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INFORMATION TECHNOLOGY AND ORGANIZATIONAL CHANGE: CAUSAL STRUCTURE IN THEORY AND RESEARCH*

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This article concerns theories about why and how information technology affects organizational life. Good theory guides research, which, when applied, increases the likelihood that information technology will be employed with desirable consequences for users, organizations, and other interested parties.

But what is a good theory? Theories are often evaluated in terms of their content—the specific concepts used and the human values served. This article examines theories in terms of their structures—theorists' assumptions about the nature and direction of causal influence. Three dimensions of causal structure are considered—causal agency, logical structure, and level of analysis. Causal agency refers to beliefs about the nature of causality: whether external forces cause change, whether people act purposefully to accomplish intended objectives, or whether changes emerge unpredictably from the interaction of people and events. Logical structure refers to the temporal aspect of theory—static versus dynamic—and to the logical relationships between the "causes" and the outcomes. Level of analysis refers to the entities about which the theory poses concepts and relationships—individuals, groups, organizations, and society.

While there are many possible structures for good theory about the role of information technology in organizational change, only a few of these structures can be seen in current theorizing. Increased awareness of the options, open discussion of their advantages and disadvantages, and explicit characterization of future theoretical statements in terms of the dimensions and categories discussed here should, we believe, promote the development of better theory.

(INFORMATION TECHNOLOGY; ORGANIZATION CHANGE; CAUSAL STRUCTURE)

Introduction

The relationship between information technology and organizational change is a central concern in the field of Information Systems (IS). In the 30 years since Leavitt and Whisler's (1958) seminal article, "Management in the 1980's," speculations on the role of information technology in organizations and its implications for organizational design have flourished. Few researchers in the IS field question the importance of the issue. In an empirical investigation of literature citation patterns, Culnan (1986) traced the origins of the IS field to Leavitt and Whisler's article and identified "computer impacts" as a clear subfield within it.

Unfortunately, the literature on information technology and organizational change does not currently support reliable generalizations about the relationships between information technology and organizational change. There are several reasons for this. The literature contains works by researchers from several academic disciplines and interdisciplinary specialties, including organizational theory, management science, sociology, and computer science, each with its own preferred concepts and theoretical and methodological biases. It includes conflicting and unclear definitions and measures of information technology (Bakopoulos 1985) and organizational structure (Fry 1982). Finally, it mixes and crosses units and levels of analysis from the individual, the

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workgroup, the department, the organization, and society—a practice which leads some observers to fear improperly specified models and ungeneralizable findings (Freeman 1978, Rousseau 1985).

One important approach to solving these problems is to focus on the *substance* of theory, such as concept definition and normative orientation. For example, Kling (1980) has identified and defined six theoretical perspectives in social analyses and empirical research on computing. These perspectives are distinguishable from each other by their respective definitions of technology and social setting, theoretical constructs, beliefs about the dynamics of technical diffusion, evaluations of "good" technology, and ideologies of the workplace. Kling and Scacchi (1982) have discussed the differing assumptions about technology, infrastructure, and the dynamics of change in "discrete-entity" versus "web" models.

Our approach differs from but complements Kling's analyses of theory substance. Instead, we focus on the *structure* of theory, that is, researchers' conceptions of the nature and direction of causality. We believe that sound theoretical structure, like good theoretical substance, is necessary for better theory. Our purpose in this paper is to analyze the causal structure of the theoretical models found in the literature on information technology and organizational change.

The causal structure of theoretical models comprises three dimensions: causal agency, logical structure, and level of analysis. Causal agency refers to beliefs about the nature of causality: whether external forces cause change (the technological imperative), whether people act purposefully to accomplish intended objectives (the organizational imperative) or whether change emerges from the interaction of people and events (the emergent perspective). Logical structure refers to the time span of theory (static versus dynamic) and to the hypothesized relationships between antecedents and outcomes: whether causes are related to outcomes in an invariant, necessary and sufficient relationship (variance models), or in a recipe of sufficient conditions occurring over time (process models). Level of analysis refers to the entities about which the theory poses concepts and relationships—individuals, collectives, or both. These three dimensions of causal structure are shown in Figure 1.

Causal structure cannot easily be separated from issues of theory substance and from various methodological issues. But a thorough understanding of causal structure requires a depth of treatment not usually found in methodological critiques (e.g., Attewell and Rule 1984; Rice 1980; Robey 1977). Consequently, our focus on causal structure will exclude several important concerns which must also figure prominently in the development and testing of good theory.

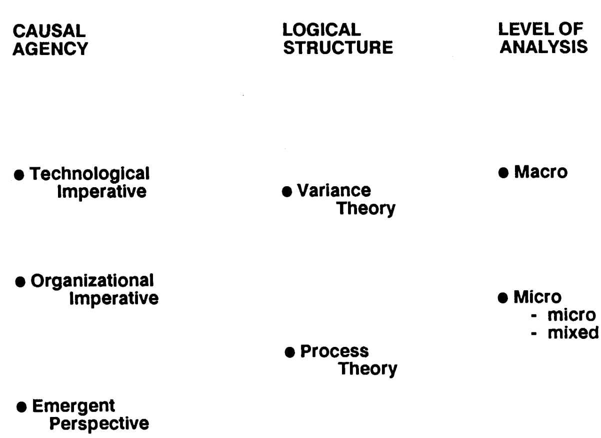

FIGURE 1. Dimensions of Causal Structure.

Causal Agency

Causal agency refers to the analyst's beliefs about the identity of the causal agent, the nature of causal action and the direction of causal influence among the elements in a theory. Pfeffer (1982), for example, has identified three perspectives on action in organizational theory. In the "situational control" perspective, external factors or events constrain or force people and organizations to behave in certain ways. In the "rational actor" perspective, people and organizations evaluate alternative courses of action and exercise free rational choice. In the "emergent" perspective on action, the behavior of people and organizations emerges from a dynamic interaction of external circumstances and internal motives or interests.[1]

Building upon the work of Pfeffer, we have identified three conceptions of causal agency in the literature on information technology and organizational change. We label these: the technological imperative, the organizational imperative and the emergent perspective. In the technological imperative, information technology is viewed as a cause of organizational change. In the organizational imperative, the motives and actions of the designers of information technologies are a cause of organizational change. In the emergent perspective, organizational change emerges from an unpredictable interaction between information technology and its human and organizational users. Each of these perspectives is discussed more fully below and summarized in Figure 2.

The Technological Imperative

The essence of the technological imperative is conveyed by the word "impact." This perspective views technology as an exogenous force which determines or strongly constrains the behavior of individuals and organizations. The technological imperative is consistent with Pfeffer's (1982) situational control perspective on action in organizations. "In this view, action is seen not as the result of conscious, foresightful choice but as the result of external constraints, demands, or forces that the social actor may have little control over or even cognizance of" (Pfeffer 1982, p. 8).

For example, Leavitt and Whisler (1958) argued that information technology would alter dramatically the shape of organizations and the nature of managerial jobs. Organizations would recentralize, levels of middle management would disappear, and a top management elite would emerge. Leavitt and Whisler urged managers to prepare for these inevitable impacts by developing their internal technological capabilities and their liaisons to external technological resources.

Simon (1977) was less pessimistic than Leavitt and Whisler in his predictions about the impact of computers, but no less deterministic. Simon contended that computers would not change the basic hierarchical nature of organizations, but would recentralize decision making. Line organizational structures would shrink in size, and the number of levels would decrease. Staff departments would increase in number and size, making structures more complex and requiring more lateral interaction.

While the technological imperative has a long history and makes some compelling claims, empirical research has generated contradictory findings on almost every dimension of hypothesized computer impact (Robey 1977; Kling 1980; Attewell and Rule 1984). Information systems have been found both to enrich and routinize jobs

[1] Slack (1984) makes similar distinctions among various conceptions of causality in an analysis of communication technologies. "Simple" causality views technology as an independent entity capable of effecting change in social systems. "Symptomatic" causality also presumes technologies to be discrete phenomena, but their effects may be mediated by social forces such as the intentions of rational actors. Slack views both simple and symptomatic conceptions of causality as mechanistic in their basic assumptions. Her descriptions of "expressive" and "structural" causality correspond more closely to Pfeffer's emergent perspective on action in that the distinctions between cause and effect are not sharply drawn.

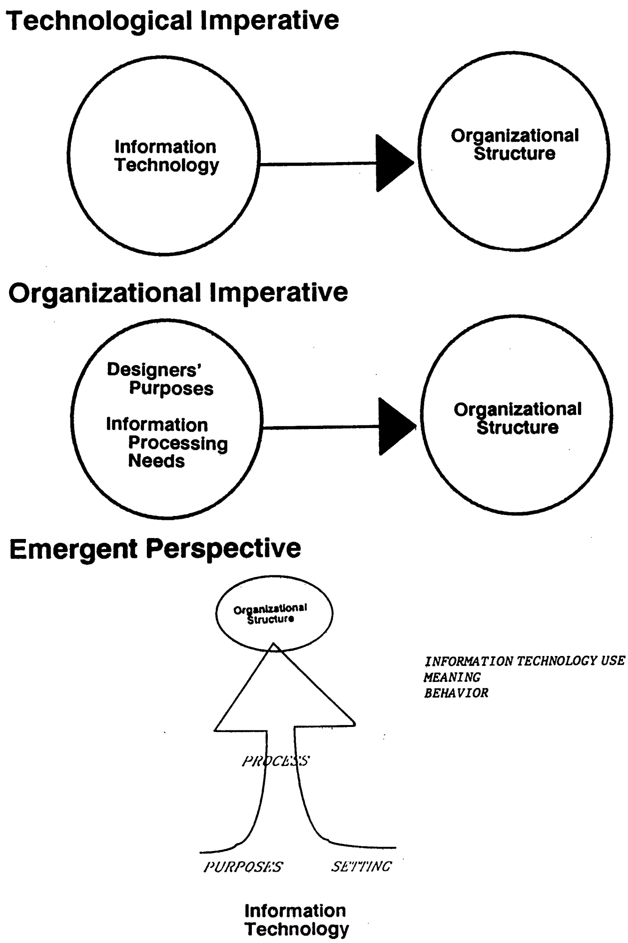

FIGURE 2. Causal Agency.

(Kling 1978; Bjørn-Andersen, Eason, and Robey 1986), both centralize and decentralize authority (Klatzky 1970; Whisler 1970; Stewart 1971; Blau, Falbe, McKinley, and Tracy 1976; Carter 1984; Foster and Flynn 1984; Dawson and McLaughlin 1986), and produce no changes where changes were expected (Robey 1981; Franz, Robey, and Koeblitz 1986).

Some investigators have proposed that contingencies affect the relationship between information technology and structural change. For example, in a review of studies conducted during the 1960s and early 1970s, Robey (1977) observed that computing appeared to support an existing decentralized structure in organizations with uncertain environments. However, in simple environments, computing appeared to strengthen a centralized authority structure. Robey suggested that computing technology be viewed as a moderating variable, affecting the strength of a causal relationship between environmental uncertainty and organizational structure.

Other contingencies have also been examined. Leifer and McDonough (1985) controlled for task routineness and found that departments using a computer-based system were more centralized, less complex, and perceived less environmental uncertainty that those not using the computer. Klatzky (1970) asserted that size was partially responsible for the decentralization of decision making that accompanied the use of information technology. Carter (1984) found that organizational size moderated the relationship between information technology and the structure of newspaper organizations. Pfeffer and Leblebici (1977) controlled for both size and environmental complexity in their study of the use of information technology in 38 small manufacturing companies. Majchrzak and Mosher (1987) used three different analysis strategies to examine organizational structure as a contingency in the technology/performance relationship at the individual level of analysis.

The Organizational Imperative

Whereas the technological imperative argues that information technology constrains or determines human and organizational behavior, the organizational imperative assumes almost unlimited choice over technological options and almost unlimited control over the consequences. The organizational imperative corresponds to Pfeffer's "intendedly rational" perspective on action. It assumes that behaviors are chosen, that such choices occur according to a set of consistent preferences, that choices occur prior to the action itself, and that action is goal directed (Pfeffer 1982, p. 6). This perspective holds that human actors design information systems to satisfy organizational needs for information.[2] Thus, information technology is the *dependent* variable in the organizational imperative, caused by the organization's information processing needs and manager's choices about how to satisfy them.

In a widely known version of this perspective, Galbraith (1977) proposed a number of organizational design alternatives by which organizations can fill the information processing needs generated by uncertainty. Managers may reduce the need to process information by managing the environment, by using slack resources, or by creating self-contained organizational units. Managers may also increase the capacity of organizations to process information by developing lateral relations and building information systems.

A similar causal argument is evident in the work of Daft and MacIntosh (1978, 1981). They hypothesized information needs to vary with task variety and knowledge about the task and proposed a relationship between information processing needs and use of information systems. Unanalyzable, nonroutine tasks require rich information, capable of conveying complex and equivocal meanings; facial expressions and voice are the media most capable of processing this rich qualitative information. Concise, computer-based information systems are more appropriate for simpler information processing requirements, according to Daft and his colleagues (see Daft and Weick 1984; and Daft and Lengel 1986).

Not surprisingly, the normative literature on information system design evinces considerable optimism about the degree of human influence over the capabilities and characteristics of information systems (Olson 1982; Olson and Lucas 1982; Olson and Turner 1985). Contextual variables, which an external or situational control perspective might view as constraints or determinants, are viewed in the organizational imperative as contingencies that managers should take into account. Among these contextual variables are work unit technology, organizational level, environment, decision making style, and uncertainty (Whisler 1975; Gordon and Miller 1976; Waterhouse and Tiessen 1978; Ginzberg 1980; Olerup 1982; Gorry and Scott Morton 1971).

The assumption of designer discretion stands in sharp contrast to the external determinism of the technological imperative. The organizational imperative assumes that systems designers can manage the impacts of information systems by attending to both technical and social concerns (Bjørn-Andersen et al. 1986; Mumford and Weir 1979).

[2] These needs are sometimes viewed as externally generated—derived from uncertainty originating in the environment or in work technology (Galbraith 1977; Daft and MacIntosh 1981; Daft and Lengel 1986; Tushman and Nadler 1978).

This view is shared by management and organization theorists who see information technology as a tool for solving organizational problems (Child 1984; Huber 1984; Huber and McDaniel 1986).

Empirical support for the organizational imperative is limited. While studies by Daft and MacIntosh (1981), Specht (1986), and Olerup (1982) support the notion that organizational characteristics correlate with information system characteristics, the models of Galbraith (1977) and Tushman and Nadler (1978) have received mixed empirical support (Tushman 1979; Morrow 1981; Penley 1982; Triscari and Leifer 1985; Saunders and Robey 1986). Unfortunately, most of these studies fail to assess designers' intentions and thus cannot be regarded as complete tests of the organizational imperative.

The Emergent Perspective

The emergent perspective holds that the uses and consequences of information technology emerge unpredictably from complex social interactions. This perspective corresponds to Pfeffer's "emergent" view of action in organizations: "Because participation in organizational decisions is both segmented and discontinuous, because preferences develop and change over time, and because the interpretation of the results of actions —the meaning of history—is often problematic; behavior cannot be predicted *a priori* either by the intention of individual actors or by the conditions of the environment" (1982, p. 9).

Kling and Scacchi's (1982) distinction between "discrete-entity" models and "web" models of computing provides a useful starting point for a discussion of the emergent perspective on information technology and organizational change. Discrete-entity models conceive of information technology as a tool with identifiable benefits, costs, and skill requirements. Like the organizational imperative, discrete-entity models assume that the goals of designers guide the development of computing applications. By contrast, web models conceive of information technology as an ensemble of equipment, applications, and techniques that carry social meanings. The primary virtue of web models is empirical fidelity, their ability to account for the details and complexities of actual situations. Their characteristic problem is analytical cumbersomeness (1982, p. 10).

Central concepts in the emergent perspective are the role of the computing infrastructure, the interplay of conflicting objectives and preferences, and the operation of nonrational objectives and choice processes. For example, Gasser's (1986) study of the integration of computing and routine work examined the misalignment between demands of the work setting and the computing resources available. Gasser identified strategies by which organizational actors coped with slippage between technology and work demands and discussed how the nature of routine work changed as a result. Rather than attributing change to actor intent or exogenous technology, Gasser focused on the dynamic interplay among actors, context, and technology.

In another recent example of an emergent model, Barley (1986) studied the introduction of computerized tomography (CT scanners) in radiology. He demonstrated that these technologies can alter the organizational and occupational structure of radiological work. However, "the identical technologies can occasion similar dynamics and yet lead to different structural outcomes" in different settings (1986, p. 105). In Barley's analysis, the scanners occasioned change not because of their inherent characteristics (as the technological imperative would hold), but "because they became social objects whose meanings were defined by the context of their use" (p. 106). The technology presented an "occasion" for structural change but did not determine which of a large variety of alternatives actually emerged from the process of structuring.

The emergent perspective admits greater complexity to the issue of causal agency and to the goal of predicting organizational changes associated with information technology. By refusing to acknowledge a dominant cause of change, emergent models differ qualitatively from the deterministic causal arguments of the two imperatives. Prediction in the emergent perspective requires detailed understanding of dynamic organizational processes in addition to knowledge about the intentions of actors and the features of information technology. This added complexity makes emergent models difficult to construct (Bendifallah and Scacchi 1987; Kling 1987).

Normative Implications

The three perspectives on causal agency presented here differ in their attributions of responsibility for the outcomes observed. These attributions imply that particular interventions will be more or less efficacious in producing or increasing the likelihood of desirable outcomes. Consequently, analysts of different persuasions can often be distinguished as easily (or more so) by their normative stance as by the specifics of their models (Mowshowitz 1981).

Technological imperative analysts hold that information technology generally or some particular constellation of technological features is responsible for "impacts" such as change in organizational structure, skill enhancement or deskilling of workers, or change in employment opportunities. Consequently, the policies and remedies proposed by these analysts center on stopping, slowing or accelerating the rate of change in information technology or selecting information technologies with particular packages of features. Organizational imperative analysts attribute the consequences of information technology to the choices and behaviors of managers and system designers. Consequently, these analysts tend to prescribe improved design and resource allocation methods and better implementation strategies and tactics. Because emergent analysts attribute outcomes to an unpredictable interaction of technological features and actors' intentions, their normative posture is less clear than those considered above. Some emergent analysts eschew intervention, arguing that prediction is impossible and outcomes are indeterminate; others advocate "emancipatory" strategies, such as extensive user participation in the analysis, design, and implementation of information technology.

Logical Structure

A second dimension of theoretical structure concerns the logical formulation of the theoretical argument. On this dimension, Mohr (1982, Chapter 2) distinguishes between variance and process theories. The distinction in theoretical structure between variance and process theories is somewhat analogous to the distinction between cross-sectional and longitudinal research methodologies. Variance theories are concerned with predicting levels of outcome from levels of contemporaneous predictor variables; variance theories are concerned with explaining how outcomes develop over time.

Variance and Process Theories

Mohr (1982) explains the difference between variance theories and process theories in terms of the hypothesized relationships between logical antecedents and outcomes. These are summarized in Figure 3. In variance theories, the precursor (loosely, that which might be referred to as the "cause") is posited as a necessary and sufficient condition for the outcome.[3] For example, in a variance theory that hypothesizes use of information technology as a cause of organizational centralization (cf. Leavitt and

[3] There is a superficial resemblance between variance theories and regression models, but the two are not identical. Many regression models contain variables which predict the outcome but which are not hypothesized to be "causal" in the necessary and sufficient sense (Mohr 1982, Chapter 2).

	VARIANCE THEORY	PROCESS THEORY
ROLE OF TIME	Static	Longitudinal
DEFINITION	The cause is necessary and sufficient for the outcome	Causation consists of necessary conditions in sequence; chance and random events play a role
ASSUMPTIONS	Outcome will invariably occur when necessary and sufficient conditions are present	Outcomes may not occur (even when conditions are present)
ELEMENTS	Variables	Discrete outcomes
LOGICAL FORM	If X, then Y; if more X, then more Y	If not X, then not Y; cannot be extended to "more X" or "more Y"

FIGURE 3. Logical Structure.

Whisler 1958), centralization is expected always to occur whenever information technology is used (where "always" is defined in terms of statistical confidence levels). In process theories, the precursor is assumed insufficient to "cause" the outcome, but is held to be merely necessary for it to occur.

In general, necessary conditions *alone* cannot constitute a satisfactory theory. For example, while water may be necessary for the growth of plants, it is not sufficient; therefore, it cannot be considered the cause of plant growth. Mohr has observed, however, that necessary conditions can comprise a satisfactory causal explanation when they are combined in a "recipe that strings them together in such a way as to tell the story of how [the outcome] occurs whenever it does occur" (1982, p. 37). In short, outcomes are (partially) predictable from a *knowledge of process*, not from the level of predictor variables.

A good example of a process theory is the "garbage-can" theory of organizational choice (Cohen, March and Olson 1972). In this model, decisions result from the (almost) random collisions of participants, choice opportunities, solutions, and decisions. Many diffusion of innovation theories are process theories, at least implicitly. Barley's study (1986) of CT scanning in radiology also meets the requirements of a process theory.

Markus (1984) proposed a process theory for explaining user resistance to information systems. Included as a necessary condition for user resistance in this "recipe" is the introduction of an information system with features differing from the features of the organizational setting. This necessary condition is not believed sufficient to ensure the occurrence of resistance, but it is believed to be necessary. Consequently, this process theory recognizes that resistance may not always occur, even when the necessary condition of "differing features" is present. In any given case, resistance may not occur for several possible reasons: people may like the changes embodied in the system; they may be too apathetic to resist; or they may find ways to circumvent the changes the system implies. More accurate predictions are only possible when these additional ingredients of the setting are known and their temporal relationships to each other are understood.

Another example of a process theory of information technology is the work of Zmud and Apple (1988) on optical scanning technology in supermarkets. Zmud and Apple distinguish between the routinization of an innovation, defined as the accommodation of an organization's governance system to the innovation, and its institutionalization, defined as the organization's achievement of higher levels of use and benefits from the innovation. They argue persuasively that these two concepts are related in a necessary but not sufficient fashion. Routinization is necessary for institutionalization, but institutionalization is not certain to occur when an innovation is routinized.

Variance theories, then, differ from process theories in their assumptions about the relationship between antecedents and outcomes. Variance theories posit an invariant relationship between causes and effects when the contingent conditions obtain. Process theories assert that the outcome can happen only under these conditions, but that the outcome may also fail to happen.[4]

Variance and process theories also differ in their conceptualization of outcomes and precursors. In variance theories, these constructs are usually conceptualized as variables: entities which can take on a range of values. This practice allows the prediction of the full range of values of the outcome variable. For example, if the use of information technology is necessary and sufficient for organizational centralization, then *increased use* of information technology should lead to *greater* centralization.

In process theories, however, outcomes are not conceived as variables that can take on a range of values, but rather as discrete or discontinuous phenomena, that might be called "changes of state." Process theories cannot be extended, as variance theories can, to explain or predict what happens when there is "more" of a precursor variable. Thus, if a process theory specifies that certain conditions are sufficient to cause user resistance, it does not follow that more of these conditions will mean more resistance.

To illustrate, in their study of the adoption of supermarket scanners, Zmud and Apple (1988) identified three distinct levels of institutionalization, each accompanied by a unique ideology of the organizational role served by scanners: to enforce retail unit worker discipline, to possess the capability of better managerial information, and to provide better managerial information. While a "higher level" of institutionalization includes the "lower level" states, the levels are better conceived as qualitatively different outcomes than as varying degrees of a single dimension.

Mohr (1982) believes that variance and process theories can "peacefully coexist," but that the distinctions between them should not be blurred in an attempt to gain the advantages of both within a single theoretical approach. He offers three reasons for this position. First, for any variance theory, it is always possible to specify mechanisms that intervene between antecedents and outcomes. But, because variance theories posit sufficiency, the inclusion of intervening variables does not improve prediction of the outcome variable. In short, intervening variables are redundant, unless one is "puzzled about the *means* of bridging the gap between one included phenomenon and another" (p. 43). Second, process theories can easily bog down under the imposition of conditions thought to increase the likelihood of the outcome (pp. 61–65). Third, while agreeing that process theories and variance theories may mutually inform each other, Mohr concludes that "odd bits and pieces of research results cannot be integrated or interchanged from one theoretical type to the other; the effort produces confusion and

[4] While contingency theories deal with necessary conditions, they are not process theories. They are variance theories, because the conditions they specify are both *necessary and sufficient* for the outcome to occur.

stagnation—the frustration of theory. Sorting the two out and keeping them separate, however, produces clarity and the basis of progress" (1982, pp. 67–68).

Relationship between Causal Agency and Logical Structure

At first glance, it may appear that all imperative theories are variance theories and all emergent theories are process theories. Slack (1984) and Mohr (1982) appear to support this observation. Indeed, we find it hard to imagine how emergent theories could effectively be cast as variance models. However, both variance and process models are available to analysts from the perspective of either the technological or the organizational imperative. An example of a technological imperative process model should suffice to make the point.

An early formulation of the technological imperative can be seen in the work of Ellul (1964) and Winner (1977). Ellul argued that technology creates social changes which reach far beyond its original applications. Once developed, technology follows a self-sustaining evolutionary path with the dynamic that whatever can be developed must be developed. Thus, techniques carry in themselves the seeds of new applications. Winner extended Ellul's theory by noting the role of supporting infrastructures, such as the huge power plant required to supply electricity for small appliances. These supporting infrastructures institutionalize and perpetuate the technologies they were originally created to support.

Initially, the inevitability of technological impact—the hallmark of the technological imperative—appears to be the salient feature of Ellul's and Winner's arguments. Yet a long historical perspective reveals many technologies that have been abandoned without trace or consequence. What seems to make the difference for a technology to have an extensive and enduring impact is the formation of an infrastructure, which, once established, perpetuates itself and institutionalizes the use of the technology. In process theory terms, the development of the infrastructure is a necessary condition (but not necessary and sufficient) for social changes to occur.

Advantages of Process Theories

To say that process models are possible does not provide a convincing rationale for their use. While we do not argue that process models are superior to variance models, process models have been unjustly neglected in favor of the more common variance theories.[5] Analysts should consider the following advantages of process theories when formulating the logical structure of their theories.

By their very structure, variance theories posit an invariant relationship between antecedents and outcomes. This assumption may simply be too stringent for social phenomena. Put differently, if a behavioral outcome occurs only some of the times when its antecedents are present, then it may not be possible to establish an invariant relationship between the antecedents and outcome, even with generous statistical confidence levels. As Sutherland has put it, "not all real-world phenomena will ultimately become deterministic if we spend enough time analyzing them." (1973, p. 145) In circumstances like these, process theories may enable researchers to find patterns in empirical data that variance theorists might miss.

Process theories have another advantage. While they retain the empirical fidelity of the emergent perspective, they also preserve the belief in the regularity and predictability of social phenomena that characterizes the technological and organizational imperatives. Prediction of patterned regularities over time is one of the goals of process theory

[5] Some of this neglect may stem from the disrepute of information systems "stage" models. Mohr (1982) describes stage models as incomplete process models, because they generally lack specification of the mechanism by which subsequent stages come about.

research. By contrast, some critics of variance theory research take a strong antipositivist stance, arguing that prediction of human action (such as the use of information systems) is not a legitimate pursuit.[6]

Thus, while empirical process research typically reveals that things are more complicated than variance theory represents them to be, such research should not be dismissed as isolated stories or illustrative cases only. With care, findings can be generalized to other settings, and predictions can be tested in later research. The advantage of process theories is that these predictions may correspond more faithfully to actual events in organizations than do the typical predictions of variance formulations.

In summary, we believe that process theories are useful precisely because, while recognizing and accepting the complexity of causal relationships, they do not abandon the goals of generalizability and prediction. By accepting a more limited definition of prediction, one in which the analyst is able to say only that the outcome is likely (but not certain) under some conditions and unlikely under others, process theorists may be able to accumulate and consolidate findings about the relationship between information technology and organizational change.

Level of Analysis

The specific theories and research studies discussed in this paper concern three different types of entities, or levels of analysis: individuals, organizations, and society. Questions about the appropriate level of analysis have been widely debated in the social sciences generally, but have rarely been explicitly discussed within those research communities concerned with the causes and consequences of information technology in organizations. The debate centers on two issues: problems of inference and ideological biases (Pfeffer 1982).

Problems of inference arise when concepts are defined and data are collected at levels of analysis inappropriate for the theoretical propositions being examined. For example, researchers interested in organizational goals often collect data on the goals of key individuals. When inferences drawn from these data refer only to organizational goals, levels of analysis have been confused. Avoiding such inference problems requires the researcher "to bound the organization in such a way that observed units are unambiguously separable from each other and from their environments in both space and time" (Freeman 1978, p. 336).

Ideological biases originate in the orientations of different disciplinary groups (Rousseau 1985). The customary division of levels of analysis into "macro-level" and "micro-level" theories reflect disciplinary boundaries, each with its favored research questions, acceptable methodologies, and conventions for reporting results. The concepts in macro-level theories are properties of large-scale collectives (organizations, populations, societies); this level of analysis is favored by macrosociologists, macroeconomists, and evolutionary theorists. The concepts in micro-level theories are properties of individuals and small groups; this level of analysis is favored by social psychologists and microeconomists.

Macro-level and micro-level proponents tend to prefer different causal structures. Macro sociological theory typically explains phenomena by referring only to macro-

[6] For example, Boland (1985) argues for a phenomenology of information science in which researchers "read the interaction during system design and use it in order to interpret the significance and potential meanings they hold" (p. 196). Hirschheim and Klein (1985; Klein and Hirschheim 1983; Hirschheim 1985) argue for a "consequentialist" perspective, based on hermeneutic analysis. Phenomenology and hermeneutics strive for subjective "understanding," and view prediction as an illegitimate goal. Lyytinen and Klein (1985) take a critical theory perspective toward information system research. In critical theory, the aim is intervention to alleviate current conditions. Prediction is irrelevant to critical theorists, since outcomes are assumed to be under the control of actors.

level concepts. Stinchcombe (1968), for example, discusses three types of causal structures—demographic, functional, and historicist—which explain social phenomena without introducing such concepts as individual attitudes, intentions, motives and choices.

Proponents of macro-level analysis argue that it is a productive strategy for generating "falsifiable, parsimonious, and readily comprehensible explanations for behavior" (Pfeffer 1982, p. 256). Critics argue that macro-level theories suffer from data insufficiency, failure to explain how macro relationships come about, and the need to assume the existence of a social system as a starting point (Coleman 1986).

An example of a proposition from macro-level theory is Leavitt and Whisler's (1958) claim that the introduction of information technology causes change in organizational structure. This proposition contains no concepts about the individuals who populate the organization, design the information technology, use the information technology, and so on. As part of a variance theory, this statement does not require any articulation of the individual behaviors and processes by which the outcome occurs. By contrast, a corresponding micro-level construction of Leavitt and Whisler's proposition might include individuals' choices to use information technology, changed coordination patterns in the work unit, and managers' needs to maintain control.

Proponents of micro-level analysis argue that only people can act; collective bodies are incapable of action. Further, social collectives consist of individuals, and macro concepts like organizational structure are permissible only when it is possible to ground them in the individual behaviors and the micro-level events and processes that comprise them (Pfeffer 1982). Critics of the micro level of analysis accuse it of logical fallacy, confusing the question of causality with the assertion of an answer, reducing social phenomena to biological phenomena, and reliance on concepts "that logically reside in the heads of people" (Pfeffer 1982, p. 22).

In contrast to our caution against mixing process and variance theory, we believe that mixing levels of analysis may be useful in research and theory on information technology and organizational change. In defense of mixed-level theory, Rousseau (1985, 1986) asserts that technologies such as office automation are neither strictly micro nor macro in character. She believes that mixed-level research should abound in an interdisciplinary field where mixed-level phenomena are the inevitable subject of study (1985; pp. 2–3). That it does not is a disturbing commentary on the power of discipline-based research groups.

In one of the few systematic attempts to address the level of analysis issue for studies of computing, Kling (1987) proposes criteria for establishing the analytic boundaries of computer applications. He argues that populations, equipment, spatial and temporal elements should be included within the boundaries of an analysis when these elements either constrain actors involved in the specific application or are taken into account by the actors in constructing their actions. These criteria expand the focal situation to include larger social arenas, thus creating a need for mixed-level research strategies.

Coleman (1986) proposes one such mixed-level strategy: "not to remain at the macrosocial level but to move down to the level of individual actions and back up again" (p. 1322). An example of a mixed-level theory of information technology and structure is seen in Barley's (1986) work. The introduction of a new computer-based technology into a work setting (macro-level) affects the skills and competencies of the people in the work unit (micro-level). Interactions among people at different levels of skill create patterns of seeking and giving advice (micro-level). Ultimately, these patterns become institutionalized as formal organizational structure (macro-level). Barley's insights on the relationship between technology and structure depend on moving carefully across levels of analysis.

The role that mixed-level theory gives to human purpose and intention is consistent with Stinchcombe's conception of technology as "a description of the causal connection between the ends people have and what they have to do to achieve those ends" (1983; p. 122). Both macro-level theory and much micro-level research tend to ignore human intentions.[7] While the mixed-level strategy preserves macro-level concepts, it grounds these concepts in individual purposes and behavior and so remains "methodologically individualist" (Coleman 1986). Consequently, a mixed-level strategy remains vulnerable to the criticisms of macro-level proponents mentioned above.

In summary, theorists and researchers who study the relationship between information technology and organizational change have given little explicit attention in their writing to the choice of an appropriate level of analysis—macro, micro or mixed. Choice of any level is subject to criticism by proponents of the others, but researchers will be better able to respond to these criticisms after deliberate and thoughtful choice of the appropriate level of analysis for their own work.

Summary and Conclusions

Social theories embody researchers' conceptions of causality. In this paper we have discussed the causal structures found in theories about the relationship between information technology and organizational change. We have evaluated theory and research in the field by focusing our discussion on three dimensions of causal structure: causal agency, logical structure, and level of analysis.

Causal agency refers to analysts' assumptions about the identity of the causal agent and the direction of causal influence. Much of our thinking about information technology's consequences in organizations has been guided by theories with fairly simple notions of causal agency. The technological imperative views technology as causal agent, and the organizational imperative views human beings as agents of social change. A third conception of causal agency, the emergent perspective, attributes causality to complex indeterminant interactions between technology and human actors in organizations. Central to the emergent perspective is the social meaning ascribed to information technology. This perspective accounts for conflicting research findings about impacts by demonstrating the different meanings that the same technology acquires in different social settings.

Logical structure in theory refers to the nature of the relationship between elements identified as antecedents and those identified as outcomes. In variance theories, antecedents are conceived as necessary and sufficient conditions for the outcomes to occur. In process theories, antecedents are necessary but not necessary and sufficient. Process theories depend heavily on the specification of temporal relations among theoretical elements, much like a recipe strings together ingredients for a finished meal. Process theories have lower aspirations about "explained variance," but provide richer explanations of how and why the outcomes occur when they do occur.

Finally, level of analysis distinguishes more or less inclusive entities as the focus of analysis. The macro level of analysis focuses on societies and formal organizations; the micro level addresses individuals and small groups. Causal structures for macro levels of analysis explain social phenomena without using the constructs of individuals' mental processes, and many micro analysis ignore human purposes and intentions. Since theories about information technology in organizations are difficult to confine naturally to one level of analysis, mixed levels of analysis have become attractive to re-

[7] Coleman (1986) traces the popularity of micro-level theories of social phenomena to the development of statistical survey research methods in the 1940s. Inferences drawn from statistical associations within survey data formed the basis for causal explanations of behavior, but the methods had little natural affinity for the intentions or purposes of individuals. The causes of human behavior were theorized as either characteristics of the individual or characteristics of the individual's environment, without recourse to individual purpose or intention (1986, p. 1314). Coleman rejects macro-level theory, particularly because it attributes purpose or intention to collectives, but he regrets the tendency of much micro-level research to ignore individual purpose or intention.

searchers in this field. By consciously mixing levels of analysis, researchers can explore the dynamic interplay among individuals, technology, and larger social structures.

It is no secret that research on information technology and organizational change has produced conflicting results and few reliable generalizations. By carefully considering each of the dimensions of causal structure discussed in this paper, researchers should be able to construct sounder theories to guide more fruitful research. While attending to research design, sampling, measurement, statistical analysis, and other research techniques will also improve the state of the art, we believe that the more fundamental issues of theory construction must be addressed first. When assumptions about causal agency, logical structure, and levels of analysis are addressed explicitly, subsequent decisions about research strategy and technique will be better informed. For example, ethnography appears better suited to emergent process research at mixed levels of analysis than does survey research. Too often, we fear, research methods are elected for reasons other than their utility in serving a particular theoretical approach.

We cannot exclusively endorse any single combination of the dimensions we have discussed as the "correct" causal structure for research in information systems. All can serve the goals of interesting discovery and rigorous testing to which researchers normally aspire. However, some causal structures fare better when evaluated against criteria of simplicity and parsimony; others fare better when evaluated for "empirical fidelity," the ability to mirror faithfully the phenomena under study. We find little balance within our field between these two sets of criteria for evaluating theories. Much of the research on resistance to systems, growth of the information systems function in organizations, systems implementation, and the like, has adopted variance theory formulations of logical structure and an imperative conception of causal agency. We suspect that greater use of theoretical structures which emphasize empirical fidelity will stimulate more and better research on these phenomena.

In conclusion, careful examination of causal structures is a productive exercise in any field. Researchers interested in the consequences of information technology for organizations should make clear and conscious choices regarding the causal structures of their theories. These choices are at least as important as more technical research issues, perhaps more so. The discussion of causal structure in this paper should facilitate choice and critical thinking both for researchers and for those who apply research findings.[8]

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