University of Baltimore
1420 North Charles Street
Baltimore, Maryland 21201-5779

September 1, 1989

TO WHOM IT MAY CONCERN:

Milt Jenkins has recently accepted a new position. Please change your records to indicate the following information:

WORK: Dr. A. Milton Jenkins
The Baltimore Gas & Electric Company
Chaired Professor of MIS
Merrick School of Business
University of Baltimore
1420 N. Charles Street
Baltimore, Maryland 21201-5779

Telephone: (~~301~~ 410) 625-~~3187~~ 3143
Secretary's (301) 625-3420
FAX: (301) 752-2821
BITNET:

HOME: Prof. Dr. A. Milton Jenkins
107 Bellehahan Court
Belleview Estates
Severna Park, ~~MD 21146~~ Maryland 21146
USA

Telephone: (~~301~~ 410) 544-7659
FAX & Voice Mail: (410) 544-7663

AMJ/drf

We need very urgently a letter of the University of Baltimore supporting the international project within the USA<->Yugoslav Research cooperation.

major decision within one of the steps in the research process (research strategy) is examined. The decision is the selection of the appropriate research methodology, a methodology that will best facilitate the researcher attaining her/his stated research objectives. The key to selecting the best methodology for any research project is recognizing the available methodologies and understanding their relative strengths and weaknesses. Consequently, this section of the paper provides a comparative analysis of the vast majority of research methodologies that have been employed in MIS research. Finally, the paper concludes with some observations and comments on current MIS research activities. These comments and observations are principally based upon the author's experiences over the last eight years as an editor for MIS research on several journals and in conducting seminars with MIS doctoral students that focus on critically evaluating the MIS research literature. Others have put forth similar comments; for example see Dixon, et al. [9], Ives, et al [19], and Keen [22]. These comments and observations are intended to stimulate thought and discussion.

DIVERSITY IN MIS RESEARCH

The purpose of this section is to provide a brief illustration of the diversity commonly encountered by an academic researcher in the MIS field and the consequent need to employ various research methodologies. These examples are drawn from the author's work over the last few years.

User-System Interface Studies

The objective of this research is to understand the relationships between the key variables associated with a human using MIS to accomplish a task and the resulting performance. The number of variables associated with this phenomenon is too large to be accommodated in a single study. This necessitated a program of research to integrate individual studies. For a detailed description of this program of research (PRIMIS) see Jenkins [20]. The objective of each individual study is to determine the relationships among a limited set of variables (usually 3 to 5 independents and 4 to 6 dependents). Since theoretical support exists for the inclusion of each variable and hypothesis testing is possible, the objective of this type of study is nearly identical to the basic objectives of the 'scientific method' as described by Kaplan [21]. The research methodology that best supports the objective of this study is laboratory experimentation -- more specifically, a laboratory simulation experiment.

Prototyping Information Systems

Prototyping, as a systems development methodology, is a relatively new phenomenon in MIS. The objective of this study is to determine the effects of prototyping on the information system under development and on the systems and user professionals engaged in the process. In this study theory is weak, occurrences of the technique are still scarce, and application variations are numerous. The research methodology that best supports the objectives of this study is case method -- multiple case studies.

4GL Operational Efficiencies

Fourth Generation Languages (4GLs), particularly those containing relational-like database management systems, have become widely used in business and industry. The appeal of 4GLs lies mainly in their ease of use. With an increasing number of 4GL systems in use, their operating efficiency under various computing and operating systems becomes a real concern. Again, this is a new and unique phenomenon involving resources not readily available in an academic environment. However, unlike the prototyping case, in this case partially controlled studies are possible with cooperating organizations. The objective of this study is to determine the operating efficiency of a specific 4GL (FOCUS) under various operating environments. The research methodology that best supports this objective is field experimentation.

Critical Success Factors (CSF)

The objective of this CSF study is to determine which factors in the MIS Manager's environment are critical to her/his continued success. The research methodology that best supports this study is, perhaps obviously, opinion research.

These examples of MIS research projects are intended to demonstrate the need for academic researchers in MIS to understand and use various research methodologies.

THE RESEARCH PROCESS

The previous section illustrated the principal role of a research methodology in the research process -- to support the attainment of the research objective. The research objective is developed in one step of the research process. The research methodology is selected in the next step in that process. A comprehensive illustration of the research process and the systems within which it functions is useful in further understanding the role and limitations of research methodologies. A model of the research process in the MIS field is presented in Figure 1.

Figure 1 contains the ideas of many scholars. The basic process, from idea to publication, is an amalgam of the concepts presented by authors such as Stone [32], Kaplan [21], Balsley and Clover [2], and Buckley, et al. [4]. The paradigm concepts are derived from Kuhn [24]. The sequential arrangement of steps through the process is, of course, an over-simplification. The feedback loops from each of the steps to any previous step illustrate the true iterative nature of the research process.

A brief description of each of the steps in the research process follows:

IDEA - Getting the idea for a research project is typically unstructured. Surprisingly little of the reported research is identified as directly flowing from another researcher's statement of needed research. This initial step in the process should stimulate the researcher to the next step.

LIBRARY RESEARCH - This step (treated as a separate research methodology in some other fields) is both difficult and essential. It is difficult because of the nature of the MIS field where

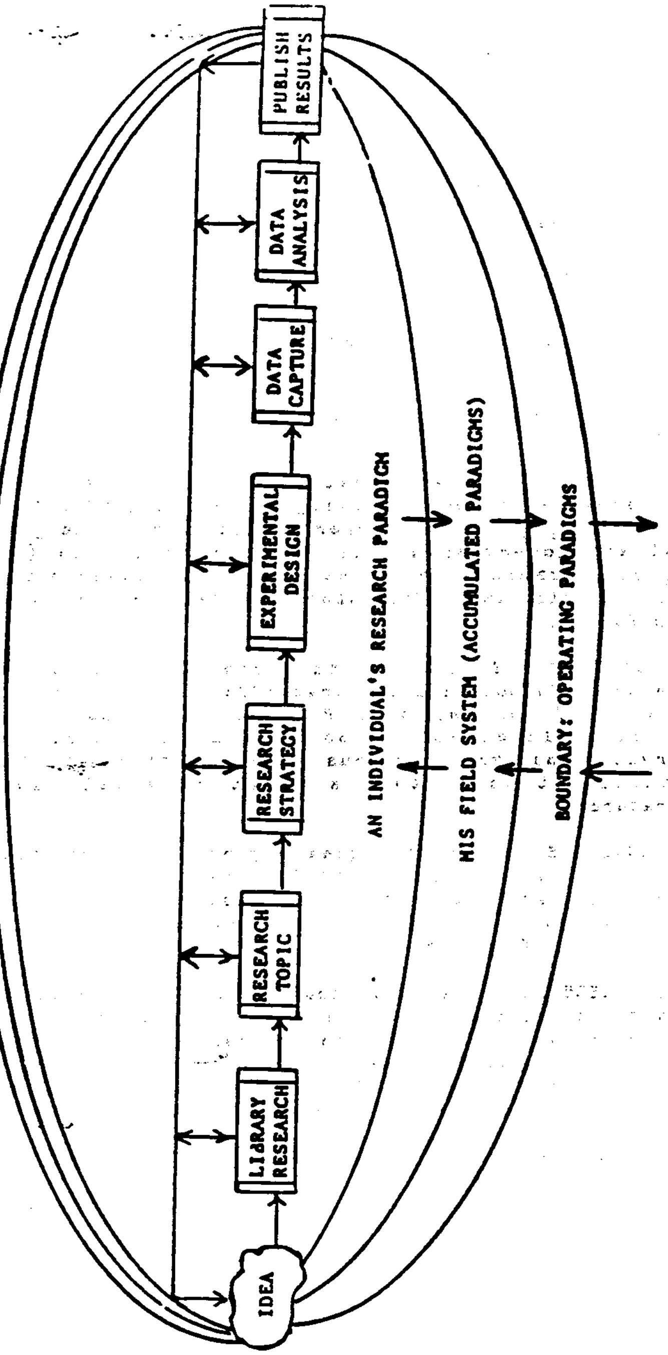

Figure 1
The Research Process In The MIS Field

research is reported over a wide range of journals. Further, few quality journals are truly international in scope and few libraries contain a comprehensive collection of conference proceedings. However difficult, there is no substitute for library research in refining the initial idea to enable the next step.

RESEARCH TOPIC - Many scholars suggest that this is the most difficult step. All researchers appreciate the problem of "asking question". See Campbell, et al. [6] for a detailed discussion of this issue. A clear, unambiguous statement of the research objective is the major output of this step.

RESEARCH STRATEGY - The successful completion of this step is contingent upon the researcher's awareness of the available research methodologies. The selection of an appropriate methodology requires the evaluation of many factors and the determination of how well they work together in supporting the research objective.

EXPERIMENTAL DESIGN - Typically, this step involves the selection of a formal experimental design. However, if a formal design is not applicable, the researcher should examine the growing number of quasi and non-experimental designs available [5 & 16]. The analysis, examination and selection of research procedures also occurs at this time. This step then defines the scope of the steps which follow.

DATA CAPTURE - Typically, this step focuses on both method and procedure. Method includes tradeoffs such as survey versus sample, the kind of sample, etc. Procedure (how the data will be collected) involves tradeoffs such as questionnaire versus interview, observation versus self-reporting, etc. The implication of choice at this step is relatively well defined in the literature.

DATA ANALYSIS - This step goes beyond the appropriate application of statistical techniques (ANOVA versus MANOVA, factor versus discriminate analysis, etc.). It requires the researcher to think about the findings, both qualitative and quantitative, and interpret the findings.

PUBLISH RESULTS - This step could easily be the subject of a book. In fact, it has been, several times (for example, see Huck [17]). Most important in this step is the researcher's obligation to relay to the reader what occurred in the seven previous steps as well as the research findings. This is frequently the most valuable contribution made to other researchers in the field.

This research process does not exist in a vacuum. It will, at a minimum, be influenced by 1) the individual's research paradigm, her/his understanding of the research process, and his/her integrity as a researcher, 2) the MIS field system -- the accumulated paradigms, values standards, and biases typically reflected in the editorial policies and practices of the leading journals, and 3) the operating paradigms that exist in the reference disciplines. Given the interdisciplinary nature of MIS, this characteristic is almost always present. The reader may believe paradigm is too strong a term to be used here. It is intended in a general way, as opposed to any specific Kuhnian definition. As such it is absolutely necessary in order for research to exist in MIS.

RESEARCH METHODOLOGIES

The exact number of different research methodologies that have been applied in the MIS field is unknown. Thirteen have been identified and defined in this paper. These thirteen are distinguished from each other on the basis of twelve categories containing a total of twenty four dimensions. A comparative analysis of the thirteen methodologies and twenty four dimensions is summarized in matrix form in Table 1.

The research methodologies are primitively ordered in Table 1. This ordering from left to right is in descending order based on the strength of the methodology in hypothesis testing. This closely corresponds to the amount of control the researcher can exert over the variables (independent, dependent, and intervening), the subjects, and the experimental findings. Philosophical research is included at the far right because this strategy is adopted primarily for the generation of hypotheses.

A brief description of each of the thirteen methodologies follows.

MATH MODELING - This methodology models the "real world" and states the results as mathematical equations. It is a closed, deterministic system in which all of the independent and dependent variables are known and included in the model. Intervening variables simply are not possible and no human subject is required. J.E. McGrath's paper "Toward a Theory of Method For Research on Organization" in Mowday and Steers [27] provides a detailed description of this methodology. This methodology is considered the highest order of methodology by many researchers. Blalock [3] describes the evolutionary process from verbal to mathematical formulations.

EXPERIMENTAL SIMULATION - This methodology employs a closed simulation model to mirror a segment of the 'real world'. Human subjects are exposed to this model and their responses are recorded. The researcher completely determines the nature and timing of the experimental events. Again, McGrath deals with this methodology in Mowday & Steers [27], and Van Horn [34] further describes this methodology in the specific context of MIS.

LABORATORY EXPERIMENT - With this methodology the researcher manipulates the independent variables, controls the intervening variables, and measures the effect of the independent variables on the dependent variables. Human subjects are commonly used in a laboratory setting. This methodology is described in great detail by Howard L. Fromkin and Siegfried Streufert in their article "Laboratory Experimentation" in Marvin D. Dunnette's Handbook of Industrial and Organizational Psychology [11]. A more basic description of this methodology and its relationship with other methodologies is provided by Eugene Stone in Research Methods in Organizational Behavior [32].

FREE SIMULATION - This methodology is similar to experimental simulation, in that with both methodologies the researcher designs a closed setting to mirror the "real world" and measures the response of human subjects as they interact within the system. However, with this methodology, events and their timing are determined by both the researcher and the behavior of the human subject. Van Horn provides the best description of this methodology in the MIS context in his paper "Empirical Studies of

TABLE 1

COMPARATIVE ANALYSIS OF RESEARCH METHODOLOGIES

RATED DIMENSIONS	MATH MODELING	EXPRMNT SIMULTN	LAB EXPRMNT	FREE SIMULTN	FIELD EXPRMNT	ADPTV EXPRMNT	FIELD STUDY	GROUP FEEDBACK	OPINION RESRCH	PARTICPTV RESRCH	CASE STUDY	ARCHIVAL RESRCH	PHIL RESRCH
COST:													
Initial Set-up	L-M	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	L-H	L
Marginal per Subj	H	L-H	L	L-H	M	M	M	M	L-M	L-M	L-H	H	H
Time Cost	L-H	L-M	L-M	M	M-H	M-H	M-H	M-H	M	M-H	M-H	L-H	L-H
VARIABLES:													
Strength of Ind Var	L-H	L-M	L-M	L-M	M	M	H	M-H	H	M-H	H	L	H
Range of Variables	L	M	L	M	M	M	H	H	H	M-H	L-H	L	M-H
Potential to Manipulate Ind Var	H	M-H	H	M-H	M	M-H	H	M	M	L-M	H	H	H
CONTROL:													
Potential for Testing Causal Hypotheses	H	M-H	H	M-H	M	M	L	L	L	L-M	H	L	H
Potential to Change Researcher or Ideas	L	L	L	L	M	M-H	M	L-H	L-M	H	H	L-M	H
Potential for Control of Confounding Vars	H	M-H	H	L	L-M	L-M	L	M	L	L-M	H	H	H
ARTIFACTS:													
Potential for Experimentr Expectancy	H	M-H	H	M	M-H	M	M	M	L	M	H	H	H
Potential for Demand Characteristics	H	M-H	H	M	M-H	M-H	M	M	L	L-H	H	H	H
Potential for Evaluatopn Apprehension	H	M-H	H	M-H	H	M-H	M	M	L-M	L-H	H	H	H
Potential for Unobtrusiveness	M-H	L	L	L-M	L-M	L-M	L-M	L-M	L	L-M	L-H	H	H

KEY: L = Low, M = Medium, H = High, N = None, Qn = Quantitative, Ql = Qualitative, Pt = Past, Pr = Present, Ft = Future

TABLE 1 (CONTINUED)

RATED DIMENSIONS	MATH MODELING	EXPRMNT SIMULTN	LAB EXPRMNT	FREE SIMULTN	FIELD EXPRMNT	ADPTV EXPRMNT	FIELD STUDY	GROUP FEEDBACK	OPINION RESRCH	PARTICPTV RESRCH	CASE STUDY	ARCHIVAL RESRCH	PHIL RESRCH
SETTING:													
Naturalness	L	L-H	L	L-H	H	M	H	M	L-H	H	N	H	H
Degree of Behaviour Setting-Dependence	N	L-H	H	L-M	H	H	H	M	L	M	M	H	N
EXTERNAL VALIDITY:													
Applicability of Results Diff Popul	N	L-H	L-M	L-H	L-M	L-M	L-M	L-M	M-H	L-M	L	H	H
Applicability of Result Diff Envirn	N	L-H	L-M	L-H	L-M	M	L	L-M	L-H	L-M	L	H	H
INTERNAL VALIDITY	H	M-H	H	M	M	L-M	L	L-M	L	L	H	L-M	N
RELIABILITY:	H	M-H	H	L-M	L-M	L-M	L-M	M	M-H	L	L	L-M	N
DESIGN OPTIONS:	L-M	M-H	M-H	M-H	M	M-H	H	L-M	L	L-M	L	L	N
EFFECTIVENESS:													
Efficiency	H	M-H	H	L-M	M	M	L	L	L-M	L	L	M	N
Comprehensiveness	M	L-M	L	M	M	M	H	H	M	H	H	L-M	N
NATURE OF RESULTS:	Qn	Qn/Ql	Ql	Qn/Ql	Qn/Ql	Ql	Ql	Ql/Qn	Qn	Ql	Ql	Ql/Qn	Ql
TIME PERSPECTIVE:	Any	Pr	Pr	Pr	Pr	Pr	Pr	Pr/Ft	Pr/Ft	Pr	Pr	Pt	Any

KEY: L = Low, M = Medium, H = High, N = None, Qn = Quantitative, Ql = Qualitative, Pt = Past, Pr = Present, Ft = Future

Management Information Systems" [34].

FIELD EXPERIMENT - This methodology guides research that takes place in a "natural setting". The researcher manipulates the independent variables while trying to control the most important intervening variables. The researcher then measures the effects of the independent variables on the dependent variables by systematic observation of human subjects. The form of "systematic observation" is the basis for distinguishing between various forms of field studies. For detailed descriptions and comparative analyses see Thomas J. Bouchard's article "Field Research Methods: Interviewing, Questionnaires, Participant Observation, Systematic Observation, Unobtrusive Measures" in Dunnette's Handbook of Industrial and Organizational Psychology [11]. Again Stone [32] provides a less complex discussion of this methodology.

ADAPTIVE EXPERIMENT - This is a "quasi-experimental" research methodology that involves before and after measures, a control group, and non-random assignment of human subjects. Data are gathered before the independent variables are introduced, but the final form is not usually known until after the independent variables have been introduced and the "after" data has been collected. An excellent description of this methodology is provided by E.E. Lawler III [25].

FIELD STUDY - Using this methodology the researcher does not manipulate any independent variables, but the dependent variables are systematically measured. The study is conducted in a natural setting using human subjects. Once again, McGrath's article in Mowday and Steers [27] provides the most detailed description of this methodology.

GROUP FEEDBACK ANALYSIS - Employing this methodology, groups of human subjects complete an objective instrument for testing of the researcher's initial hypothesis. Following the statistical analysis of the collected data, the data and the analysis are discussed with the subject group to obtain their subjective evaluation. The intent is to achieve a deeper analysis than that afforded by the statistical analysis alone. This methodology allows a re-evaluation of the original hypothesis. Frank Heller provides a detailed description of this methodology in his article, "Group Feedback Analysis: A Method of Field Research " [15].

OPINION RESEARCH - The objective of this methodology is to gather data on attitudes, opinions, impressions and beliefs of human subjects. This is accomplished by asking them (via questionnaires, interviews, etc.). This methodology allows testing of a priori hypotheses and offers an iterative approach to the generation of hypotheses. A good description of this methodology is contained in Research Methodology and Business Decisions by J.W. Buckley, M.H. Buckley and Hung-Fu Charing [4].

PARTICIPATIVE RESEARCH - This methodology, also referred to as "Action Research", allows the researcher to become a part of the research -- to be affected by and to affect the research. The objective with this methodology is not the finite testing of a particular hypothesis but the realization of the "human creative potential". Human subjects in this methodology are "of the essence". A detailed description of this methodology can be found in B.L. Hall's article "Participatory Research: An Approach For Change" [14].

CASE STUDY - Using this methodology a particular subject, group of subjects or organization is observed by the researcher without intervening in any way. No independent variables are manipulated, no control is exercised over intervening variables and no dependent variables are measured. The case study attempts to capture and communicate the reality of a particular environment at a point in time. Stone [32] and Leenders and Erskine [26] provide a good description of this methodology.

ARCHIVAL RESEARCH - This methodology is primarily concerned with the examination of historical documents. Secondarily, it is concerned with any recorded data. All data are examined ex-post-facto by the researcher. Buckley, et al., [4] provide a good description of this methodology.

PHILOSOPHICAL RESEARCH - This methodology defines a purely mental pursuit. The researcher thinks and logically reasons causal relationships. The process is intellectual and the aim is for the flow of logic to be explicit, replicable and testable by others. Again, Buckley, et al., [4] provide a good general description of this methodology.

Each of these research methodologies has its own strengths and weaknesses. A researcher must be aware of these in order to select the methodology which will provide him/her with the highest probability of reaching his/her research objective. Selecting a research methodology typically involves the balancing of many tradeoffs and always requires judgment. Although the following twenty four dimensions (organized in twelve categories) are not a complete enumeration of all possible dimensions, they do provide much of the information required in the selection process. Each of the research methodologies is rated for each of the twenty four dimensions in Table 1. A brief description of each of the twenty four dimensions follows.

OH3-7

COSTS - The costs associated with research are a real and critical factor to consider when selecting a methodology. Costs are broken down into three classes. First, there are the initial setup costs. These are the monetary costs involved in initially setting up and conducting the research. Second, there are the marginal costs per subject. These are the incremental monetary costs involved in testing each additional subject. Third, there are the time costs. These are the costs measured by the time necessary to implement the methodology. For a diverse discussion of these costs see Davis and Parker [8], Heller [15], and Kimberly [23].

VARIABLES - Variables are, of course, central to all research. Three aspects of the variables are considered here. First, the strength of the independent variable determines the power of the independent variable to affect the dependent variables. Second, the range of variables is the magnitude of values that the variables can assume. Third, the potential to manipulate the independent variable is the degree of freedom the researcher has to change the values of the independent variables. Note that the number of variables (independent and dependent) is not covered in this classification schema. This is because this factor is nearly always a function of the experimental design rather than the research methodology. For discussions of this issue see Hersen and Barlow [16], Turner [33], and Dunnette [11].

CONTROL - There are three aspects of control that are important to most researchers. First, the potential for testing causal hypotheses is the potential for determining that changes in the independent variables cause changes in the dependent variables. Second is the potential to change the researcher's ideas or to alter the researcher's hypothesis or concepts. Third, the potential for control of the confounding variables is the control the researcher has over alternative explanations of the effects on the dependent variables, for example, the identification of intervening variables. Dunnette [11], and Blalock [3], and Argyris [1] provide good additional discussion of the control issue.

ARTIFACTS - Artifacts are always with the researcher; their potentials are important considerations when selecting a methodology.. Four of these potentials are included in this classification. First is the potential for experimenter expectancy effects; that is, the potential for the researcher's expectation to affect the outcome of the experiment by influencing the responses of the subjects. Second, the potential for demand characteristics is the potential for the researcher to convey perceptual cues to the subjects about the hypothesis being tested. Third, the potential for evaluation apprehension is the possibility for the responses of the subjects to be attributed to their awareness of being participants in a research study. Fourth, the potential for unobtrusiveness lies in the ability of the researcher to be inconspicuous (hidden) while conducting the research. For a further discussion of artifacts, consult Hunter [18], Orme [30], and Argyris [1].

SETTING - Two aspects of the research setting are distinguished here. First, naturalness is the extent to which the research setting approximates the real world. Second, is the degree to which behavior is dependent. This is the potential for the research setting to influence the responses of the subjects. For detailed coverage of this issue see Bouchard in Dunnette [11].

EXTERNAL VALIDITY - Two dimensions of external validity are evaluated here. First is the applicability of the results to different populations or sub-populations; that is, the extent to which the research findings may be generalized across populations. Second, the applicability of the results to different environments is the extent to which the research results may be generalized to other settings or environments. Stone [32], and Elden [12] provide further information about this issue.

INTERNAL VALIDITY - This is the potential for determining that the independent variable (and nothing else) caused the observed effects on the dependent variable. Campbell & Stanley [5], Stone [32], and Blalock [3] discuss this issue in great deal.

RELIABILITY - This is the potential for the research to be repeated with the same findings; that is, the extent to which the results are free from measurement errors. For a more complete discussion, see Campbell in Dunnette [11], Hunter [18], and Blalock [3].

DESIGN OPTIONS - This refers to the number of experimental designs that can be employed; that is, the design options available to the researcher, e.g. pre-test-post-test, longitudinal, between-group/within-group, full-factorial/fractional-factorial, etc. For an in-depth coverage of this issue, consult Sage [31], Daft & Wiginton [7], Stone [32].

EFFECTIVENESS - Two dimensions of effectiveness are represented here: efficiency and comprehensiveness. Efficiency represents the potential for the methodology to yield a large ratio of accountable information to potential information from the study. Comprehensiveness represents the potential for the methodology to yield a large ratio of the potential information from the study to the potential information inherent in the referent situation. For further discussion of this issue, refer to Nugent & Vollman [28].

NATURE OF RESULTS - The basic taxonomy employed here is simply the distinction between a qualitative and quantitative statement of the research results. Guba [13], Huck [17], and Hunter [18] all address this issue.

TIME PERSPECTIVE - This involves the time period for which the methodology is best suited, e.g., past, present or future. For discussion see Blalock [3] and Kimberly [23].

COMMENTS

Several academics, Dixon, et al. [7] and Keen [18] for example, have commented on the problems existing in the field of MIS. They may be correct, but I see an even more basic problem. The problem is that many MIS faculty and most MIS doctoral students are simply not research literate. That is, they are not sufficiently aware of the research process and the importance of each step in that process.

This paper has addressed two of the research steps and the relationships between them. My reason for selecting these steps is that they have been much discussed in the literature (outside of the MIS field). However, an informal review conducted last year examining MIS publications indicated 1) that nearly half of a sample of 68 articles did not contain a clear, unambiguous statement of the researcher's objective, and 2) of those that did clearly state their objectives, over one third did not then select the research strategy that best supported meeting the objectives. We appear to have a very basic problem.

Academics in MIS have a major influence on what is published as research in MIS journals. We are, in effect, the "quality control" group for our field. It appears to me we are not doing a good job. I would like our dialogue to focus on how we can begin to do better.

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Meeting the Challenge for Information Systems in the 80's

by

A. Milton Jenkins

Graduate School of Business

Indiana University

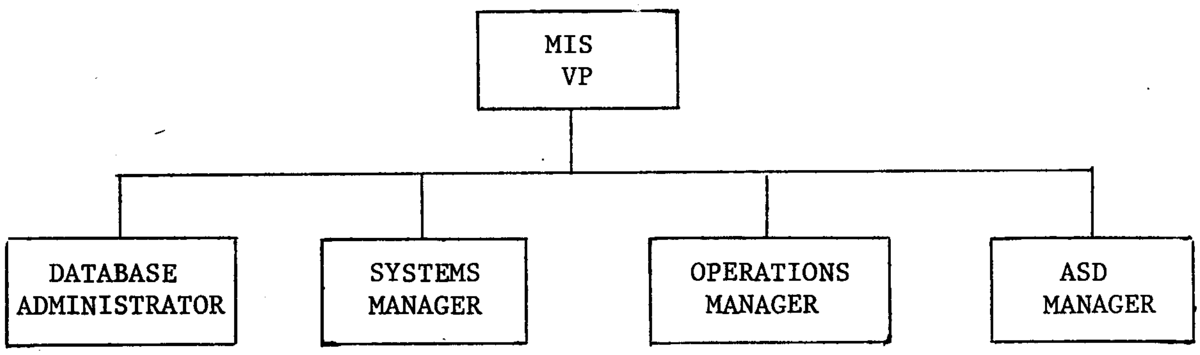
April 1982

Introduction

The hazards and difficulties associated with management positions in the MIS department of any organization are well known. During the early and mid sixties computer systems management was the most difficult position. A major contributor to this difficulty was the rapid technical advances in both the hardware and systems software. During the late sixties and through the mid seventies the Data Processing (DP) Manager's position was the "hot seat" in MIS. Several surveys reported "life-expectancies" of less than one year for DP managers during this time. The application system explosion is usually credited with being the largest contributor to the problems DP Managers faced during this time. The most difficult managerial position in MIS during the late seventies was that of the Database Administrator. The rapidly expanding supply of corporate data from transactional and operational application systems, coupled with an increasing awareness that data and information could and should be viewed as organizational resources, contributed toward making the Database Administrator's position difficult during this time. The rapid technological advances in database management systems and the proliferation of new software products by both hardware vendors and newly evolving software houses farther contributed to the problems of managing the organization's data resources.

From 1960 to 1980 the typical MIS organization chart changed considerably, reflecting the changing role of MIS in the organization, the changing management needs within the MIS organization, and the influences of computer and systems technology. Today the top levels of most MIS organization charts appear as illustrated in figure 1. The senior MIS manager today is usually at the vice president level and has four senior managers reporting directly to him/her. The Database Administrator is responsible for managing the organizations' data resources and increasingly plays a major role in providing consulting and training services to the user community. The Systems Manager is responsible for providing appropriate hardware, software and communications facilities for the organization.

The Operations Manager (formally called the DP Manager) is responsible for processing of all applications systems in the organization. The ASD Manager is responsible for meeting the needs of all user organizations for application systems.



Typical Early 1980s MIS Organization Chart

FIGURE 1

The current managerial "hot seat" in MIS is the Applications Systems Development (ASD) Manager. The biggest task facing this manager today is meeting the challenge to deliver effective and efficient information systems to any user group in the organization that "requests" an information system. That challenge is the topic of this paper.

The Major Challenges

The major challenges to the ASD Manager arise from three sources: 1) technological advances in computer hardware, software, and methodologies, 2) increasing organizational awareness of the need to manage the information resource, and 3) increasing management awareness of the value of information in increasing their own and their subordinates' productivity. This paper will focus on those issues that are most common to all ASD Managers, recognizing that the sequence and level of concern over the issues may vary significantly across organizations. These issues will be presented in the form of questions-- questions that the ASD manager will have to find answers for in the near future.

How do I manage the growing backlog of new application system development projects?

A frequent first reaction to this question is to ask why such a backlog exists and why is it growing. These are natural questions given that hardware costs in 1980 are 1% of what they were in 1960 and that programmer productivity is five times what it was in 1960. The explanation of this apparent paradox lies in the fact that user expectations are growing faster than development capacity, even with increasing development budgets. Another factor explaining the lag in development capability is that a high proportion of most development budgets are expended on maintenance of or enhancements to existing systems. Reports of maintenance costs at eighty percent or more of the total development budget are common.

Let's look at the feasibility of some typical solutions considered by ASD Managers. The first solution set is based on expanding the MIS resource base.

Since the largest capacity constraint is the programmer/analyst, why not just hire more programmers. Intuitively this response is appealing. But even if the development budget could be expanded to meet increases in the development staff, are these skilled people readily available? The answer is almost always no. While the number of programmers has grown considerably the demand for these people has grown even faster, as illustrated in figure 2.

Date	Programmer Jobs Available	Programmers Available	Shortfall
1975	320,000	308,000	12,000 (4%)
1985	640,000	476,000	164,000 (26%)

Source: U.S. Department of Labor Statistics

Programmer Availability

FIGURE 2

Turning from the resources available to the ASD Manager, let's examine the demand side of the question. Assuming that the requested application systems have been subjected to an appropriate value (cost-benefit) analysis, the demand is real. The best that can be gained from prioritizing the backlog is a higher return on investment. Given the difficulty in quantifying payoffs (especially for decision support systems (DSS) which are rapidly becoming the most common type of new application system) there is little to be gained in structuring the backlog.

Can the ASD Manager learn to live with the backlog? Probably not, because of the next question to be answered by the ASD manager.

How do I respond to upper managements' increasing demand for solutions?

One solution that is attracting considerable attention today is user-developed systems. The title of James Martin's latest book, Application Development Without Programmers, reflects this orientation. Further, the tremendous number of personal computers in use and their continued decreasing cost indicates that the typical organization user can afford this solution. Many advocates of user-developed systems argue that non-procedural languages and user-friendly software packages allow the user to implement this solution. Given that this solution is economically and technically feasible raises the next question.

How do I handle users seeking their own solutions?

One answer, suggested by advocates of user-developed systems is: You don't. Leave the users alone and let them seek their own solutions. The problem most ASD Managers have with this solution is: How do I manage application systems development if any user can build his/her system? The answer, of course, is he/she can't. The bigger question is, does the process need to be managed? The weight of evidence at this time seems to clearly indicate an affirmative answer. The major reason for managing the process is that the risks of not managing are too high. Gordon Davis recently articulated several of these risks: the high probability of programming errors leading to a loss of information integrity, a resurgence of all the problems associated with duplication of data files and databases, and large inefficiencies associated with duplication of effort. The next question is closely linked to this issue.

How do I effectively manage the organizations' information resources?

One necessary response is, by not advocating managerial responsibility or totally delegating that responsibility to the users. The most important issue to understand here is that the ASD Manager manages in cooperation with the other MIS managers. These managers must work in concert to manage the organizations' information resources. When the MIS function is managed, new technologies are regularly introduced in the organization. This raises another question for the ASD Manager.

How do I utilize technological advances wisely?

Given the scarcity and high cost of people, the increased availability of inexpensive computational capacity, and the availability of fourth generation software, what tradeoffs are available to increase the productivity of the systems/information analyst? In other words, how do I best use technology to get systems developed?

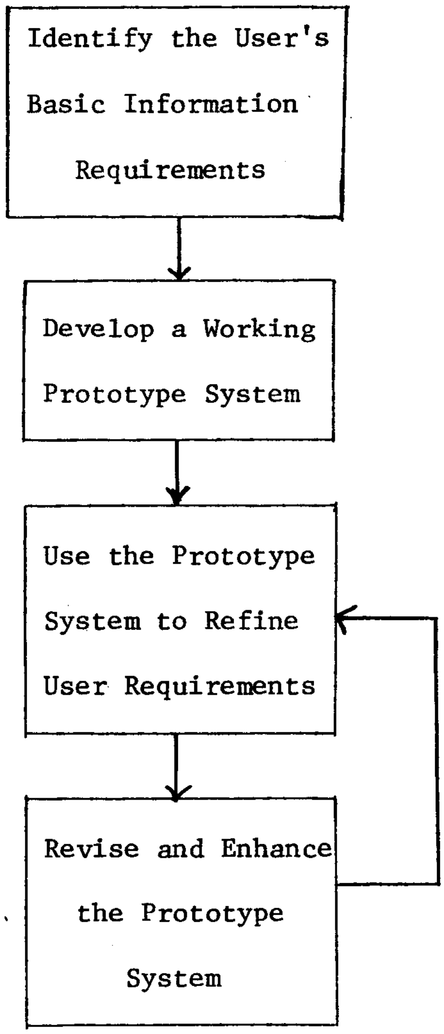
The answer to this, and the other questions asked by the ASD Manager, lies in the examination of the process used to build systems. Ninety percent of all systems developed in 1980 were built using the same methodology that was used in 1960. That methodology is the systems' development life cycle. Over the last twenty years the major costs (in time and dollars) have shifted from the physical design phase of the life cycle to the logical design phase, and particularly to the information requirements definition step in that phase. But the methodology has remained essentially unchanged. A new system development methodology, prototyping, goes a long way in helping the ASD Manager meet the challenge for information systems in the eighties.

Meeting The Challenges

Prototyping is presented here as the most appropriate way for the ASD Manager to meet the challenge for information systems in the '80's. Prototyping is not a panacea, it is simply a sound methodology that provides answers to many of the present needs in the systems development area. The following sections define and describe the methodology, the tools required for its successful application and then describes how it meets the challenges facing the ASD Manager.

What is Prototyping?

Prototyping is a development methodology; A methodology which has been used in the design fields (engineering, architecture, etc.) for centuries; A methodology both philosophically and operationally different from the traditional life cycle methodology. Prototyping has not been used in the application systems development area in the past for one simple reason -- the tools required to enable prototyping of application systems were not available until the late '70's. Prototyping is not piloting, although one can pilot a system that was developed by prototyping. The prototype process is typically carried out by two individuals -- a competent user and a technically skilled systems analyst. The prototype process is described in figure 3.



The Prototype Process

FIGURE 3

Prototyping is a four step process. The first step is to identify and capture a nucleus or skeleton that embodies the essential features of the user's requirements. The systems analyst works with the user during this process which usually takes less than four hours. Both the data abstracting and the process simulating approaches are successful in this step. The second step is completed by the systems analyst using a unique set of resources that have become widely available in the last five years.

The most important characteristic of this initial prototype is that it must be implemented in a very short time -- over night, if possible. The initial prototype is purposefully incomplete. It is a simulation in the sense that it represents the essential elements desired by the user in a simplified form. Design and implementation of the system is accomplished not by completely determining the user's information requirements but by developing a system which delivers as output the key or critical information requirements.

Steps one and two of the prototype process return nothing to the user. Step three, however, is delivery, installation, training, operation and use of the prototype system. This "hands-on" experience with a real system provides a basis for mutual understanding of the system by both user and analyst. The user exercises the system during this step and records the problems and incongruities as well as his/her discoveries as to what they wish the system could do. The user controls the time spent in this step and then contacts the analyst to begin step four. This final step involves only the analyst. The analyst's job is to enhance and modify the prototype system to meet the desires and needs of the user. These modifications must be made rapidly -- within a few days. Steps 3 and 4 are repeated as many times as the user feels necessary and at intervals determined by the user.

This prototype process is based on a simple principle -- that it is easier for the users to describe what they don't like about an existing system, than it is for them to describe what they would like in an imaginary system.

The Tools Required for Prototyping

Prototyping takes advantage of the technological advances made in the last decade. The basic tools that are essential for prototyping are: 1) Interactive systems (either through time sharing or mini/micro computers). Interactive facilities extend the apparent power of information processing resources by reducing delays and by extending control over the resources to the user. 2) Database management systems (with as full a range of enhancements as possible). A natural language based query language is essential. 3) Generalized input and output software is required if not available with the database management system. This software includes report generators, report writers and nonprocedural, natural languages. 4) A model base (which contains all of the essential features of a database). Many other tools are desirable when prototyping but the purpose of this paper is not to discuss the tools in detail, rather it is to describe how to meet and beat the challenges for information systems in the 80's.

How Prototyping Meets the Challenges for Information Systems

The prototyping solution addresses the basic reason for most of the challenges ASD Managers face today. It strikes at the heart of the problems -- an inefficient, time consuming and labor intensive development methodology. For the last twenty years the systems development life cycle has remained essentially unchanged and has been the only methodology employed to develop application systems. Prototyping provides a viable and attractive alternative methodology. All future application systems will not be developed using prototyping. But based on the reported evidence and my personal experiences with prototyping over the last four years, I am convinced that prototyping will be the dominant development methodology by the mid-eighties. Let's examine some of the reasons why.

Prototyping provides a real response to upper management's demands for solutions. Prototyping provides a real solution because: 1) It reduces the development time required to deliver a functional and useful system to the user. While the reductions in development time vary considerably, times between 10% and 20% of that required by the traditional methodology are very common. 2) The proportion of systems analyst time to user time in the development process shifts significantly placing a greater load on the users to do what they can do best -- define their own information and systems requirements. By reducing the time required to develop application systems and by lessening the systems analyst's involvement, prototyping shows great promise for reducing the applications development backlog.

Prototyping helps handle users seeking their own solutions. Prototyping provides an alternative to the users. The users can get the system they want without having to become a computer non-programmer. Prototyping focuses the user's attention and energy on that aspect of systems development for which he/she is best qualified. The results, universally reported, are much higher user satisfaction with the application system.

Prototyping helps the ASD Manager to manage the organization's information resources. Prototyping trades off machine inefficiencies for people efficiencies. With cheap and abundant computational resources and expensive and scarce human resources, this is the appropriate management tradeoff.

Conclusion

There are large numbers of compelling reasons to use prototyping as a development methodology. It far surpasses any other available alternative in meeting the challenges facing ASD Managers today. But a word of caution is appropriate in closing. There appear to be two potential problems with prototyping: the reduction of controls on both the process and product and the difficulty in easily integrating prototyped systems with other, traditionally developed systems. The ASD Manager should carefully assess these potential problems lest he/she simply trade one set of challenges for another.

Milt JENKINS:
Opening address on the 1st IS conference
BAHREIN, May '88

INFORMATION TECHNOLOGIES, USER EDUCATION AND DEVELOPMENT

ABSTRACT

The thesis of this paper is simply that future development will be based largely on the effective use of information technologies (to access information) and that the effective use of information technologies requires education. This required education can not be provided solely by educational institutions. Business organizations must play a major role in the educational process or suffer the consequences of not keeping pace with society. The educational role of Management Information Systems Departments within business organizations is emphasized here. Current activities in both educational and business organizations directed toward providing this education are reviewed with commentart on measuring their impact and effectiveness. Finally the fundamental problem of providing education on rapidly changing and wide-reaching technologies and their impact on both "how we do things" and "what things we do" is explored together with some of the suggested soluitions.

INTRODUCTION

Many of the terms used here may have slightly different meaning to different individuals. To avoid ambiguity a few operational definitions will be useful. First, the term information technology: Historically this term has been synonomous with computing technology. Today it means significantly more. At the least it includes computer technology, telecommunication technology and systems engineering.

That is the context of the term as used in this paper. Next the term user: There are at least three current perspectives on who constitutes a user community. At the narrowest level users mean all those persons who are currently actually using the system. At the broadest level it includes all members of a society regardless of their current activities. The middle ground, which is used in this paper defines users as all current and prospective users of formal information systems within an organizational environment.

The paper beging with a decsription of the subject matter of educational programs -- Information as a resource and Information Technologies -- hardware, software and information systems. Next the paper presents a description of the roles played by formal educational institutions from primary school through university as well as educational and professional societies and commercial educational firms. The focus then shifts to the roles played by business, more specifically, the roles played by Management Information Syatems Departments within organizations. The paper concludes with some commentary on the fundamental problem of technology transfer today.

THE SUBJECT MATTER FOR EDUCATIONAL ACTIVITIES

Here I dicsuss what is being taught with little regard to who, where or how it is being done. The goal is to make you aware of the breadth of the relevant subjects regardless of their current popularity or implementation. There are three primary subjects to be discussed: Information, Information Systems (that generate information) and Information Technologies (that are utilized to create the information systems). All of these subjects apply in varrying degrees to all educational programs regardless of how they are taught or by whom.

Information

Information, as used here is not the "information" of the of the mathematical theory of information -- which has no symantic content and doesn't address human users. Here we are dealing with information as it applies to human users. The most common approach to this topic is to deal with information as a resource. Information is a resource, but a resource unlike land, labor and capital. Information and it value are most frequenty presented in the context of other resources.

** use examples here: EFTw/capital MRPw/materials ES,AIw/material

Perhaps the single most important factor constraining the effective teaching of this topic is that we currently lack a viable economic thoery of information. Without such a theory most presentations are compelled to slight the asset value of information and instead address the attributes of information, such as surprise value, ideosyncratic worth and reproduceability.

** present examples of each of the above here

Setting the perspective is important to facilitate learning this subject. The most effective framing observed to date has been the "information revolution".

** present the information revolution story here

Typically, the behavioral objective of most courses of study on this topic are modest and can be generalized as inhancing information literacy.

Information Systems

This topic is currently the most popular focus in nearly all educational programs. These programs tend to divide the topic into the following subcatagories: design and development methodologies and the user's role in each, the role of information systems (IS) in organizations, the impact of IS on the organization, and the value of IS to the business functions. Each of these subtopics deal with specific user needs. For example, what role the user plays in getting the ISs they need (under LCDM, Prototyping and UDM). User training has become an integral part of most design and development methodologies, although the level of acquired knowledge varies greatly across methodologies.

** give example of prototyping versus LCDM

The basic objective of this type training is to make the users aware of the critical part they play in design, development and use of information systems.

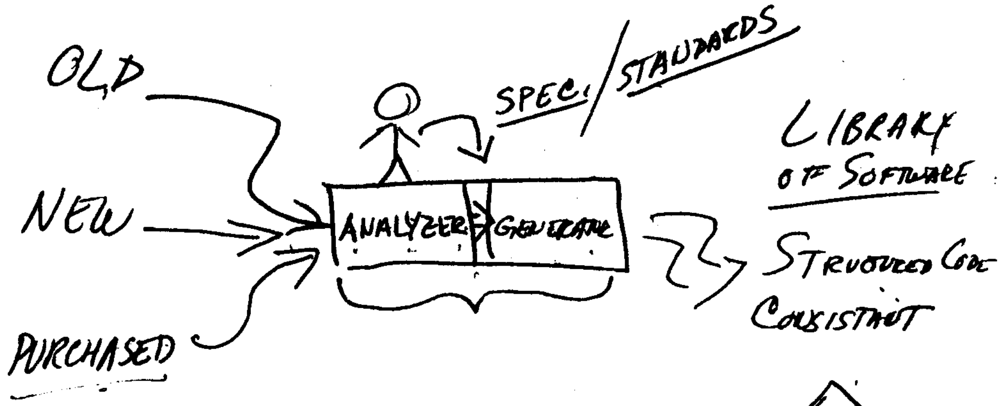
Addressing the role and impact of the IS in the organization intends to rise the user's awareness of the importance of IS in general and to help users identify opportunities or problems. Thusfar the value of IS to the business function has been focused on potential user -- typically upper level managers engaged in planning activities. The continueing trend toward more integrated MIS and business plans have spured on this type of training.

Information Technologies

User training on the information technologies has tended to focus on two topics: Hardware (particularilly micros) and software (mostly word processing, spreadsheets and database management systems). The greatest emphasis here is on how to use the tool. In that sense one may wish to distinguish between training and education. I'll leave that discussion for another time. But remember the emphasis here is on how to make the tool work not on what to do with it or the products it creates. Education on specific tool currently represents the largest class of educational activity in field.

MAINTAINABILITY
CORRECTNESS
EFFICIENCY ±10%

} GOOD



QUALITY ASSURANCE

MIS . ORG