of the project on which the analyst is working will both be related to extent of use. Both relationships predicted here were tested and the results found not be statistically significant. While there appeared to be come support for this hypothesis in the comments made by several respondents during the interviews, the extent of use measure used here was not specific to a particular project but rather referred to use during the entire year. For analysts who worked on more than one project, the relationships tested here may not have been represented in the data.

SUMMARY AND RECOMMENDATIONS

This study was undertaken for the purpose of developing a better understanding of the implementation of structured systems development methodologies by analysts in the environment of a large firm. The implementation process was described from the point of view of individual analysts. Four hypotheses regarding the association between selected organizational, attitudinal, ability and opportunity variables and the extent of use of two structured methodologies were tested.

In this chapter the results of the study are summarized and implications for the organization and for future research are presented. In the first section the findings are presented. The second section provides recommendations for action by management of the systems development organization to increase the effectiveness of implementation of the two methodologies. In the third section directions for future research are suggested.

Findings of the Study. The findings of this study are summarized here in three parts: extent of use of the methodologies, perceived benefits of the methodologies and selected organizational, individual and opportunity variables related to the implementation of these methodologies by individual analysts.

Two structured systems methodologies developed by the computer technology group in a large industrial firm were adopted by the information systems organization for use as productivity improvement techniques. These methodologies were designed to improve the effectiveness of analysts at two stages in the applications development sequence. The first methodology, M1, is used at the early stage of development when the analyst is learning about the client's business, defining client needs and recommending a solution to meet those needs. The second methodology, M2, is used at a later stage in the sequence when the analyst is designing, coding and documenting the computer program which will become the application or software product to be delivered to the client. M2 was developed in the mid 1970's and has been in use in the organization for a number of years. M1 was developed in the late 1970's and has been adopted for use only over the past few years. The organization provides formal training of three to five days duration for its analysts in each of the methodologies and encourages, but does not require, use of the methodologies in tasks for which they are appropriate. For the purpose of this study it was assumed that the decision to use a methodology or an alternative approach was made by the analyst.

The extent of use of both M1 and M2 by analysts in the organization varied. Overall approximately half of the respondents reported using M1 at least some of the time when they were working on tasks for which M1 is applicable. Approximately 60 per cent of respondents reported using M2 at least some of the time when they were working on those tasks for which M2 is applicable. This means that about 50 per cent of analysts who work on M1-appropriate tasks never use M1, and about 40 per cent of analysts who work on M2 tasks never use M2.

Analysts and members of the computer technology group were both asked what they perceived as the benefits and disadvantages of these methodologies. There was agreement that M1 provides improved communications, helps understand the client's business and improves the definition of requirements. Analysts also saw the fact that M1 is a structured approach as an advantage. There was agreement, too, on the advantages of M2. It was seen by both groups as providing better documentation, making the application for which it was used more maintainable and providing a structured design.

Both analysts and developers of the methodologies saw as a common disadvantage of M1 and M2 that these techniques are time consuming. Analysts reported further that the methodologies are unfamiliar and that they are not useful for maintenance (i.e. modification or enhancement of previously existing applications or systems, as opposed to creation of entirely new systems). Additional insight into the decision to use alternative approaches was provided when analysts gave their reasons for selecting alternatives. Considerations of short run costs, particularly in terms of additional time needed by analysts relatively inexperienced in using the methodologies and in relation to the size and complexity of the project, appear to dominate the decision.

One factor which was found to relate to use, and which for the purposes of this study was considered an opportunity variable, was the extent of training received. A substantial portion of the sample reported having had no access to training in these methodologies (about 20 per cent in the case of M1 and 40 per cent in the case of M2).

A number of other organizational, individual and opportunity variables were found to be related to use of the methodologies. Organization variables for which a significant association was found include client's attitude, supervisor's desires and organizational values. Individual variables which proved to be associated with use were attitude toward structured methodologies in general, attitude toward M1 and M2 specifically, and certain skill variables. Skill in each methodology was positively related to use of that methodology. Skill in programming languages (PL1 and Fortran) showed significant associations with use, but in opposite directions depending on the language,. Finally the technical background of analysts as measured by years of systems development experience was found to be positively associated with extent of use. Type of education, technical as compared to nontechnical, was associated with access to training, with nontechnically educated analysts more likely to have had high access. However, given at least a minimum level of training or skill in the methodologies, there were no further associations found between technical education and extent of use. Opportunity variables, including type of tasks and complexity of project, were both found to be associated with use.

In most of the relationships reported above, the association with extent of use was with M1 use rather than M2 use. Desires of the supervisor and time spent on maintenance, as well as respondent's own skill level, were the exceptions to this pattern.

Recommendations for More Effective Implementation. Data analyzed in this study, along with the comments of respondents on the implementation process, suggest a number of actions on the part of systems development managers which might increase the extent of use of the structured methodologies and improve the effectiveness of analysts. These actions address the disadvantages currently perceived by analysts as well as the potential for more extensive use of the techniques. Five areas for potential action are identified in this. section: measurement, training, motivation, monitoring and user involvement.

A large number of comments regarding both advantages and disadvantages of the methodologies touch on the related issues of costs of use and benefits. Each analyst and each member of the computer technology group, speaking from his or her own experience, had opinions about cost and benefits. Many were interested in discussing the issue. Although there is general agreement that precise productivity measurement is not possible, it appears that there are advantages to constructing at least approximate measures of inputs and outputs using the methodologies compared with equivalent measures of similar tasks performed without the methodologies. How much "overhead" labor cost is required? How steep is theexperience curve? What is an appropriate size of project to set as a minimum for requiring use of the methodologies? What are the short run costs, how do these compare with the long run gains? An attempt to measure some of these effects, over time, would at least have the advantage of focusing the attention of analysts on the relevant dimensions.

Skill acquisition is a second area in which management action is needed. If the organization favors the use of M1 and M2, it is up to management to train all analysts and to be sure that the skills acquired are kept current. This can be done with a combination of formal courses, local consultants and networks of experienced users or advocates, and printed or on-line documentation, tutorials or updates. Project leaders and others in supervisory positions are most likely in a good position to keep track of the skill level of their team members. They should be encouraged to do so, perhaps by being consulted on the form, content and timing of training activities or by being given responsibility for conducting the training themselves,as was done at one of the locations. It is possible that simply reorienting the training to include more practical applications, and scheduling training so as to be closer in time to each analyst's opportunity for use of the skills on the job will be enough of a change to produce an increase in use of the techniques. Clearly training is not an isolated activity through which the required skills are transmitted on a one-shot basis, but rather an integral part of the productivity improvement process.

Motivation and performance incentives constitute another area in which management actions are possible. Currently analysts perceive that they are judged primarily on the basis of meeting client needs, performing according to time plan and working within budget. While many expressed a commitment to professional standards such as quality, maintainability, structured design and similar features which tend to make an application more effective in the long run, few stated that they were evaluated primarily for their success in these areas. The methodologies are seen as helping improve the quality and other features, but at a definite cost in the short run. Until the organization finds a way to cover the cost, or to provide motivation or incentives which will outweigh the costs in the mind of analysts, the individuals making decisions on use of the methodologies will tend to select the lower cost alternatives. They may make that choice even while admitting that the result may be, in the long run, a less effective product.

Management must also find ways to monitor more closely the use of M1 and M2, if only to insure that the decision not to use one of the methodologies is justified. A simple checkoff as part of completion of each phase of a project is used at one of the locations and it appears to have this effect, according to several respondents. Monitoring need not entail requiring use ofany technique. There are advantages of allowing analysts to make choices according to their needs. But the visibility of the technique, and the message that it is approved for use by the organization, are both increased through use of a monitoring system.

Recommendations for Future Research. The current study has identified a number of issues of interest both to managers concerned with increasing systems development productivity and to researchers concerned with the understanding the process through which change is implemented in an organization. The study was limited by the need to conserve resources and for this reason focused on only a small part of the implementation problem. The current study leaves for later research efforts a number of promising leads.

First, the literature on implementation clearly suggests that factors related to organizational environment are important determinants of change. In regard to differences in organizational factors across the three locations sampled here, this study has only begun to explore the implications for effective implementation. Follow up work can explore such issues as the following: In what ways does organizational policy differ in regard to use of the methodologies, for example in assignment to training, access to consulting help, status of methodologies in written systems development guidelines? In what ways is management in the various locations organized differently (e.g. centralized vs. distributed authority for selecting appropriate methodologies)? To what extent are there differences in mobility between the applications development teams and the various. end-user organizations who are the clients of these teams? Previous studies suggest that organizations which are characterized by top management support of an innovation, which are centralized in their decision-making related to an innovation, and which evidence movement by employees into and out of the group adopting an innovation will tend to implement the innovation more readily than is the case where these factors are not present. To make implementation more effective, the corporation will want to identify specific local level changes in organizational structure or policy which can facilitate change.

Two recently published papers provide some insight into the importance of linking the study of technological change with an assessment of the desired and expected impact of the change on the organization in which it is implemented. Both discuss organizational impact of technological change in terms of risk or uncertainty, and both suggest that management of that change can best be understood as a problem of managing uncertainty. The first is a model which describes choice of an implementation strategy in terms of the risk to the organization of installing a new technology (Gibson et al., 1983). The authors find, in a study of twenty cases of new information system implementation, that traditional implementation and project management techniques work best in situations in which the risk of failure due to organizational impact are low. In other situations, when the organizational risk is higher, different management strategies are more effective. They suggest that the appropriate strategy for implementing a technological change should be selected only after an organizational impact assessment is conducted and the level of risk understood. A similar conclusion emerges from a conceptual study on the management of large software development efforts (Zmud, 1980) which places structured systems development methodologies among a number of methodologies used by management to address productivity issues. The author argues that the productivity problem is largely due to uncertainty at the early stages of systems development, when systems analysts are expected to make decisions which will determine the way the remainder of the work is conducted. These uncertainties are due in large part to the complexity of communications among analysts and between analysts and clients. They are exacerbated, over time, by personnel turnover and changes in system requirements. The resolution of these difficulties depends on new methodologies, but these methodologies are seen as effective only when implemented in the context of organizational changes. In short, organizational factors are part of the problem and necessarily part of the solution.

Another way to build on the current study is to verify and expand on the findings on extent of use, attitudes and perceptions of analysts and perceived values in the organization by extending the study to include clients on the one hand and supervisors on the other in the population to be sampled. The decision to use the methodologies is clearly influenced strongly by both client and supervisor, and an understanding of the views of both of these groups will complement the understanding developed in this paper regarding the views of analysts. There is further value in including these groups in future studies, in that their responses can serve to check and perhaps modify the conclusions drawn from the data gathered here, limited to the admittedly subjective responses of just one set of players in the implementation game.

A particularly promising way to expand the subject population and at the same time improve the design of the study is to change the unit of analysis from the individual analyst to the job or project. It appears that in most cases where a decision is made to use one of the methodologies or an alternative approach, that decision is made in the context of a set of tasks comprising a project and conducted over a period of months for a client, most often by a team of analysts. The variables developed and relationships tested in the current study can easily be apapted to a study of implementation by project teams. The addition of parallel sets of independent variables to analyze the role of the project leader, group leader and client in the decision to implement the methodologies would greatly enrich the findings.

It would be of interest, too, to explore in more depth the unstated and perhaps unconscious resistance of some analysts to trying or using the new methodologies. The current study focussed on the stated rationale for analysts' choices while accepting unquestioned respondents' statements that the methodologies were "not appropriate", or their assertion in some cases that they had never heard of the methodologies or did not know enough about them to respond to certain questions. The study did not probe, in many cases, respondents' claims that they used their own methods to determine just what those methods were, and to what extent an explicit choice had been made rather than just a decision to avoid the new, unfamiliar and perhaps difficult or threatening alternative. In several interviews the study team found that respondents expressed reluctance to use the methodologies because the methodologies had been developed elsewhere in the organization, without sufficient consultation with analysts (the Not Invented Here syndrome). In other cases, respondents claimed they had no skill in the methodologies because they had been prevented by their supervisor from attending training sessions. Data gathered in the current study is not sufficient to allow any sophisticated analysis of these statements, nor would it justify drawing any conclusions regarding resistance due to these factors. It is likely, however, that resistance is present, in some analysts and in some parts of the organization more than others, and it would be helpful in improving analyst productivity to isolate and counteract this resistance. One source of data might be the training sessions in which analysts encounter the metholdologies initially. Structured observation of the training, interviews pre- and post-training with participants, and interviews with experienced trainers could lead to an understanding of types and sources of resistance, impact of resistance on learning and strategies effective in overcoming resistance prior to and during implementation.

It is quite possible that some of the resistance encountered is based in quite reasonable objections to characteristics of the methodologies; the current study stopped short of examining ways analysts felt the methodologies failed to meet their needs. It is particularly important for the technology development group to assess the validity of any such objections, since that group is continuing to modify these methodologies and will continue to have an interest in their effective and widespread use. It is often difficult for a developer actively to listen to, hear and respond to critical comments made by the users of his or her product. Nevertheless, end-user acceptance of the product is the key factor in successful implementation and acceptance is based on end-user perceptions of product characteristics, not the perceptions of the development group. A study in which analyst perceptions of the technical characteristics and capabilities of the product were examined in depth would help provide valuable information for product modification. It would in addition be able to focus, more precisely than the present study, on the characteristics of the methodologies which are perceived as their strong points and which may be expanded on in the future.

One dimension not addressed in this study but worth examining in the future is the history of innovation, adoption and implementation of these methodologies. A longitudinal study which focussed on the decision variables and the decision-making process at each phase in the life cycle of this new product could highlight key individuals and key positions in the organization in regard to effectiveness of implementation. These findings would suggest, in turn, ways in which future change efforts should be organized to take advantage of potential sources of support and to avoid potential sources of resistance. We found evidence in the current study that such variables as contact with methodology advocates and level of supervisor support both made a difference in the extent of use of the methodologies. At what point are in the life cycle are these two factors the most important, and in whaztt ways do they relate to the sequence of decisions made in the organization over time? It might be worthwhile also to compare the level of acceptance of Methodology 1, which is only about two years old, with that of Methodology 2 which has been in use for five years or more. The visibility and reputation of an early product can influence willingness to use a later, related one. This and other possible interactions will be of particular interest in this setting in that the organization has plans for the release of a series of automated tools, one set for each of the methodologies, over the next few years, and the success of these new products will likely be related to the patterns of use of their precursors, the structured methodologies.

Finally, it is recommended that future studies establish a clear framework for assessment of the methodologies within the broader policies of the firm in regard to information systems strategy. Higher level management in the Computer Science department, as well as management in the end-user departments, have explicit or implicit goals for increasing productivity in the organization. The design of future studies should be shaped, in part, by these goals. If the organization is moving toward end-user computing future studies should include clients to a much greater degree in the universe to be sampled, and client concerns should be defined and used to frame the hypotheses. If the organization is concerned with increasing long run productivity in systems development, future studies should attempt to identify existing baseline data and develop ways to compare systems developed with the methodologies to systems developed without the methodologies in regard to well-defined measures. If the organization aims to improve short run productivity, a study might be designed to establish the validity of analysts' statements that use of the methodologies is costly and time-consuming and decreases productivity as currently measured. If management goals include productivity improvement of any sort, it would be worthwhile to examine the incentives and performance evaluation criteria currently in place to see whether they encourage or discourage use of the methodologies, assuming that the methodologies do in fact increase productivity.

As is common with research in organizational change, this study raised as many questions as it answered. The need for more work along the lines suggested here is clear.

BIBLIOGRAPHY

Anderson, C. Michael, "SSA - A Tool for Involving Users in Systems Development", paper presented at the American Association for the Advancement of Science, Annual Meeting, Toronto, 1981.

Anderson, David G., "Mobility and Innovation in Organizations", unpublished dissertation proposal, Stanford University, 1981.

Benjamin, Robert I., "Information Technology in the 1990's", MIS Quarterly, June, 1982.

Bertan, Jennifer, "Learning Styles and Job Satisfaction among Systems Analysts", unpublished master's thesis, Sloan School of Management, MIT, May 1983.

Bigoness, W.J., and Perreault, W.D. Jr., "A Conceptual Paradigm for the Study of Innovations", Academy of Management Journal, vol.24 (1981).

Blau, Peter M., The Dynamics of Bureaucracy, Chicago, University of Chicago Press, 1963.

Brooks, F.P., The Mythical Man-Month, Addison-Wesley, Reading, Massachusetts, 1975.

Campbell, Joh P., "Personnel Training and Development", in Annual Review of Psychology, Paul Mussen and Mark Rosenzweig, eds., vol. 22, (1971).

Campbell, John P., Dunnette, M.D., Lawler, E.E. and Weick, K.E., Managerial Behavior and Effectiveness, McGraw Hill, New York, 1970.

Crawford, A., "Implementation of Electronic Mail", MIS Quarterly, March, 1982.

Cyert, Richard M. and March, J.G., A Behavioral Theory of the Firm, Prentice-Hall, Englewood Cliffs, 1963.

Downs, George W. Jr. and Mohr, L.B., "Conceptual Issues in the Study of Innovation", Administrative Science Quarterly, Dec. 1976.

Gibson, Cyrus, "Making the Information Revolution Organizationally Friendly", Index Systems, Cambridge, Massachusetts, 1983.

Goldstein, David K., "Effects of Structured Development Methodologies on Job Satisfaction of Programmer-Analysts", Working Paper No. 1330-82, Sloan School of Management, 1982.

--------, "The Impact of Development Aids on the Systems Development Process", Conference Proceedings, Human Factors in Computer Systems, Center for Information Systems Research, Sloan School of Management, MIT, 1982.

Gremillion, Lee L. and Pyburn, P. "Breaking the Systems Development Bottleneck", Harvard Business Review, vol. 61 no. 2 (1983).

Hage, Jerald and Aiken, M., Social Change in Complex Organizations, Random House, New York, 1970.

-------- and Dewar, R., "Elite Values Versus Organizational Structure in Predicting Innovation", Administrative Science Quarterly, 1973.

Hammer, Michael, "Strategic Issues in Office Automation: The Innovative Process", Proceedings, Symposium for Senior Executives, Sloan School of Management, MIT, Nov. 1981.

Holton, John, "Are the New Programming Techniques Being Used?", Datamation, July, 1977.

Johnson, James R. "A Working Measure of Productivity", Datamation, vol. 23, 1977.

Keene, Peter, "Editor's Preface", Office: Technology and People, vol. 1, 1982.

Kerr, Stephen, "On the Folly of Rewarding A while Hoping for B", The Academy of Management Journal, Dec. 1975.

Khalil, M.A., "A Strategic Planning Framework for Office Automation", unpublished master's thesis, Sloan School of Management, MIT, 1980.

Knight, Kenneth E., "A Descriptive Model of the Intra-Firm Innovation Process", Journal of Business, vol. 40 (1967).

Kraft, Philip, Programmers and Managers, Springer-Verlag, New York, 1977.

Leonard-Barton, Dorothy, "Professionals as Information Priests in the Diffusion of Innoavations", paper presented at the workshop, Consumerism and Beyond, sponsored by the Harvard Marketing Science Institute, April, 1982.

-------, "Introducing Production Innovation into an Organization: Structured Methods for Producing Computer Software", paper presented at the ORSA/TIMS Conference, Chicago, April, 1983.

Locke, E.A., "The Motivational Effect of Knowledge of Results", Journal of Applied Psychology, vol. 51.

-, Bryan, J.F. and Kendall,, L.M., "Goals and Intention as Mediators of Monetary Incentives on Behavior", Journal of Applied Psychology, vol. 52.

March, James G., "Footnotes to Organizational Change", Administrative Science Quarterly, 1981.

------- and Simon, H., Organizations, John Wiley & Sons, New York, 1958.

Markus, Lynne M., "Power, Politics and MIS Implementation", Industrial Liaison Symposium, MIT, March 1981.

Martin, James, Applications Development without Programmers, Prentice-Hall, Englewood Cliffs, 1982.

McErlean, Donald, Training and Communications and the use of Structured Systems Methodologies, unpublished master's thesis, Sloan School of Management, MIT, 1983.

McGowan, Clement L. and Kelly, J.R., Top-Down Structured Programming, Mason/Charter Publishers, Inc., 1975, reprinted by Datapro Research Corporation, Delran, NJ 1976.

McLaughlin, R.A., "That Old Bugaboo, Turnover", Datamation, Oct., 1977.

Mendes, Kathleen S., "Structured Systems Analysis", Sloan Management Review, MIT, vol. 21 no. 4, Summer, 1980.

Menard, Jayne B., "Exxon's Experience with the Michael Jackson Method", Data Base, vol. 11, no. 3, Winter, 1980.

Moch, M.K., "Structure and Organiz tional Resource Allocation", Administrative Science Quarterly, vol. 21, 1976.

------- and Morse, E.V., "Size, Centralization and Organizational Adoption of Innoavations", American Sociological Review, vol. 42, 1977.

Mohr, L., "Determinants of Innoavation in Organizations", American Political Science Review, vol. 63, 1969.

Nolan, Richard L., "Controling the Cost of Data Services", Harvard Business Review, July, 1977.

-------, "Managing the Crisis in Data Processing", Harvard Business Review, March, 1979.

Parikh, Girish, How to Measure Programmer Productivity, Shetal Enterprises, Chicago, 1981.

Pelz, Donald C. and Andrews, Frank M., Scientists in Organizations: Productive Climates for Research and Development, John Wiley & Sons, 1966.

Pierce, J.L. and Delbecq, A.L., "Organizational Structure, Individual Attitudes and Innovation", Academic Management Review, vol. 2, 1977.

Porter, L.W. and Lawler, E.E., Managerial Attitudes and Performance, Dorsey, Homewood, IL, 1968.

Rogers, Everrett, Diffusion of Innovation, Free Press, Glenco, NY, 1962.

Rowe, Lloyd A., and Boise, W.B., "Organizational Innovation: Current Research and Evolving Concepts", Public Administration Review, vol. 34, 1974.

Strassman, Paul A., "Managing the Costs of Information", Harvard Business Review, Sept., 1976.

-------, "Strategic Aspects of Information Management", Office: Technology and People, vol. 1, 1982.

Synnott, William R. and Gruber, W.H., Information Resource Management, John Wiley & Sons, New York, 1981.

Thurow, Lester T., conversation with the author, November, 1982.

Yourdan, Edward, Managing the Structured Techniques, Yourdon, Inc., New York, 1976.

Zaltman, Gerald, Duncan, R. and Holbek, J., Innovations in Organizations, John Wiley & Sons, New York, 1973.

Zmud, Robert W., #"Management of Large Software Development Efforts", MIS Quarterly, June, 1980.

-------, "Diffusion of Modern Software Practices", Management Sciences, vol. 28, no. 12, 1982.

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M.I.T. STUDY OF ANALYST ATTITUDES TOWARDS, AND USE OF NEW SYSTEMS DEVELOPMENT TECHNOLOGIES

January 24, 1983

Version 3.0

APPENDIX

FOR CODING ONLY

Work Description

PLEASE ANSWER THE FOLLOWING QUESTIONS IN THE WAY WHICH BEST DESCRIBES YOUR JOB RESPONSIBILITIES OVER THE PAST 12 MONTHS, FROM JANUARY 1982 TO THE PRESENT

__4__ 1. What is your current job title? ____________________

__5__ __6__ 2. How long have you held this job? _____ years _____ months

3. What projects have you worked on in this position over the past 12 months? INDICATE CLIENT ORGANIZATION AND PROJECT DURATION AND DESCRIBE PROJECT BRIEFLY.

a. Client: ____________ Duration: _____ months

Your role in that project (CHECK ONE)
- ___ Group Leader
- ___ Project Leader
- ___ Project Member
- ___ Other

__7__ __8__ __9__ __10__ Brief Description:

b. Client: ____________ Duration: _____ months

Your role in that project (CHECK ONE)
- ___ Group Leader
- ___ Project Leader
- ___ Project Member
- ___ Other

__11__ __12__ __13__ __14__ Brief Description:

c. Client: ____________ Duration: _____ months

Your role in that project (CHECK ONE)
- ___ Group Leader
- ___ Project Leader
- ___ Project Member
- ___ Other

__15__ __16__ __17__ __18__ Brief Description:

FOR ADDITIONAL PROJECTS PLEASE USE LAST PAGE OF QUESTIONNAIRE.

[IMPORTANT NOTE FOR SUPERVISORS AND PROJECT LEADERS: FOR QUESTIONS 4-20 ANSWER IN TERMS OF THE PROJECT TEAMS' ACTIVITIES, NOT YOUR PERSONAL ACTIVITIES.]

4. What proportion of the time over the past 12 months have you worked in each of the following functional areas?

__19__ __20__	engineering	___ %
__21__ __22__	finance	___ %
__23__ __24__	logistics	___ %
__25__ __26__ __27__	other: __________	___ %
	TOTAL	100 %

FOR CODING ONLY

5. **What proportion of the time have you worked with each systems type?**

For coding only		
28 29	operational/transactions systems	___ %
30 31	stewardship systems (e.g. reporting)	___ %
32 33	planning/analysis systems (e.g. decision support)	___ %
34 35 36	other: ____________	___ %
	TOTAL	100%

6. **What proportion of the time have you worked at each project level?**

For coding only		
37 38	scoping/exploration	___ %
39 40	systems development/acquisition	___ %
41 42	major enhancement of existing system	___ %
43 44	application/user support, including maintenance	___ %
45 46 47	other: ____________	___ %
	TOTAL	100 %

7. **What proportion of the time have you worked on each of the following tasks?** RESPONSES NEED NOT TOTAL 100% IF YOU HAVE WORKED ON TASKS NOT LISTED HERE. FOR ANY TASKS YOU HAVE NOT WORKED ON, ENTER 0%.

For coding only		
48 49	understand business operation	___ %
50 51	define client needs	___ %
52 53	recommend solution based on alternatives	___ %
54 55	document solution specifications	___ %
56 57	produce logical data base design	___ %
58 59	analyze role of information (data dependencies) in business and solution	___ %
60 61	design program to meet system specifications	___ %
62 63	code program with or without aids	___ %
64 65	document program with or without aids	___ %
66 67	provide user support	___ %

FOR CODING ONLY

8. Which three of these tasks do you find most important in their impact on the quality of your work?
PLEASE RANK ORDER, USING 1 FOR MOST IMPORTANT, 2 FOR SECOND MOST IMPORTANT, 3 FOR THIRD MOST IMPORTANT.

FOR CODING ONLY	TASK	RANK
68	understand business operation	___
69	define client needs	___
70	recommend solution based on alternatives	___
71	document solution specifications	___
72	produce logical data base design	___
73	analyze role of information (data dependencies) in business and solution	___
74	design program to meet system specifications	___
75	code program with or without aids	___
76	document program with or without aids	___
77	provide user support	___

9, 10. Which three of these tasks do you find most difficult? Most satisfying?
PLEASE RANK ORDER, USING 1 FOR MOST DIFFICULT/SATISFYING, 2 FOR SECOND MOST DIFFICULT/SATISFYING, 3 FOR THIRD MOST DIFFICULT/SATISFYING.

1 2 3

FOR CODING ONLY	TASK	RANK: MOST DIFFICULT	RANK: MOST SATISFYING
4 5	understand business operation	___	___
6 7	define client needs	___	___
8 9	recommend solution based on alternatives	___	___
10 11	document solution specifications	___	___
12 13	produce logical data base design	___	___
14 15	analyze role of information (data dependencies) in business and solution	___	___
16 17	design program to meet system specifications	___	___
18 19	code program with or without aids	___	___
20 21	document program with our without aids	___	___
22 23	provide user support	___	___

FOR CODING ONLY

Methodologies and Alternatives (Questions 11-19)

: ... structured methodologies (. . ...) have been developed for use in various tasks for which you may have been responsible over the past 12 months. The questions in this section refer to your choice of either the methodology or an alternative approach for each task you have spent time on.

PLEASE RESPOND TO THESE QUESTIONS ONLY FOR THE TASKS YOU HAVE WORKED ON DURING THE PAST 12 MONTHS (SUPERVISORS: ANSWER FOR YOUR PROJECT TEAM).

11. To what extent have you used . to carry out each task listed below? SEE KEY FOR EXTENT OF USE. CIRCLE APPROPRIATE NUMBER IN EXTENT OF USE COLUMN. CIRCLE N/A FOR ANY TASKS YOU HAVE NOT WORKED ON.

12. When you have not used ., what has been your principal alternative approach? SEE KEY FOR ALTERNATIVE APPROACH. CIRCLE APPROPRIATE NUMBER IN ALTERNATIVE APPROACH COLUMN OR WRITE IN YOUR OWN RESPONSE IN BLANKS PROVIDED.

KEY:
EXTENT OF USE

1 always
2 frequently
3 sometimes
4 infrequently
5 never
N/A not applicable

KEY:
ALTERNATIVE APPROACH

1 my own method
2 flowcharting
3 peer discussions
4 client discussions
5 prototyping
6 other structured methodologies
7 other: ______________________
8 other: ______________________
NA not applicable

For coding only	TASK AND METHODOLOGY	EXTENT OF USE	ALTERNATIVE APPROACH
24 25 26 27 28	a) Understand the business operation (..)	1 2 3 4 5 N/A	1 2 3 4 5 6 7 8 N/A
29 30 31 32 33	b) Define client needs (.)	1 2 3 4 5 N/A	1 2 3 4 5 6 7 8 N/A
34 35 36 37 38	c) Evaluate alternatives and recommend solution ( )	1 2 3 4 5 N/A	1 2 3 4 5 6 7 8 N/A

13. When you used an alternative approach rather than .., what were your reasons: PLEASE EXPLAIN BRIEFLY IN THE SPACE BELOW.

a) ______________________

____

b) ______________________

____

c) ______________________

____

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FOR CODING ONLY

14. To what extent have you used . .. to carry out each task listed below? SEE KEY FOR EXTENT OF USE. CIRCLE APPROPRIATE NUMBER IN EXTENT OF USE COLUMN. CIRCLE N/A FOR ANY TASKS YOU HAVE NOT WORKED ON (SUPERVISORS: ANSWER FOR YOUR PROJECT TEAM).

15. When you have not used .., what has been your principal alternative approach? SEE KEY FOR ALTERNATIVE APPROACH. CIRCLE APPROPRIATE NUMBER IN ALTERNATIVE APPROACH COLUMN OR WRITE IN YOUR OWN RESPONSE IN BLANKS PROVIDED.

KEY:
EXTENT OF USE

1 always
2 frequently
3 sometimes
4 infrequently
5 never
N/A not applicable (Haven't done this task)

KEY:
ALTERNATIVE APPROACH

1 my own method
2 flowcharting
3 peer discussions
4 client discussions
5 prototyping
6 other structured methodologies
7 other: ____________________
8 other: ____________________
NA not applicable

	TASK AND METHODOLOGY	EXTENT OF USE	ALTERNATIVE APPROACH
39 40 41 42 43	a) Analyze role of information in business and in solution (..)	1 2 3 4 5 N/A	1 2 3 4 5 6 7 8 N/A
44 45 46 47 48	b) Produce logical data base design (..)	1 2 3 4 5 N/A	1 2 3 4 5 6 7 8 N/A

16. When you used an alternative approach rather than .. , what were your reasons: PLEASE EXPLAIN BRIEFLY IN THE SPACE BELOW.

a) ____________________

____

____

b) ____________________

____

____

____

____

FOR CODING
ONLY

17. To what extent have you used   to carry out each task listed below? SEE KEY FOR EXTENT OF USE. CIRCLE APPROPRIATE NUMBER IN EXTENT OF USE COLUMN. CIRCLE N/A FOR ANY TASKS YOU HAVE NOT WORKED ON.

18. When you have not used ..., what has been your principal alternative approach? SEE KEY FOR ALTERNATIVE APPROACH. CIRCLE APPROPRIATE NUMBER IN ALTERNATIVE APPROACH COLUMN OR WRITE IN YOUR OWN RESPONSE IN THE BLANKS PROVIDED.

KEY:
EXTENT OF USE

1 always
2 frequently
3 sometimes
4 infrequently
5 never
N/A not applicable

KEY:
ALTERNATIVE APPROACH

1 my own method
2 flowcharting
3 peer discussions
4 client discussions
5 prototyping
6 other structured methodologies
7 other: ____________
8 other: ____________
NA not applicable

FOR CODING ONLY	TASK AND METHODOLOGY	EXTENT OF USE	ALTERNATIVE APPROACH
_49 _50 _51 _52 _53	a) Design program to meet system specifications (_)	1 2 3 4 5 N/A	1 2 3 4 5 6 7 8 N/A
_54 _55 _56 _57 _58	b) Code program (_) (with or without AIDS)	1 2 3 4 5 N/A	1 2 3 4 5 6 7 8 N/A
_59 _60 _61 _62 _63 _64 _65	c) Document program (_) (with or without AIDS)	1 2 3 4 5 N/A	1 2 3 4 5 6 7 8 N/A

19. When you used an alternative approach rather than _, what were your reasons: PLEASE EXPLAIN BRIEFLY IN THE SPACE BELOW.

a) ____

b) ____

c) ____

20. What approach do you use in carrying out support tasks?

____

____

____

FOR CODING ONLY

We are now interested in how you personally perceive your work, your organizational environment and yourself.

21. "Good Job" questions

a. We are interested in finding out what factors are important to you personally in evaluating your own work. Please select from the following list the three factors which are the most important to you in judging your own work as an analyst, and rank order these three. (1 = most important.) Your own work as an analyst,

66	______	completed on time
67	______	clearly documented
68	______	completed within the budget
69	______	easily enhanced
70	______	easily run by the user
71	______	easily maintained
72	______	designed to the user's specifications
73	______	meeting standards and guidelines for methodology requirements
74	______	accuracy of solution
75	______	good communication with user
4 5	______	other: ______________________________

b. Now please rank three factors in the order of importance which you think your supervisor would assign them in judging the results of your work:

6	______	completed on time
7	______	clearly documented
8	______	completed within the budget
9	______	easily enhanced
10	______	easily maintained
11	______	easily run by the user
12	______	designed to the user's specifications
13	______	meeting standards and guidelines for methodology requirements
14	______	accuracy of solution
15	______	good communication with user
16 17	______	other: ______________________________

FOR CODING ONLY

c. Now please rank three factors in the order in which you think <u>your clients</u> would rank them in judging the results of your work:

18 ______ completed on time
19 ______ clearly documented
20 ______ completed within the budget
21 ______ easily enhanced
22 ______ easily maintained
23 ______ easily run by the user
24 ______ designed to the user's specifications
25 ______ meeting standards and guidelines for methodology requirements
26 ______ accuracy of solution
27 ______ good communication with user
28 29 ______ other: ________________________________

d. In your opinion, which three of the following factors are the most important to <u>upper level management</u> in meeting managerial goals for your organization:

30 ______ completed on time
31 ______ clearly documented
32 ______ completed within the budget
33 ______ easily enhanced
34 ______ easily maintained
35 ______ easily run by the user
36 ______ designed to the user's specifications
37 ______ meeting standards and guidelines for methodology requirements
38 ______ accuracy of solution
39 ______ good communication with user
40 41 ______ other: ________________________________

FOR CODING ONLY

22. Whether you have ever used ., and . or not, we would like to know what you think are the advantages and disadvantages of the current versions of these systems development technologies. We have listed below some possible responses. If you feel that these responses do not adequately express your thoughts, please write your own in the space provided on page 10.

a. For each of the technologies, please rank order the three most important advantages and the three most important disadvantages by writing the corresponding number in the allotted space on page 10.

b. Also please indicate your overall rating of each technology in the space provided on page 10 using the following scale.

1	2	3	4	5
excellent				very poor

ADVANTAGES

1. Structured approach
2. Easier operation by user
3. Faster
4. Improves requirement definition
5. Provides structured design
6. Produces better documentation
7. Application more maintainable
8. Easier to create and alter information diagrams
9. Provides improved communications
10. Helps me understand clients' business
11. Good for less experienced analysts
12. Meets standards and guidelines for methodology requirements
13. Other (WRITE RESPONSE IN SPACES ON PAGE 10)

DISADVANTAGES

1. Time consuming to use
2. Restrictive (inhibits creativity)
3. Unfamiliar/requires learning time and effort
4. Not oriented to my application
5. Not useful for maintainence
6. Difficult to use
7. Too expensive for client (time or budget)
8. Incompatible with programming language I used
9. Poor hard copy quality (for aids)
10. Hardware equipment (for aids) inaccessible
11. Other ______________________

FOR CODING ONLY

ENTER NUMBER FROM KEYS ON PAGE 9 OR WRITE IN YOUR OWN RESPONSE.

FOR CODING ONLY	TECHNOLOGY	ADVANTAGES	DISADVANTAGES
___42 ___43 ___44 ___45		________________	________________
___46 ___47 ___48 ___49		________________	________________
___50 ___51 ___52 ___53		________________	________________
___54		OVERALL RATING (PLEASE CIRCLE) 1 2 3 4 5	
___55 ___56 ___57 ___58		________________	________________
___59 ___60 ___61 ___62		________________	________________
___63 ___64 ___65 ___66		________________	________________
___67		OVERALL RATING (PLEASE CIRCLE) 1 2 3 4 5	
___68 ___69 ___70 ___71		________________	________________
___72 ___73 ___74 ___75		________________	________________
___4 ___5 ___6 ___7		________________	________________
___8		OVERALL RATING (PLEASE CIRCLE) 1 2 3 4 5	
___9 ___10 ___11 ___12		________________	________________
___13 ___14 ___15 ___16		________________	________________
___17 ___18 ___19 ___20		________________	________________
___21		OVERALL RATING (PLEASE CIRCLE) 1 2 3 4 5	
___22 ___23 ___24 ___25		________________	________________
___26 ___27 ___28 ___29		________________	________________
___30 ___31 ___32 ___33		________________	________________
___34		OVERALL RATING (PLEASE CIRCLE) 1 2 3 4 5	

FOR CODING ONLY

Now we would like to know how skilled you feel you personally are in the use of certain systems development methods, techniques, and languages and the extent in which these skills have been augmented by TRAINING AND COMMUNICATION.

23. How skilled are you in the use of each of the following:
(FILL IN THE BLANK TO THE LEFT OF THE ITEM WITH A NUMBER FROM 1 to 5)

1	2	3	4	5
Extremely Skilled	Very Skilled	Moderately Skilled	Slightly Skilled	Not at all skilled

IMPLEMENTATION TOOLS AND LANGUAGES

35 _______ 1. FORTRAN

40 _______ 2. NOMAD, FOCUS, RAMIS OR OTHER FOURTH-GENERATION LANGUAGES

41 _______ 3. COBOL

42 _______ 4. PL-1

ANALYSIS AND DESIGN TECHNIQUES

43 _______ 5.

44 _______ 6.

45 _______ 7.

46 _______ 8.

47 _______ 9.

OTHER (FOR EXAMPLE: APPLICATION GENERATORS, MINI-COMPUTERS)

48 _______ 10. Other, please specify _______________

49 _______ 11. Other, please specify _______________

FOR CODING ONLY

24. Please indicate next to the tool or technique listed below, the number corresponding to the source of instruction which was most helpful, second most helpful, and third most helpful.

SOURCES OF INSTRUCTION

1. Consulting with designated local experts on the new tool or technique.
2. Consulting with other experienced user (informal expert)
3. Consulting with the Computer Technology Division
4. Formal Training Sessions
5. Instruction Manual/Documentation
6. Self (i.e., Trial and Error)
7. Consulting with S&C Applications Software Coordinator
8. Other (specify) ________________________

FOR CODING ONLY	(ENTER NUMBER 1-8) Most Helpful	(ENTER NUMBER 1-8) Second Most Helpful	(ENTER NUMBER 1-8) Third Most Helpful
50 51 52	____	____	____
53 54 55	____	____	____
56 57 58	____	____	____
59 60 61	____	____	____
62 63 64	____	____	____

FOR CODING ONLY

29. Do you know anyone who is a real advocate for (really "sells") ?

22 ______ NO   ______ YES

If yes: How well do you know that person? (CIRCLE NUMBER)

1   2   3   4   5

23 very well   not well at all

30. Do you know anyone who is a real advocate for (really "sells") ?

24 ______ NO   ______ YES

If yes: How well do you know that person? (CIRCLE NUMBER)

1   2   3   4   5

25 very well   not well at all

31. How many times in the past 12 months have you had the following types of contact with the Computer Technology Division ? (CIRCLE THE CATEGORY IN COLUMN "A" WHICH BEST REPRESENTS THE NUMBER OF TIMES).

32. For each type of contact you had, please indicate how productive in general you felt that communication was. (CIRCLE A NUMBER IN COLUMN "B": 1 = very productive; 2 = somewhat productive; 3 = no comment; 4 = somewhat unproductive; 5 = very unproductive.)

For coding only		(A) CIRCLE A CATEGORY	(B) CIRCLE A NUMBER
26 27	a. Walk-through of new technology	0/1-2/3-4/5 or more times	1 2 3 4 5
28 29	b. You requested help in using a new technology	0/1-2/3-4/5 or more times	1 2 3 4 5
30 31	c. You made a suggestion about modifying the training	0/1-2/3-4/5 or more times	1 2 3 4 5
32 33	d. You made a suggestion about modifying a technology	0/1-2/3-4/5 or more times	1 2 3 4 5
34 35	e. CTD asked you if you were using one of the new technologies	0/1-2/3-4/5 or more times	1 2 3 4 5
36 37	f. Informal conversation with someone in CTD	0/1-2/3-4/5 or more times	1 2 3 4 5
38 39	g. You attended a CTD program review	0/1-2/3-4/5 or more times	1 2 3 4 5
40 41	h. Received information from CTD on methodology updates	0/1-2/3-4/5 or more times	1 2 3 4 5
42 43	i. other (please describe)	0/1-2/3-4/5 or more times	1 2 3 4 5
44	____________________________		
	____________________________		

FOR CODING ONLY

How many times in the past 12 months have you had the following types of contact with the Systems and Computer Senior Staff? (CIRCLE THE CATEGORY IN COLUMN "A" WHICH BEST REPRESENTS THE NUMBER OF TIMES).

For each type of contact you had, please indicate how productive in general you felt that communication was. (CIRCLE A NUMBER IN COLUMN "B": 1 = very productive; 2 = somewhat productive; 3 = no comment; 4 = somewhat unproductive; 5 = very unproductive.)

For coding only		Type of contact	(A) CIRCLE A CATEGORY	(B) CIRCLE A NUMBER
45	46	a. Walk-through of new technology	0/1-2/3-4/5 or more times	1 2 3 4 5
47	48	b. You requested help in using a new technology	0/1-2/3-4/5 or more times	1 2 3 4 5
49	50	c. You made a suggestion about modifying the training	0/1-2/3-4/5 or more times	1 2 3 4 5
51	52	d. You made a suggestion about modifying a technology	0/1-2/3-4/5 or more times	1 2 3 4 5
53	54	e. CTD asked you if you were using one of the new technologies	0/1-2/3-4/5 or more times	1 2 3 4 5
55	56	f. Informal conversation with someone in CTD	0/1-2/3-4/5 or more times	1 2 3 4 5
57	58	g. You attended a CTD program review	0/1-2/3-4/5 or more times	1 2 3 4 5
59	60	h. Received information from CTD on methodology updates	0/1-2/3-4/5 or more times	1 2 3 4 5
61	62	i. other (please describe)	0/1-2/3-4/5 or more times	1 2 3 4 5
63		________________________________		
		________________________________		

FOR CODING ONLY

33. Please indicate the person to whom you would go FIRST for day to day consultation about the following application technologies and indicate how accessible that person is (in terms of their willingness/time to help and geographic proximity).

1 = not Accessible; 2 = fairly Accessible; 3 = reasonably Accessible; 4 = Accessible; and 5 = extremely Accessible

Coding		Computer Technology Div.	Locally Designated Contact	Section Head	Supervisor	Project Leader	Peer	Accessibility (1 - 5)
64 65	a. SSA	___	___	___	___	___	___	___
66 67	b. LDA	___	___	___	___	___	___	___
68 69	c. PST	___	___	___	___	___	___	___

34. We would like to know what you have heard about the first version of , the one on the Tektronix hardware.

70 a. Did you use that version of ? ________no ________yes

IF YES:
Was that experience:
(CHECK ONE) ________mostly positive ________mostly negative

71 About how many people whom you know tried that version?

72 73 b. (NOTE NUMBER ONLY) ________people

74 c. Have the comments you heard been (CHECK ONE) ________mostly positive ________mostly negative

35. How would you rate each technology on the elements listed below (compared to other technologies you are familiar with), using a scale of 1 to 5, where 1 = excellent and 5 = very poor?

1 ——— 2 ——— 3 ——— 4 ——— 5

excellent ... very poor

NOTE: IT IS NOT NECESSARY TO HAVE USED THE TECHNOLOGY TO ASSIGN IT A RATING

Coding						
75 4 5 / 6 7	Documentation					
8 9 10 / 11 12	Access to Consulting Help					

FOR CODING ONLY

VALUES IN ORGANIZATIONS

36. Each of the words or phrases listed in the far left column describes a quality or characteristic of work. From the row of phrases and associated numbers (1 to 7), select one (BY CIRCLING THE NUMBER) which best describes the attitude of YOUR WORK GROUP towards that quality or characteristic. How is it valued or emphasized?

			Very Highly Valued/Emphasized	Highly Valued	Valued	Somewhat Valued	Not Much Valued	Not at all Valued	Disliked/ De-emphasized
13	a.	Creativity	1	2	3	4	5	6	7
14	b.	Standardization	1	2	3	4	5	6	7
15	c.	Craft (Art; Individual style)	1	2	3	4	5	6	7
16	d.	Engineering (Structured Process)	1	2	3	4	5	6	7
17	e.	Long Range Work Goals	1	2	3	4	5	6	7
18	f.	Immediate Client Needs	1	2	3	4	5	6	7
19	g.	Getting the work out quickly	1	2	3	4	5	6	7
20	h.	High quality in design	1	2	3	4	5	6	7
21	i.	Easily maintained, well documented code	1	2	3	4	5	6	7

FOR CODING ONLY

37. Each of the words or phases listed in the far left column describes a quality or characteristic of work. From the row of phrases and associated numbers (1 to 7), select one (BY CIRCLING THE NUMBER) which best describes the attitude of the Systems and Computing Management toward that quality or characteristic, as nearly as you can judge from what you know about that organization. How do they value or emphasize that quality?

Coding			Very Highly Valued/Emphasized	Highly Valued	Valued	Somewhat Valued	Not Much Valued	Not at all Valued	Disliked/ De-emphasized
22	a.	Creativity	1	2	3	4	5	6	7
23	b.	Standardization	1	2	3	4	5	6	7
24	c.	Craft (Art; Individual style)	1	2	3	4	5	6	7
25	d.	Engineering (Structured Process)	1	2	3	4	5	6	7
26	e.	Long Range Work Goals	1	2	3	4	5	6	7
27	f.	Immediate Client Needs	1	2	3	4	5	6	7
28	g.	Getting the work out quickly	1	2	3	4	5	6	7
29	h.	High quality in design	1	2	3	4	5	6	7
30	i.	Easily maintained, well documented code	1	2	3	4	5	6	7

FOR CODING ONLY

AGREE/DISAGREE STATEMENTS

38. Please indicate you agreement or disagreement with the following statements by selecting a number from 1 to 5, where 1 means strongly agree, 2 = agree, 3 = neutral, 4 = disagree 5 = strongly disagree. WRITE SELECTED NUMBER IN BLANK.

31 ____ 1. No one gets rewarded for effective design and programming around here.

32 ____ 2. Structured application development (as a concept) is a good idea.

33 ____ 3. My client users cannot determine whether a piece of code is efficient or not.

34 ____ 4. Organizational guidelines do not influence my decision to use

35 ____ 5. Computer Technology Division is actively designing methodologies and tools that will make my job easier.

36 ____ 6. People in Application Development Groups should have major involvement in methodology and tool development.

37 ____ 7. The application development technologies developed by Computer Technology Division are scalable to the extent warranted by the nature of the application.

38 ____ 8. In the next 5-7 years, will be obsolete.

39 ____ 9. Most of my dissatisfactions with my job are due to the nature of the work.

40 ____ 10. People in Application Development Groups know best what tools their job requires.

41 ____ 11. Structured application development techniques (in general) increase maintainability of code.

42 ____ 12. It is not important for my client users to understand how a program works as long as it does the job.

43 ____ 13. My supervisor (over the past year) would have liked me to use .

44 ____ 14. The guidelines for application development are generally followed by programmer-analysts whom I know.

45 ____ 15. I am rewarded according to the quality (versus quantity) of product I put out.

46 ____ 16. My client users want maintainability more than efficiency in code.

47 ____ 17. Computer Technology Division understands what it takes to do my job.

48 ____ 18. The main reason I haven't used the new systems development technologies more is that I don't have time to.

49 ____ 19. System development methodologies inhibit my creativity.

50 ____ 20. No one in the organization besides the Computer Technology Division really cares whether or not I use the new system development technologies.

51 ____ 21. We need to move towards application development as a highly structured, engineering process.

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52 ____ 22. If and when I use the new system development technologies developed by Computer Technology Division my client users appreciate my work more.

53 ____ 23. increases productivity.

54 ____ 24. I do not need to use structured application development techniques.

55 ____ 25. I won't be developing applications long enough to make it worthwhile to learn new methodologies and techniques.

56 ____ 26. My client users don't really want to know how a program works.

57 ____ 27. Application development is an art.

58 ____ 28. My supervisor (over the past year) would have liked me to use .

LEARNING STYLE INVENTORY

39. This inventory is designed to assess your method of learning. As you take the inventory, give a high rank to those words which best characterize the way you learn and a low rank to the words which are least characteristic of your learning style.

You may find it hard to choose the words that best describe your learning style because there are no right or wrong answers. Different characteristics described in the inventory are equally good. The aim of the inventory is to describe how you learn, not to evaluate your learning ability.

Instructions

There are nine rows of four words listed below. Within each row, rank order each of the four words assigning a 1 to the word which best characterizes your learning style, a 2 to the word which next best characterizes your learning style, a 3 to the next most characteristic word, and a 4 to the word which is least characteristic of you as a learner. Be sure to assign a different rank number to each of the four words in each row. Please do not make ties.

59	60	61	62	1.____ discriminating	____ tentative	____ involved	____ practical
63	64	65	66	2.____ receptive	____ relevant	____ analytical	____ impartial
67	68	69	70	3.____ feeling	____ watching	____ thinking	____ doing
71	72	73	74	4.____ accepting	____ risk-taker	____ evaluative	____ aware
75	4	5	6	5.____ intuitive	____ productive	____ logical	____ questioning
7	8	9	10	6.____ abstract	____ observing	____ concrete	____ active
11	12	13	14	7.____ present-oriented	____ reflecting	____ future-oriented	____ pragmatic
15	16	17	18	8.____ experience	____ observation	____ conceptu-alization	____ experimentation
19	20	21	22	9.____ intense	____ reserved	____ rational	____ responsible

FOR CODING ONLY

40. Now please indicate how you personally feel about the job you have held the last 12 months.

Each of the statements below is something that a person might say about his or her job. You are to indicate your own personal feelings about your job by marking how much you agree with each of the statements, based on the following scale:

SA Strongly Agree
A Agree
N Neutral
D Disagree
SD Strongly Disagree

FOR EACH STATEMENT BELOW, PLEASE CIRCLE THE APPROPRIATE RESPONSE

23	a.	It's hard, on this job, for me to care about whether or not the work gets done right.	SA	A	N	D	SD
24	b.	My opinion of myself goes up when I do this job well.	SA	A	N	D	SD
25	c.	Generally speaking, I am very satisfied with this job.	SA	A	N	D	SD
26	d.	Most of the things I have to do on this job seem useless or trivial.	SA	A	N	D	SD
27	e.	I usually know whether or not my work is satisfactory on this job.	SA	A	N	D	SD
28	f.	I feel a great sense of personal satisfaction on this job.	SA	A	N	D	SD
29	g.	The work I do on this job is very meaningful to me.	SA	A	N	D	SD
30	h.	I feel a very high degree of personal responsibility for the work I do on this job.	SA	A	N	D	SD
31	i.	I frequently think of quitting this job.	SA	A	N	D	SD
32	j.	I feel unhappy when I discover that I have performed poorly on this job.	SA	A	N	D	SD
33	k.	I often have trouble figuring out whether I'm doing well or poorly on this job.	SA	A	N	D	SD
34	l.	I feel that I should personally take the credit or blame for the results of my work on this job.	SA	A	N	D	SD
35	m.	I am generally satisfied with the kind of work I do on this job.	SA	A	N	D	SD
36	n.	My own feelings generally are not affected much one way or the other by how well I do on this job.	SA	A	N	D	SD
37	o.	Whether this job gets done right is clearly my responsibility.	SA	A	N	D	SD

FOR CODING ONLY

PLEASE CHECK APPROPRIATE RESPONSE

38 41. Sex: 1 Male _____ 2 Female _____

39 Age: 1 Under 20 ___
2 20 - 29 ___
3 30 - 39 ___
4 40 - 49 ___
5 50 - 59 ___
6 60 or over ___

40 Education: PLEASE CHECK THE HIGHEST LEVEL YOU HAVE ATTAINED

1. High school degree ___
2. College degree, computer concentration ___
3. College degree, other concentration ___
4. Masters degree, computer concentration ___
5. Masters degree, other concentration ___
6. Higher degree ___

41 42 43 44 How long have you worked at this company? ___years ___months

45 46 47 48 How long have you worked in the field of systems development? ___years ___months

49 50 How long have you worked in systems development activities at ? ___years

51 52 53 54 How long have you worked in your current work group? ___years ___months

55 56 How many members are there in your work group? ___members

57 42. a. In general do you see yourself pursuing a managerial or technical career path?

38 ___Managerial ___Technical

b. In the future, what type of work do you see yourself doing? Write the appropriate number in the blank beside each question, or write in your own response.

1. Systems development/management
2. Managing a technical group
3. General management
4. Other (Please specify): ______________________________

TYPE OF WORK (enter number)

59 1 year from now? __________

60 3 years from now? __________

61 5 years from now? __________