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Abstract

The literature exploring computer-based information system (CBIS) evaluation has explicated a number of methods for investigating the impact of systems on organizations. However, while CBIS evaluation methods have been scrutinized and debated, the assumptions embedded in differing evaluative approaches have remained largely tacit. Highlighting the ontological (about the nature of reality) and epistemological (about the nature of valid knowledge) assumptions of alternative evaluative methods suggests two paradigms for CBIS evaluation - positivist and interpretive. Positivist CBIS evaluation is characterized by detachment of evaluator from subject, a priori categorization, and a quest for generalizable knowledge. Interpretive CBIS evaluation is characterized by experiential involvement of researcher in subject, an absence of a priori classification, and a quest for accurate descriptions of particular circumstances. Recognizing the ontological and epistemological differences between positivist and interpretive evaluation suggests four propositions useful in improving CBIS evaluation research. These propositions include acknowledging values, beliefs, and assumptions implicit in CBIS evaluation, recognizing and discussing evaluation trade offs, building 'complicated' descriptions of CBISs, and recognizing the interdependence of positivist and interpretive evaluation approaches.

An organization implements a computer-based information system (CBIS). Later, someone asks if the CBIS is a success or failure. Does it contribute to organizational goals? Should it be maintained, expanded, replaced, or abandoned?

Recent research suggests that a major obstacle to investment in new CBISs is the inability to measure and evaluate productivity gains resulting from such investments (Blacker and Brown, 1988; Strassman, 1985). Controversy over measuring productivity contributions from new technology has resulted in increasing skepticism regarding the benefits of CBIS in general (Business Week, 1988), and microcomputers (Bowen, 1986) and office automation (Strassman, 1985; Uttal, 1982) in particular. This controversy over CBIS productivity mandates a reexamination of CBIS evaluative practice. Specifically, how can we determine why and when CBISs contribute to managerial productivity?

IS researchers have long recognized the importance and complexity of this and related questions. As a result, a number of methods for evaluating CBIS have evolved. However, it is not generally recognized that methods of evaluating CBIS reflect basic values, beliefs, and assumptions about what constitutes valid knowledge. While the methods for CBIS evaluation have been scrutinized and debated (e.g., Hamilton and Chervany, 1981a; Sprague and Carlson, 1982), the assumptions embedded in differing evaluative approaches have remained largely tacit. However, the hidden values and assumptions implicit in CBIS evaluation methods can impede understanding of the benefits and limitations of alternative evaluation practices (Hirschheim and Smithson, 1988). IS researchers are less likely to trip over assumptions implicit in evaluative methods if these assumptions are highlighted, discussed, and debated. The purpose of this paper is to highlight differing epistemologies used in evaluation, and to relate these epistemological differences to CBIS evaluation practice.

One important approach to improving CBIS evaluation has been to explicate alternative methods of CBIS evaluation (Hamilton and Chervany, 1981a, 198b; Sprague and Carlson, 1982; Srinivasan, 1985), and to delineate differing paradigmatic approaches to evaluation (Hirschheim and Smithson, 1988). Another important line of research has examined conditions in which CBISs are incorporated into organizations (Kling and Iacono, 1984; Markus and Robey, 1988; Zmud and Apple, 1989). These efforts provide a foundation for understanding the fundamental relationships between information technology and organizational change, and for linking theories of evaluation with more general scientific principles. This paper complements these efforts by explicating the paradigmatic assumptions of alternative theoretical perspectives of evaluation, and by linking these assumptions with CBIS evaluation methods.

I. CBIS EVALUATION

CBIS evaluation is herein defined as the process of formally determining how a CBIS impacts and is impacted by an organization. Several assumptions are implicit in this definition. First, that a CBIS has been implemented, meaning that evaluation is a post-implementation activity. Evaluation is therefore identified as distinct from feasibility analysis (Caddell, 1985) and a priori justification of CBIS (Bozcany, 1983; Gremillion and Pyburn, 1985). Second, formal processes are used to evaluate the CBIS. While these formal processes may be qualitative, they are systematic and not purely impressionistic, off-hand reflections. Third, it is assumed that organizations both create and are created by CBIS. Evidence suggests that the process of implementing a CBIS creates complex, often unanticipated chains of events in organizations (Barley; 1986; Markus and Robey, 1988). These chains of events ultimately mean that organizations create CBISs and CBISs create organizations. Finally, it is assumed that significant linkages exist between evaluation methodologies and theoretical models (Markus and

Robey, 1988; Weick 1984). One's choice of a method is colored by implicit theoretical values and biases. As a result, the choice of a CBIS evaluative methodology is also frequently an implicit choice of a theoretical perspective (since "believing is seeing," Weick, 1979, p. 135).

Why do organizations evaluate CBIS? Research suggests that evaluations contain dual relevance to organizations[1]. Evaluation is useful in producing valid knowledge by probing and sensing internal organizational realities (Patton, 1987). However, evaluation is also an important component of the authority structure of an organization (Scott, Dornbusch, Busching, and Laing, 1967). As a component of the organizational authority structure, evaluations play a crucial role in administering rewards and punishments to organizational actors (Pfeffer, 1978). The dualistic nature of evaluations causes evaluative processes to both impact and reflect the more general interplay between rational and political processes in organizations. As a result, alternative approaches to evaluating CBISs reflect not only alternative modes and methods of acquiring valid knowledge, but also alternative methods for legitimating political activity (Legge, 1984), for signalling and symbolizing rationality and competence (Feldman and March, 1981), and for managing and manipulating organizational actors (Hirschheim and Smithson, 1988).

The role of evaluation in producing valid knowledge can be conceived as an application of general scientific principles of inquiry and knowledge (Legge, 1984). Kuhn's concept of "paradigm," while the focus of considerable debate, is useful in delineating differing modes of inquiry used in evaluating CBIS. As

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[1] The dual nature of evaluative activity exists regardless of relationships between evaluator and organization. Academicians, who are relatively independent of the organizations whose systems they evaluate, are generally concerned about both contributing to the body of research knowledge and acquiring status, resources, and security within the research community (Whitley, 1984). IS professionals who evaluate CBISs are generally concerned about both learning the impact of specific systems and using the evaluation process to further political ends.

conceived by Kuhn (1970) and expanded by others (e.g., DeMey, 1982; Toulmin, 1972), a paradigm is not a synonym for theory, but rather identifies the mosaic of theoretical frameworks, methodology, and ideology that comprise a discipline. Legge, building upon the work of Burrell and Morgan (1979), suggests that choices of evaluation methods follow directly from paradigmatic differences:

> A paradigm, as defined by Kuhn (1970) is a set of interrelated assumptions about the social world which provides a philosophical and conceptual framework for the systematic study of that world. These assumptions are ontological (about the nature of reality), epistemological (about the grounds of knowledge, about how people know, what they know and what the limits of that knowledge might be) and methodological (about the methods to be employed to gain knowledge about reality). The methodological assumptions essentially are derived from the epistemological, which, in turn, are derived from the ontological assumptions of the researcher. Hence any evaluation design derives basically from a particular world view held by the evaluator (Legge, 1984, p. 74).

Viewing the role of evaluation in producing valid knowledge from the context of general principles of scientific inquiry suggests two basic methods of inquiry or "paradigms". Legge identifies the basic paradigms of evaluation as positivist and interpretive. These paradigms contain fundamentally differing sets of values, beliefs and assumptions that are reflected in differing methods, approaches, and ideologies of CBIS evaluation. While related dichotomies have been discussed in the CBIS evaluation literature[2], previous research has not focused on explicating the assumptions underlying differing evaluative paradigms, or on the implicit linkages between paradigmatic assumptions and evaluation methodologies. Such is the intent of this paper.

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[2] Researchers have identified formative versus summative evaluation (Hamilton and Chervany 1981a, 1981b; Meals, 1977), analytical versus interpretive evaluation (Hirschheim and Smithson, 1988), discovery versus testing research (Franz and Robey, 1987), and positivist and process research (Blacker and Brown, 1983).

II. THE POSITIVIST AND INTERPRETIVE EVALUATION PARADIGMS

Positivist and interpretive evaluation are both useful in CBIS evaluation. However, they approach problems with different values, assumptions, and methods, and provide radically different evaluation results. To more clearly explicate paradigmatic differences, they are presented herein as polar opposites. In reality however, there is a wide spectrum of approaches to scientific inquiry and CBIS evaluation, many of which combine paradigmatic elements (Morgan and Smircich, 1980). Hence, dichotomizing evaluation paradigms represents an oversimplification. However, by explicating the extremes of different approaches, and magnifying their differences, a clearer picture emerges of the usefulness of alternative evaluative paradigms in exploring CBIS impact.

Figure 1 (adapted from Evered and Louis, 1981) summarizes the positivist and interpretive modes of inquiry. The vertical axis describes the paradigm (positivist and interpretive) while the horizontal axis defines paradigmatic characteristics. The first set of assumptions to be examined relate to the *evaluator's role*, the *evaluator's relationship to the setting*, and the *validation basis* used to determine the adequacy of knowledge. In positivist evaluation, the evaluator's role is that of an onlooker, or outsider (Legge, 1984). The researcher views herself as detached and separate from the object under study, and valid knowledge obtains when the evaluator accurately mirrors the objective reality of the phenomena under study. Valid knowledge is obtained by accurately measuring the phenomena under study, analyzing the resulting data for logical patterns, and comparing empirical results with hypothesized relationships.

Insert Figure 1 about here

Underlying positivist evaluation's detachment of researcher from the object under study are crucial epistemological assumptions: that there exists an

Figure 1
Characteristics of Positivist and Interpretive Evaluation
(adapted from Evered and Louis, 1981)

Defining Characteristics	Mode of Inquiry: Positivist	Mode of Inquiry: Interpretive
Evaluator's Role	Onlooker	Actor
Evaluator's Relationship to Setting	Detatched, Neutral	Immersed, Involved
Validation Basis	Measurement and Logic	Experiential
Sources of Categories	A priori	Emergent
Knowledge Acquired	Universal, nomethetic, theoria	Particular, idiographic, Praxis
Nature and Meaning of Data	Factual, Context Free	Interpreted, Contextually Embedded
Evaluation Language	Quantitative	Qualitative

objective reality consisting of facts that have a determinate nature or essence that is knowable. Beginning with Popper (1972a, 1972b) however, philosophers of social science have increasingly questioned the validity of viewing theory as separate from observed phenomena (Feyerabend, 1975; Kuhn 1970; Lakatos 1970). However, critics of positivism argue that, "observations are fallible propositions which are theory-dependent and therefore cannot act as the neutral arbitrator between competing theories" (Chua, 1986, p. 612). Habermas (1978) refers to the assumption of a knowable, external world as the "objectivist illusion."

Banker and Kauffman's (1988) study of the impact of automated teller machines (ATMs) on bank profitability illustrates positivist evaluation assumptions. The evaluators were logically separated from the phenomena under study (i.e., the banks), and came to "know" the impact of ATMs on bank profitability by collecting data from an external, knowable world. Data provided by the banks themselves, from U.S. Census information, and from a private consulting firm were seen as objective and independent of the theoretical propositions advanced. Since data and theory were derived independently, the data consisting an empirical validation of the "truth" of the theoretical propositions regarding the impact of ATMs on bank profitability.

Interpretive evaluation views the evaluator's role, the evaluator's relationship to the setting, and the basis of valid knowledge very differently. In interpretive evaluation, the evaluator is also a participant in the evaluation process. The researcher comes to know the "subject" by immersion and involvement in the phenomena under study. Knowledge is validated not by forming arbitrary distinctions between "theory" and "data", but by appeal to a combination of logical consistency, subjective interpretation, and agreement with actors' common-sense interpretation (Schutz, 1962).

Underlying interpretive evaluation is a very different set of epistemological assumptions: knowledge results from human experience, which is inherently continuous and nonlogical, but which can be symbolically represented (Heidegger, 1962). Because there exists no neutral, objective world of facts to act as final arbitrator, evaluators must take seriously the social, subjective realities of actors that emerge in human interaction. The hazard of such a perspective is that no clear standards exist for judging the adequacy of an explanation (Bernstein, 1976; Habermas, 1978). As a consequence, the findings of the evaluation may be distorted and contaminated by the values and beliefs of the evaluator. Bertram Russell (1945) refers to the rejection of an objective, knowable world as the "fallacy of subjectivism."

Mann and colleagues (Mann and Hoffman, 1960; Mann and Williams, 1960) study of the introduction of a transaction processing system (TPS) in a power company illustrates interpretive evaluation. The investigators began interviews with employees of the power company six years prior to introduction of the new system, and collected data for the five years during which the system was designed and implemented. The evaluators came to "know" the impact of the new system through over 300 unstructured interviews with employees at a variety of levels in the organization. Although the evaluators were not members of the organization under study, by intense, sustained observation, awareness of linguistic cues, and careful attention to detail, the investigators came to understand what the new TPS "meant" to organizational actors.

The Banker and Kauffman, and Mann and colleague investigations also reveal differences in paradigmatic assumptions regarding the *sources of analytical categories* used to classify data collected during evaluations. In positivist evaluation, investigators typically preselect categories used to classify data, and then generate hypotheses or predictions from these categorizations.

For example, Banker and Kauffman's (1988) assertion that ATMs can be used as competitive weapons by banks evidences a priori classifications regarding how the data will be analyzed. Only data relevant to these prespecified categorizations were collected. Such prespecification contains the hazard that important results will be omitted since they fall outside of preclassifications. At an extreme, a priori classification can lead to evaluations that "discover" only what the evaluators expect to discover (Weick, 1984), by providing data that are hopelessly biased by the preconceptions of investigators.

In contrast, interpretive evaluations begins with observations rather than theories. Salient features of the phenomena under study are uncovered through the experiential process of exploring the social meanings and interactions of organizational actors. Data and categories emerge simultaneously and interactively as information is interpreted in light of shared understandings evident in the language and ideology of the social system under scrutiny (Morgan and Smircich, 1980). However, categorization in interpretive evaluation has been criticized for being idiosyncratic and nongeneralizable beyond the particular evaluative setting within which it arose. At an extreme, interpretive evaluation yields information that is unusable beyond individual contexts (Legge, 1984).

Mann's study of computing illustrates an interpretive approach to categorization. Theoretical propositions about the impact of the system emerged from the data, rather than being *a priori* constructs to be validated by the data. Conclusions are grounded in the specific circumstances found in the evaluative setting explored by the evaluators. For example, significant changes in procedures, job structure, and management attitudes were found to result from the introduction of the TPS. These findings were not hypothesized, and are presented as being dependent upon the complex, interrelated forces found in the organizational environment surrounding the new system.

The differing modes of inquiry also result in fundamentally different types of *knowledge acquired*. Positivist evaluation generates generalizable, universal knowledge or *theoria* (Heidegger, 1962). Positivist evaluation seeks universal laws or principles that can be used to explain, predict, and control events. Such principles are evident in the Banker and Kauffman study. The use of a particular ATM network is associated with positive market share (p. 145). Such a finding provides general knowledge regarding the relationship between ATM networks and profitability. The fact that positivist evaluation may show that such a relationship is contingent upon other factors (e.g., effective marketing practices), merely means that additional environmental preconditions are necessary for predicting, explaining, and controlling events. Even when contingencies are necessary to produce a predicted result, positivist evaluation approaches still yield general, universal knowledge.

Interpretive evaluation generates knowledge that is relevant to particular situations. Interpretive evaluation emphasizes understanding events, rather than predicting and controlling them. Interpretive evaluation can be characterized as seeking *praxis* knowledge, or the knowledge of how to act in particular situations (Bernstein, 1971). Such knowledge cannot exist independent of an understanding of human organizations. Mann and colleague's descriptions of implementing a TPS does not generate generalizable knowledge about implementing TPSs, but instead provides a detailed understanding of a particular implementation. Such knowledge provides a highly accurate description as a result of the intense, sustained involvement of the researchers. However, the description is of questionable generalizability. In contrast, positivist evaluation produces generalizable knowledge that is of questionable value in understanding particular evaluative results and settings.

Assumptions about the *nature and meaning of data* significantly differ between evaluative paradigms. Positivist evaluation obtains generalizable knowledge by stripping away what is peculiar to individual organizations to reveal the kernel of presumed universal truth. Data are context-free: they have the same meaning across organizational settings. Data are separated from context by a quantitative *evaluation language*, that applies standardized sampling, aggregation, and statistical analysis to strip away what is unique about organizations and reveal what is general to them. Banker and Kauffman therefore collect only data that are common to all banks studied, and intentionally ignore particular circumstances within individual banks that might explain ATM profitability or usefulness.

Interpretive evaluation views data as contextually embedded in the complex fabric of political, social, and historical forces from which it emerges. "Facts" cannot be logically separated from contexts, since the "meaning" of such "facts" is dependent upon the shared understandings of organizational participants. When the evaluator understands contexts and the nature of the forces that have produced them, then real knowledge obtains. The *evaluation language* in interpretive evaluation places the evaluator directly in the organizational context, and emphasizes obtaining a qualitative understanding of the perspectives of organizational participants. Mann's study illustrates the interpretive view of contextually-embedded data and meaning. Mann spent eleven years understanding and interpreting the complex, interdependent forces that shaped computing in the power company under study. His data are qualitative and designed to reveal the perspectives of individual organizational participants, rather than to generate universal statements regarding the impact of computing on organizations.

III. PARADIGMATIC LINKAGES WITH EVALUATION METHODOLOGY

The evaluation paradigms described in section two logically link with CBIS evaluation methodology. By first considering evaluation methodology in general, the linkages are made more prominent, and the dominant methodologies are more evident. Figure 2 (adapted from Douglas (1976) and Weick (1984)) can be characterized as a continuum of evaluation methodologies that range from pure immersion in natural experience to highly controlled observations. Although specific orderings are debatable, the forms of observation near the top and middle of the list are less controlled and involve naturalistic, emergent inquiry. Forms of observation near the bottom of the list are more controlled and involve methods of observation that use a priori classification.

Insert Figure 2 about here

Low and high variety evaluation

One important characteristic of an evaluative methodology is its capacity for environmental sensing or *variety* (Patton, 1987; Pondy, 1977). The law of requisite variety states that, in order to accurately sense a system, the sensing mechanism must be at least as complex as the system (Conant and Ashby, 1970). Stated differently, a sensing mechanism must contain variety in order to register variety in a system under observation. For example, a photographer who must separately photograph ten objects, each of which is a different distance from the camera, must have a camera with at least ten distinct settings, if all of the photographs are to appear uniformly sharp (Weick, 1979). If the camera has fewer than ten settings, then it possesses insufficient variety for the task.

Methods in the lower half of Figure 3 are of low variety, while those in the upper half are of high variety. Low variety evaluation will detect, process, and exhibit relatively less variety in CBIS, since the quantitative language of low variety

Figure 2
Continuum of Evaluative Methodologies
(Adapted from Douglas (1976) and Weick (1984))

Everyday Life/ Social Experience and Thought	1. Conscious Experience 2. Practical Thought and Action 3. Diaries and Memories 4. Travelogues 5. On-Site Field Studies and Reports 6. Systematic Reflection 7. Philosophical Reflection
Field Research/ Participant Field Research	8. Depth-Probe Field Research 9. Investigative Reporting, Detective Work 10. Covert Field Research 11. Overt Journalism and Police Work 12. Overt Field Work
Nonparticipant Field Research	13. Discussion Research (free-flowing), In-Depth Interviews 14. In-Depth Interviews with Flexible Checklists of Questions
Controlled Experimental Methods	15. Natural Experiments 16. Preprogrammed Interviews (with statistical analysis) 17. Official Data and Business Analysis Reports 18. Judicial Investigations (operating under rules of evidence) 19. Panel (test and retest) Studie 20. Laboratory Experiments 21. Questionnaires and Polls 22. Computer Simulation Studies 23. Mathematical and Statistical Models

methods contains a smaller pool of symbols than does the qualitative, "natural" language of high variety evaluation (Daft and Wiginton, 1979; Patton, 1987; Pondy, 1977). Low variety evaluation converts both the complex and the simple, the ambiguous and the unambiguous into the exact, unequivocal languages of statistics and mathematics. In contrast, high variety methodologies register relatively more variety, since natural, qualitative language contains a larger pool of symbols for expressing ideas. Natural language contains more words than any person can or needs to understand and assimilate, resulting in countless possible combinations for capturing the variety present in organizations.

Low variety methodologies offer precision as an alternative to variety (Campbell, 1975). Low variety methods can be used to generate precise, unequivocal statements about CBIS by using a small set of precisely-defined symbols. For example, the definitions of a "t test" and "probability" are relatively universal. In contrast, agreement on the correct method for determining the meaning of CBIS "success" is ambiguous and dependent upon organizational context. The quantitative languages of statistics and mathematics provide low variety evaluation methodologies with precise symbols that are useful in generating unambiguous descriptions of systems. In contrast, high variety methods use less precise natural language as a medium of expression (Daft and Wiginton, 1979).

Methods for evaluating CBIS do not exist independent of issues of epistemology and ontology. Further, the choice of a method strongly influences what is "found", since epistemological and ontological assumptions are embedded in evaluation methods (Douglas, 1976). As a result, what researchers "find" is strongly influenced by what they expect to find (Weick, 1984). Consequently, positivist CBIS evaluators generally use low variety methods, since they seek and expect universal, generalizable knowledge, while interpretive CBIS

evaluators generally use high variety methods, since they seek and expect particular, contextually-embedded knowledge.

Low variety methods provide positivist CBIS evaluators with "preprogrammed" techniques designed to eliminate the biases of the investigator, and to engender the assumed separation of observer and observed (Legge, 1984). The stronger control over observation present in low variety methods are related to positivist assumptions regarding a priori classification of observations. Low variety methods rely more on theoretical preconceptions of what is to be observed, and less on observation (Douglas, 1976).

High variety methods provide interpretive CBIS evaluators with methods for "natural" observation, intended to capture the experience of organizational actors. Control over observations is lessened, since data are expected to "tell their own story." This story will be pieced together by the researcher through ex post classification and categorization. High variety methods therefore rely more on observation and less upon theoretical preconceptions.

However, while methods are related to epistemological assumptions, they do not map directly into assumptions. Evaluators can and do mix low variety methodology categories with an interpretive perspective, and high variety methods with positivist perspectives. For example, covert field work conducted by an evaluator working within a positivist paradigm might be used to count the number and length of interactions between a systems analyst and a system user. The same method used within an interpretive paradigm could be used to explore the subjective meanings shared by analyst and user. Thus, while associations between paradigms and methodologies are found, there does not exist a one-to-one mapping of paradigms into methods.

IV. CBIS EVALUATION METHODS

Examining the CBIS evaluation literature in light of evaluative epistemology and methodological variety provides insight into the assumptions and strategies that dominant CBIS evaluation. While it is not the intent of this article to exhaustively review the CBIS evaluation literature, examining selected examples of CBIS evaluation illustrates both common and unusual CBIS evaluation approaches and provides insight into improving CBIS evaluation.

Low Variety Methods

The most common approach to CBIS evaluative is to combine low variety methods with a positivist paradigm. Most user surveys (e.g., Franz, Robey, and Koeblitz, 1986; Rushinek and Rushinek, 1983; Srinivasan; 1985), measures of computer usage (Ferrari, 1978; Hiltz and Turoff, 1981), and other uses of external, "objective" data sources (e.g., Banker and Kauffman, 1988; Laudon, 1986) to evaluate computing activities combine low variety methods with positivist assumptions. Sprague and Carlson (1982) explicitly argue for a positivist paradigm, survey sampling approach to evaluating decision support systems.

One striking feature of low variety, positivist evaluation is the relative absence of measures of what people do with systems as opposed to what they say they do. While exceptions do exist (e.g, Banker and Kauffman, 1988; Laudon, 1986), the majority of low variety CBIS evaluation relies upon self-reports of systems usage and usefulness, rather than measures of system usage and usefulness. The organizational and political contexts within which systems are implemented provide strong motivations for organizational actors to appear highly rational, satisfied, and consistent in their relationships with organizational CBIS (Feldman and March, 1981; Kling, 1987). Direct measures of systems usage are therefore less likely to be biased towards appearances of rationality than are self reports of system usage.

Combining low variety methods and an interpretive paradigm is unusual, since interpretive perspectives generally assume complexities in computing relationships not captured by low variety methods. However, Robertson (in press) illustrates a low variety method/interpretive paradigm approach to evaluating systems usage in a management consulting firm. Robertson's theory of systems impact is strongly interpretive. Information systems are socially determined, and are dependent upon the shared meanings of subgroups of organizational actors. However, Robertson uses structured self-reports of relationships between organizational actors, and sophisticated statistical methodology to analyze relationships between organizational actors. Results suggest partial support for hypothesized relationship between social interpretations of systems and organizational subgroup.

Kling (1987) cautions researchers against exclusive use of low variety methods within an interpretive perspective. Kling argues that low variety methods, such as standardized surveys, can only be effectively combined with interpretive perspectives when high variety methods have been previously used to delineate important computing relationships in an organization. Kling argues that low variety methods do not provide sufficient variety to capture the subtleties and complexities that interpretive researchers assume exist in and around computing relationships in organizations.

High Variety Methods

While less frequent, high variety methods are employed to evaluate CBIS. Examples of depth-probe or longitudinal field research combined with an interpretive paradigm include Mann and Williams (1960), Boland and Day (in press), and Barley (1986). Boland and Day (in press) illustrate interpretive evaluation using high variety methods from the upper end of Figure 2. They conducted interviews with one credit union systems analyst over a two year

period. The first year's interviews were conducted while the analyst worked on a new loan application system, while the second year's interviews consist of the analyst's reflections about the previous year's systems design experience. These interviews reveal that systems design may require more moral, ethical choices by systems analysts than is generally recognized. For example, the systems analyst was asked to design an easy-to-use system to allow poorly paid workers to replace higher pay, higher talent workers.

Articles suggesting CBIS evaluation strategies for IS practitioners frequently reflect a high variety / positivist perspective to evaluation (e.g., Burch and Grudnitski 1986). For example, Keen (1975, 1981) argues that consideration of qualitative benefits should be the most important consideration in evaluating systems and that high variety methods are appropriate for evaluating such benefits. However, Keen argues for high variety methods within a framework of positivist assumptions that include detachment between evaluator and evaluation, a priori specification of "success" and of system goals, and objective analysis of data. Existing evidence suggests that, while high variety/positivist perspectives for CBIS evaluation are frequently recommended in the IS literature, they are seldom applied by their assumed constituency of IS practitioners (Hogue and Watson, 1984; Sprague and Carlson, 1982). One explanation for the apparent lack of interest in high variety/positivist approaches to evaluation may be that IS professionals do not share the epistemological convictions of the positivist research paradigm. For example, IS professionals may be unconcerned with obtaining controlled, objective observations, that are mediated by a priori classification.

"Mixed" Methods

Geertz (1983) has observed that once-distinct boundaries between social science disciplines are increasingly blurred, and that mixing of methods and

perspectives is emerging as a dominant research trend. This mixing of methods and perspectives is reflected in the increasing use of mixed methods and mixed paradigms in CBIS evaluation. "Mixed" CBIS evaluations have combined a variety of methodologies including questionnaires, financial and budgetary data analysis, unstructured interviews, examination of documents and memoranda, observations at meetings, and tape recordings to understand systems impact. The mixing of high and low variety methodologies is frequently combined with a mixing of paradigms, leading to explorations of the implications of contrasting paradigmatic assumptions. Two recent examples illustrate mixing paradigmatic assumptions and evaluation methods.

Franz and Robey (1984) studied the impact of an automobile insurance company information system over a 22 month period, using a combination of open-ended interviews, questionnaires, examination of critical incident files, formal documents, and observations at meetings. Their paradigmatic perspective is largely interpretive, but also involves exploring the extent to which positivist theories can explain observed systems development behavior. Their theoretical perspective compares and contrasts rational and political explanations for observed systems design behavior. Both quantitative and qualitative data is gathered to motivate and interpret theoretical propositions.

Kaplan and Duchon (1988) combined low and high variety methodologies to evaluate the impact of a new computerized data management in a medical laboratory. Methods employed include open-ended interviews, sustained observation, and surveys. Both quantitative and qualitative data analyses were used to evaluate systems impact and success, and both interpretive and positivist assumptions are explicated, discussed, and evaluated. Based upon their combined qualitative and quantitative data analyses, Kaplan and Duchon propose

a largely interpretive model to explain changes in job characteristics and work relationships resulting from computerization.

V. IMPLICATIONS FOR CBIS EVALUATION

Viewing CBIS evaluation within the framework of paradigmatic assumptions and evaluation methodology suggests several implications for improving CBIS evaluation. In particular, four propositions emerge. These observations pertain to recognizing implicit values, beliefs, and assumptions, acknowledging trade offs, building complicated descriptions of CBIS, and using positivist and interpretive evaluation as interdependent, not competing, modes of inquiry.

> Proposition #1 - CBIS evaluations always contain implicit assumptions, values, and beliefs.

Any evaluation of a CBIS contains the implicit values, beliefs, and assumptions of the evaluator. Positivist evaluators believe in separation of researcher and subject, the importance of objective, generalizable knowledge, and quantitative methodologies. Interpretive evaluators belief in immersing the researcher in the subject, the importance of particular, subjective knowledge, and qualitative methodologies. While positivist assumptions can be mixed with interpretive assumptions, assumptions, values, and beliefs cannot be eliminated from the process of CBIS evaluation.

However hidden, implicit assumptions cannot be argued, debated, or scrutinized. Consequently, effective presentation of CBIS evaluation research requires explicitly recognizing and acknowledging one's assumptions, values, and beliefs. Ultimately, the issue is not whether or not researchers bring values, assumptions and beliefs to CBIS evaluation, but whether these values, assumptions, and beliefs are defenselessly recognized, acknowledged, and discussed.

Proposition #2 - CBIS evaluators always make trade offs.

The choice of an evaluation method or perspective always involves trade offs. To see this, consider Thorngate's postulate of commensurate complexity (Thorngate, 1976; Weick, 1979, 1984) . Thorngate observes that it is impossible to generate explanations of behavior that are simultaneously general, accurate, and simple. At best, two of the three objectives can be met. Movement toward any two objectives is movement away from the third. Therefore, as a theory moves towards greater generality and simplicity, it necessarily becomes less able to predict specific behavior (i.e., less accurate). As a theory moves towards greater accuracy and simplicity, it becomes less able to describe behavior in general. And as a theory becomes more general and accurate, it loses simplicity.

The implication of Thorngate's postulate for CBIS evaluators is that the choice of a method and perspective in evaluating a CBIS is a forced trade off between the competing goals of accuracy, generality, and simplicity. While CBIS evaluators may differ as to which goals are of greater importance, trade offs are inevitable. Consciously acknowledging these trade offs, and openly discussing the value of alternative combinations of goals is likely to lead to an improved understanding of the merits of alternative perspectives and approaches to CBIS evaluation.

Proposition #3 - 'Complicated' evaluations of CBIS are likely to be more accurate.

Boulding (1956) and Pondy and Mitroff (1978) have observed that human organizations are among the most complex of known systems. Effectively evaluating CBIS requires understanding the relationship between computing technology and complex, on-going human organizations. Recent approaches to

CBIS evaluation attempt to understand and describe the complexity of human organizations by using multiple evaluation methods, and by mixing assumptions from positivist approaches with those of interpretive approaches. Such approaches are designed to reflect the complexity of human organizations by providing "complicated descriptions" (Weick, 1979) of the impact of computing technology on organizations.

Triangulating evaluation methods provides one means of generating complicated descriptions of systems. Triangulation involves combining high and low variety methodologies to study a phenomena (Denzin, 1978). Researchers using multiple methods can be more confident in their findings, are more likely to discover unusual or unexpected phenomena, and can more effectively synthesize and integrate disparate theories or paradigms (Jick, 1979). However, the use of multiple measures is not a sufficient condition for achieving triangulation in measurement (Webb, Campbell, Schwartz, and Sechrest, 1966). For example, the use of multiple survey questions regarding user satisfaction does little to achieve measurement triangulate, since such measures are largely redundant (Rushinek and Rushinek, 1983). Rather, triangulating measurement requires choosing low and high variety methods from Figure 1.

An alternative approach to generating "complicated descriptions" is to triangulate theory. Achieving theoretical triangulation requires holding conflicting assumptions regarding the impact of a CBIS. Simultaneously trusting and doubting the same assumption achieves a theoretical triangulation that can be matched with methodological triangulation. As Weick observes:

> Any person who has a view of the world and who also discredits part of that view winds up with two ways to examine a situation. Discrediting is a way to enhance requisite variety and a way to register more of the variety that's present in the world (Weick, 1979, p. 228).

Two methods exist for generating and holding conflicting assumptions and theoretical perspectives. One is to triangulate investigators by creating a multi-perspective team with differing ontological and epistemological assumptions (Denzin, 1978; Legge, 1984). Such an approach to triangulation is used by Kaplan and Duchon in their investigation of computing in a medical laboratory. Alternatively, CBIS evaluators can make themselves more "complicated," by consciously generating and explicating alternative, conflicting theoretical perspectives (Bartunek, Gordon, and Weathersby, 1983; Streufert and Swezey, 1986). Using either approach to achieving theoretical triangulation increases the likelihood of producing accurate descriptions of the effects of CBIS evaluation and reduces the chance that evaluators will "see" only what they expect to see.

Proposition #4 - Interpretive and positivist evaluation are interdependent, not competing, modes of inquiry.

Positivist and interpretive approaches to science are often viewed as competing, unreconcilable paradigms for conducting research (e.g., Chua 1986; Legge, 1984). However, achieving theoretical triangulation in evaluation requires viewing interpretive and positivist approaches not as competing, but as complementary modes of inquiry (Johnson, 1989). In conducting "complicated" evaluation, evaluators focus exclusive attention on interpretive and positivist paradigms only temporarily, and move between paradigms in order to generate more accurate descriptions.

Why might cycling between interpretive and positivist evaluation lead to more accurate descriptions of the effects of CBISs? One explanation for the effectiveness of interdependent, concurrent modes of inquiry may be that such approaches reflect a "natural" division of responsibility in the brain. Research suggests that the left and right brain hemispheres of humans utilize distinct approaches to acquiring information about the world (Meyer, 1985; Simon, 1977;

Taggert and Robey 1981). Levy summarizes the considerable research with subjects whose brain hemispheres have been separated as follows:

> Each side of the brain is able to perform and chooses to perform a certain set of cognitive tasks which the other side finds difficult or distasteful or both... The right hemisphere synthesizes over space. The left hemisphere analyzes over time. The right hemisphere notes visual similarities to the exclusion of conceptual similarities. The left hemisphere does the opposite. The right hemisphere perceives form, the left hemisphere, detail. The right hemisphere codes sensory input in terms of images, the left hemisphere in terms of linguistic descriptions. The right hemisphere lacks a phonological analyzer; the left hemisphere lacks a Gestalt synthesizer (Levy, 1974, p. 167).

Moving between interpretive and positivist assumptions in CBIS evaluation may generate more accurate descriptions of organizational phenomena because brain physiology loosely corresponds to the alternative modes of inquiry found in interpretive and positivist approaches to evaluation. The right brain hemisphere is concerned with experiential, impressionistic understanding, while the left is concerned with logic and analysis. Similar observations can be made with respect to the processes of knowledge acquisition used in interpretive and positivist modes of inquiry. Interpretive inquiry largely relies on experiential approaches to acquiring knowledge while positivist inquiry relies on analytical, logical approaches.

VI. CONCLUSION

Banville and Landry (1989), building on the work of Whitley (1984) have recently described the MIS research field as a "fragmented adhocracy," characterized by: (1) distinct, independent schools of thought, (2) little standardization as to methods and measures, (3) problems of broad scope that defy standardization. Culnan's co-citation analysis of MIS research supports the view of MIS as a multiparadigmatic discipline. She identifies nine subfields of MIS in one study (Culnan, 1986) and five in a subsequent one (Culnan and Swanson,

1987). Banville and Landry suggest that fruitful inquiry in a fragmented adhocracy is fueled by applying multiple perspectives and methods to complex, ill-defined problems.

The CBIS evaluation literature reflects the "fragmented adhocracy" characteristics of the more general MIS literature. The CBIS evaluation literature shows distinct schools of thought (e.g., positivist and interpretive), little agreement as to appropriate methods and measures (e.g., high and low variety), and a concern with tackling broad, encompassing problems that defy standardized formulation (e.g., the value of CBIS). The existence of a "fragmented adhocracy" in CBIS evaluation suggests that disparate approaches will be used to evaluate CBIS. However generating productive, consequential scholarship requires sufficient cohesion among investigators that research findings can be shared and understood (Weick, 1983).

One key element of cohesion that can be built into CBIS evaluation is shared understanding of the values, assumptions, and beliefs implicit in alternative approaches to CBIS evaluation. The plurality of perspectives within MIS insures that CBIS evaluation will be examined from a variety of perspectives. However, effectively discerning the relative contributions of individual research efforts requires understanding alternative epistemological assumptions and limitations. By defenselessly explicating and discussing these underlying assumptions, CBIS evaluators can understand one another more clearly, thereby increasing the likelihood of improving our understanding of the impact of systems on organizations, and of organizations on systems.

REFERENCES

Banker, R.D. and R.J. Kauffman, "Strategic Contributions of Information Technology: An Empirical Study of ATM Networks," Proceedings of the Ninth International Conference on Information Systems, Minneapolis, 1988.

Banville, C. and M. Landry, "Can the Field of MIS be Disciplined?," Communications of the ACM, 32, 1 (1989), 48-60.

Barley, S.R., "Technology as an Occasion for Structuring: Evidence from Observations of CT Scanners and the Social Order of Radiology Departments," Administrative Science Quarterly, 31 (1986), 78-108.

Bartunek, J.M., J.R. Gordon, and R.P. Weathersby, "Developing 'Complicated' Understanding in Administrators," Academy of Management Review, 8, 2 (1983), 273-284.

Bernstein, R.J., Praxis and Action, Philadelphia: University of Pennsylvania Press, 1971.

Bernstein, R.J., The Restructuring of Social and Political Theory, Oxford: Basil Blackwell, 1983.

Blackler, F.H. and Brown, C.A., "Qualitative Research and Paradigms of Practice," Journal of Management Studies, 20, 3 (1983), 349-365.

Boland, R.J., Jr., and W. Day, "The Experience of System Design: A Hermeneuitics of Organizational Action," Scandanavian Journal of Management, in press.

Boulding, K.E., "General Systems Theory: The Skeleton of Science," Management Science, 2 (1956), 197-207.

Bowen, W., "The Puny Payoff From Office Computers," Fortune (May 26, 1986), 20-24.

Bozcany, W.J., "Justifying Office Automation," Journal of Systems Management, 34, 7 (1983), 15-19.

Burch, J.G. and G. Grudnitski, Information Systems: Theory and Practice, New York: Wiley and Sons, 1986.

Burrell, G. and G. Morgan, Sociological Paradigms and Organisational Analysis, London: Heinemann, 1979.

Business Week, "The Productivity Paradox - A Special Report," (June 6, 1988), 100-114.

Caddell, D.D., "The Limited Computer Feasibility Study: A Cost-saving Approach," Journal of Accountancy, (April, 1985), 122-126.

Campbell, D.T., "'Degrees of Freedom' and the Case Study," Comparative Political Studies, (July, 1975), 178-193.

Chua, W.F., "Radical Developments in Accounting Thought," The Accounting Review, 61, 4 (October, 1986), 601-632.

Conant, R.C. and R.W. Ashby, "Every Good Regulator of a System Must be a Model of That System," International Journal of Systems Science, 1, 2 (1970), 89-97.

Culnan, M.J., "The Intellectual Development of Management Information Systems. 1972-1982: a Co-citation Analysis," Management Science, 32, 2 (1986), 156-172.

Culnan, M.J. and E.B. Swanson, "Mapping the Intellectual Structure of MIS. 1980-1985: a Co-citation Analysis," MIS Quarterly, 11, 3 (1987), 340-353.

Daft, R.L., and J.C. Wiginton, "Language and Organization," Academy of Management Review, 6, 3 (1979), 385-395.

DeMey, M., The Cognitive Paradigm, Boston: D. Reidel, 1982.

Denzin, N.K., The Research Act, 2nd edition, New York: McGraw-Hill, 1978.

Douglas, J.D., Investigative Social Research, Beverly Hills: Sage Publications, 1976.

Evered, R. and M.R. Louis, "Alternative Perspectives in the Organizational Science: 'Inquiry From the Inside' and 'Inquiry From the Outside,'" Academy of Management Review, 6, 3 (1981), 385-395.

Feldman, M.S. and J.G. March, "Information in Organizations as Signal and Symbol," Administrative Science Quarterly, 26, 2 (June 1981), 171-186.

Ferrari, D., Computer Systems Performance Evaluation, Englewood Cliffs, NJ: Prentice-Hall, 1978.

Feyerabend, P., Against Method: An Outline of an Anarchistic Theory of Knowledge, London: New Left Books, 1975.

Franz , C. and D. Robey, "An Investigation of User-led ystems Design: Rational and Political Perspectives," Communications of the ACM, 27, 12 (1984), 1202-1209.

Franz , C. and D. Robey, "Strategies for Research on Information Systems in Organizations. A Critical Analysis of Research Purpose and Time Frame," in R.J. Boland and R.A. Hirschheim (Eds.) Critical Issues in Information Systems Research, New York: Wiley, 1987.

Franz, C.R., D. Robey, and R.R. Koeblitz, "User Response to an Online Information System: A Field Experiment," MIS Quarterly, 10 (1986), 29-42.

Geertz, C., "Blurred Genres: the Refiguration of Social Thought," Chapter 1 in Geertz, C., Local Knowledge: Further Essays in Interpretive Anthropology, New York: Basic Books, 1983, 19-35.

Gremillion, L.L. and P.J. Pyburn, "Justifying Decision Support and Office Automation Systems," Journal of Management Information Systems, 2, 1 (1985), 5-17.

Habermas, J., Knowledge and Human Interest, 2nd Edition, London: Heinemann, 1978.

Hamilton, S. and N.L. Chervany, "Evaluating Information System Effectiveness - Part I: Comparing Evaluation Approaches," MIS Quarterly, (September, 1981a), 55-69.

Hamilton, S. and N.L. Chervany, "Evaluating Information System Effectiveness - Part II: Comparing Evaluator Viewpoints," MIS Quarterly, (December, 1981b), 55-69.

Heidegger, M., Being and Time, New York: Harper, 1962.

Hiltz, S.R. and M. Turoff, "The Evolution of User Behavior in a Computerized Conferencing System," Communications of the ACM, 24, 11 (1981), 739-751.

Hirschheim, R.A. and S. Smithson, "A Critical Analysis of Information Systems Evaluation," in N. Bjorn-Andersen and G.B. Davis (Eds.), Information Systems Assessment: Issues and Challenges, Amsterdam: North-Holland, 1988.

Hogue, J., and Watson, H., "Current Practices n the Development of Decision Support Systems," Proceedings of the Fifth International Conference on Information Systems, Tucson, 1984, 117-127.

Jick, T.D., "Mixing Qualitative and Quantitative Methods: Triangulation in Action," Administrative Science Quarterly, 24 (1979), 602-611.

Johnson, O., "Accounting Research Education: View or Vision," unpublished working paper, University of Illinois, 1989.

Kaplan, B. and D. Duchon, "Combining Qualitative and Quantitative Methods in Information Systems Research: A Case Study," MIS Quarterly, 12, 4 (1988), 571-587.

Keen, P.W., "Computer-Based Decision Aids: The Evaluation Problem," Sloan Management Review, 16, 3 (Spring, 1975), 17-30.

Keen, P.W., "Value Analysis: Justifying Decision Support Systems," MIS Quarterly (March, 1981), 1-14.

Kling, R., "Defining the Boundaries of Computing Across Complex Organizations," in R.J. Boland, Jr. and R. A. Hirschheim (Eds.), Critical Issues in Information Systems Research, New York: Wiley, 1987.

Kling, R. and S. Iacono, "The Control of Information Systems Developments After Implementation," Communications of the ACM, 27, 12 (1984), 1218-1226.

Kuhn, T.S., The Structure of Scientific Revolution (2nd edition), Chicago: University of Chicago Press, 1970.

Lakatos, I. "Falsification and the Methodology of Scientific Research Programmes," in I. Lakatos and A. Musgrave (Eds.), Criticism and the Growth of Knowledge, Cambridge: Cambridge University Press, 1970.

Laudon, K., "Data Quality and Due Process in Large Interorganizational Record Systems," Communications of the ACM, 29, 1 (1986), 4-11.

Legge, K., Evaluating Planned Organizational Change, New York: Academic Press, 1984.

Levy, J., "Psychobiological Implications of Bilateral Asymmetry," in S.J. Dimond and J.G. Beaumont (Eds.), Hemisphere Function in the Human Brain, New York: Wiley, 1974, 121-183.

Mann, F.C. and L.K. Williams, "Observations on the Dynamics of a Change to Electronic Data-Processing Equipment," Administrative Science Quarterly, 5 (1960), 217-256.

Mann, F.C. and L.R. Hoffman, Automation and the Worker: A Study of Social Change in Power Plants, New York: Wiley, 1960.

Markus, M.L. and D. Robey, "Information Technology and Organizational Change: Causal Structure in Theory and Research," Management Science, 34, 5 (May, 1988), 583-598.

Meals, D.W., "Systems Evaluation," Journal of Systems Management, (July, 1977), 6-9.

Meyer, A. D., "Iconic Data in Organizational Research," unpublished working paper, University of Oregon, 1985.

Morgan, G. and L. Smircich, "The Case for Qualitative Research," Academy of Management Journal, 5, 4 (1980), 491-500.

Patton, M.Q., How to Use Qualitative Methods in Evaluation, Beverly Hills: Sage Publications, 1987.

Pfeffer, J., Organizational Design, Arlington Heights, IL: AHM Publishing, 1978.

Pondy, L.R. and I.I. Mitroff, "Beyond Open Systems Models of Organization," in B.M. Staw (Ed.) Research in Organizational Behavior, Greenwich, Conn.: JAI Press, 1978.

Pondy, L.R., "The Two Faces of Evaluation," in H.W. Melton and D.J.H. Watson (Eds.), Interdisciplinary Dimensions of Accounting for Social Goals and Social Organizations, Columbus, OH: Grid Inc., 1977.

Popper, K.R., Conjectures and Refutations, 3rd Edition London: Routledge and Kegan Paul, 1972a.

Popper, K.R., The Logic of Scientific Discovery, London: Hutchinson, 1972b.

Robertson, D.C., "Social Determinants of Information Systems Use," Journal of MIS, in press.

Russell, B., A History of Western Philosophy, New York: Simon, 1945.

Rushinek, A., and S.F. Rushinek, "An Evaluation of Mini/Micro Systems: An Empirical Multivariant Analysis," Database (Summer, 1983), 37-47.

Schutz, A., Collected Papers, Vol. 1: The Problem of Social Reality, (M. Natanson Ed.), The Hague: Nijhoff, 1962.

Scott, W.R., S.M. Dornbusch, B.C. Busching, and J.D. Laing, "Organizational Evaluation and Authority," Administrative Science Quarterly, 12 (1967), 93-117.

Simon, H.A., "On the Forms of Mental Representation," working paper #344, Carnegie-Mellon University, 1977.

Sprague, R.H., Jr. and E.D. Carlson, Building Effective Decision Support Systems, Englewood Cliffs, NJ: Prentice-Hall, 1982.

Srinivasan, A., "Alternative Measures of System Effectiveness: Associations and Implications," MIS Quarterly, 9, 3 (September, 1985), 243-253.

Strassman, P., Information Payoff: The Transformation of Work in the Electronic Age. New York: Free Press, 1985.

Streufert, S. and R.W. Swezey, Complexity, Managers, and Organizations, New York: Academic Press, 1986.

Taggart, W. and D. Robey, "Minds and Managers: On the Dual Nature of Human Information Processing and Management," Academy of Management Review, 6 (1981), 187-195.

Thorngate, W., "'In General' Vs. 'It Depends,': Some Comments on the Gergen-Schlenker Debate," Personality and Social Psychology Bulletin, 2 (1976), 404-410.

Toulmin, S., Human Understanding, Vol. 1, Princeton, NJ: Princeton University Press, 1972.

Uttal, Bro, "What's Detaining the Office of the Future?," Fortune (May 3, 1982), 176-196.

Webb, E.J., D.T. Campbell, R.D. Schwartz, and L. Sechrest, Unobtrusive Measures, Chicago, IL.: Rand McNally, 1966.

Weick, K.E., The Social Psychology of Organizing, Reading, MA: Addison-Wesley, 1979.

Weick, K.E., "Contradictions in a Community of Scholars: the Cohension-Accuracy Tradeoff," The Review of Higher Education, 6, 4 (1983), 253-267.

Weick, K.E., "Theoretical Assumptions and Research Methodology Selection," in F.W. McFarlan (Ed.), The Information Systems Research Challenge, Boston, MA: Harvard Business School Press, 1984.

Whitley, R., The Intellectual and Social Organization of the Sciences, Oxford: Clarendon Press, 1984.

Zmud, R.W. and L.E. Apple, "Measuring the Infusion of a Multi-Business Unit Innovation," unpublished working paper, Florida State University, 1989.