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ORGANIZATIONAL INFORMATION REQUIREMENTS, MEDIA RICHNESS AND STRUCTURAL DESIGN*

RICHARD L. DAFT AND ROBERT H. LENGEL
Department of Management, Texas A & M University, College Station, Texas 77843
Department of Management and Marketing, University of Texas, San Antonio, Texas 78285

This paper answers the question, "Why do organizations process information?" Uncertainty and equivocality are defined as two forces that influence information processing in organizations. Organization structure and internal systems determine both the amount and richness of information provided to managers. Models are proposed that show how organizations can be designed to meet the information needs of technology, interdepartmental relations, and the environment. One implication for managers is that a major problem is lack of clarity, not lack of data. The models indicate how organizations can be designed to provide information mechanisms to both reduce uncertainty and resolve equivocality.
(INFORMATION IN ORGANIZATIONS; STRUCTURAL DESIGN; ORGANIZATION STRUCTURE)

1. Introduction

Why do organizations process information? The answer most often given in the literature is that organizations process information to reduce uncertainty. This line of reasoning began when Galbraith (1973) integrated the work of Burns and Stalker (1961), Woodward (1965), Hall (1962), and Lawrence and Lorsch (1967) in terms of information processing. Galbraith explained the observed variations in organizational form based upon the amount of information needed to reduce task related uncertainty and thereby attain an acceptable level of performance.

Galbraith (1973), (1977) proposed that specific structural characteristics and behaviors would be associated with information requirements, and a line of research and theorizing has provided support for this relationship. Studies by Tushman (1978), (1979), Van de Ven and Ferry (1980), Daft and Macintosh (1981), and Randolph (1978) support a positive relationship between task variety and the amount of information processed within work units. Van de Ven, Delbecq, and Koenig (1976) found that departmental communication increased as interdependence among participants increased. A number of other studies have found that either the amount or nature of information processing is associated with task uncertainty (Meissner 1969; Gaston 1972; Bavelas 1950; Leavitt 1951; Becker and Nicholas 1969).

Why do organizations process information? The organizational literature also suggests a second, more tentative answer: to reduce equivocality. This answer is based on Weick's (1979) argument that equivocality reduction is a basic reason for organizing. Equivocality seems similar to uncertainty, but with a twist. Equivocality presumes a messy, unclear field. An information stimulus may have several interpretations. New data may be confusing, and may even increase uncertainty. New data may not resolve anything when equivocality is high. Managers will talk things over, and ultimately enact a solution. Managers reduce equivocality by defining or creating an answer rather than by learning the answer from the collection of additional data (Weick 1979).

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Emerging research suggests that equivocality is indeed related to information processing. Daft and Macintosh (1981) found that equivocal data were preferred for ambiguous tasks, and managers used experience to interpret these cues. Putnam and Sorenson (1982) found that subjects used more rule statements and pooled diverse interpretations for equivocal than for unequivocal messages. Kreps (1980) reported that equivocal issues stimulated frequent communication feedback cycles in faculty senate meetings. Lengel and Daft (1984) reported that face-to-face media were preferred for messages containing equivocality, while written media were used for unequivocal messages. These findings suggest that when equivocality is high, organizations allow for rapid information cycles among managers, typically face-to-face, and prescribe fewer rules for interpretation (Weick 1979; Daft and Weick 1984).

Why do organizations process information? The literature on organization theory thus suggests two answers—to reduce uncertainty and to reduce equivocality. While these answers are different, in some respects they are also similar. Both answers say something about information processing, about how organizations and managers should behave in the face of these circumstances. Both answers have implications for the type of structure an organization should adopt to meet its information processing requirements to attain an acceptable level of performance (Lewin and Minton 1986).

The purpose of this paper is to integrate the equivocality and uncertainty perspectives on information processing. One purpose of organizational research and theory building is to understand and predict the structure that is appropriate for a specific situation (Schoonhoven 1981). The concept of information processing provides a useful tool with which to explain organizational design. The prevalent view in organization theory has been that organization design enables additional data processing to reduce uncertainty (Galbraith 1973, 1977; Tushman 1978; Tushman and Nadler 1978). This idea is important and is integrated with Weick's ideas about designing the organization to reduce equivocality through means other than obtaining more data. Specific organization structures are recommended depending on the extent of uncertainty and equivocality faced by the organization from its technology, departmental interdependence, and environment.

2. Background and Assumptions

Our approach to the study of organizations is based on several assumptions about organizations and information processing. The most basic assumption is that organizations are open social systems that must process information (Mackenzie 1984), but have limited capacity. Information is processed to accomplish internal tasks, to coordinate diverse activities, and to interpret the external environment. Human social systems are more complex than lower level machine or biological systems (Boulding 1956; Pondy and Mitroff 1979). Many issues are fuzzy and ill-defined. The interpretation of data cannot be fixed or routinized as in lower level systems (Cohen, March and Olsen 1972; Weick 1976). Despite the information complexity facing organizations, they have boundaries on their information capacity (March and Simon 1958; Simon 1960; Cyert and March 1963). All available information to interpret the world cannot be processed. Managers try to find decision rules, information sources, and structural designs that provide adequate understanding to cope with uncertainty. One challenge facing organizations is to develop information processing mechanisms capable of coping with variety, uncertainty, coordination, and an unclear environment.

The second assumption pertains to level of analysis in organizations. Individual human beings send and receive data in organizations, yet organizational information processing is more than what occurs by individuals (Hedberg 1981; Daft and Weick

1984). One distinguishing feature of organizational information processing is sharing. An individual decision maker may interpret data in response to a problem (Simon 1960; Ungson, Braunstein, and Hall 1981). Information processing at the organization level, however, typically involves several managers who converge on a similar interpretation. Another distinguishing feature of organization information processing is the need to cope with diversity not typical of an isolated individual. Decisions are frequently made by groups so a coalition is needed. But coalition members may have different interpretations of the same event, may be pursuing different organizational priorities or goals, and hence may be in conflict with respect to data interpretation or its significance for goal attainment (Ungson et al. 1981). Information processing at the organization level must bridge disagreement and diversity quite distinct from the information activities of isolated individuals.

The final assumption is that organization level information processing is influenced by the organizational division of labor (Burton and Obel 1980). Organizations are divided into subgroups or departments. Each department utilizes a specific technology that may differ from other departments (Hall 1962; Van de Ven and Delbecq 1974; Daft and Macintosh 1981; Daft 1986). For the organization to perform well, each department must perform its task, and the tasks must be coordinated with one another. Uncertainty and equivocality may arise from departmental technology, from coordination of departments to manage interdependence, or from the external environment (Tushman and Nadler 1978).

3. Two Information Contingencies

Uncertainty

Based on early work in psychology (Miller and Frick 1949; Shannon and Weaver 1949; Garner 1962), uncertainty has come to mean the absence of information. As information increases, uncertainty decreases. Uncertainty can be illustrated by a typical laboratory experiment. Laboratory subjects might play the game of 20 questions, wherein they receive yes-no answers to questions about the identity of an unknown object, which can be animal, vegetable or mineral (Bendig 1953; Taylor and Faust 1952). The "information" obtained from each answer can be precisely calculated as the increased probability that the subject can identify the object. Improvement in identifying the object is a reduction in uncertainty. When the person identifies the object correctly, uncertainty is gone so additional questions provide no additional information.

The definition of uncertainty as the absence of information persists in organization theory today (Tushman and Nadler 1978; Downey and Slocum 1975). Galbraith defined uncertainty as "the difference between the amount of information required to perform the task and the amount of information already possessed by the organization" (Galbraith 1977). Organizations that face high uncertainty have to ask a large number of questions and to acquire more information to learn the answers. The important assumption underlying this approach, perhaps originating in the psychology laboratory, is that the organization and its managers work in an environment where questions can be asked and answers obtained. New data can be acquired so that tasks are performed under a reduced level of uncertainty.

Equivocality

Equivocality means ambiguity, the existence of multiple and conflicting interpretations about an organizational situation (Weick 1979; Daft and Macintosh 1981). High equivocality means confusion and lack of understanding. Equivocality means that asking a yes-no question is not feasible. Participants are not certain about what

questions to ask, and if questions are posed, the situation is ill-defined to the point where a clear answer will not be forthcoming (March and Olson 1976). For example, Mintzberg et al. (1976) examined 25 organizational decisions, and in many cases did not find the type of uncertainty where alternatives could be defined and information obtained. They found instead decision making under ambiguity where almost nothing was given or easily determined. Managers had to define and figure things out for themselves. Little data could be obtained. Uncertainty as studied in the psychology laboratory did not characterize the ambiguity experienced by managers. A laboratory situation analogous to the ambiguity faced by managers would be to provide subjects with partial or contradictory instructions for the experimental game, or to leave it to subjects to figure out and create their own game.

Two Forces

Thus we propose that two complementary forces exist in organizations that influence information processing. One force is defined as uncertainty and is reflected in the absence of answers to explicit questions as has been studied in laboratory settings; the other force is defined as equivocality and originates from ambiguity and confusion as often seen in the messy, paradoxical world of organizational decision making. The two forces are analogous to an n-dimensional information space (Marschak and Radner 1972; Baligh and Burton 1981). Uncertainty is a measure of the organization's ignorance of a value for a variable in the space. Equivocality is a measure of the organization's ignorance of whether a variable exists in the space. When uncertainty is low, the organization has data that answer questions about variables in the space. When equivocality is low, the organization has defined which questions to ask by defining variables into the space. Each force has value for explaining information processing behavior, and each force leads to different behavioral outcomes. Equivocality leads to the exchange of existing views among managers to define problems and resolve conflicts through the enactment of a shared interpretation that can direct future activities. Uncertainty leads to the acquisition of objective information about the world to answer specific questions.

4. Integrating Framework

The two causes of information processing are combined into a single framework in Figure 1. The horizontal axis in Figure 1 represents organizational uncertainty. Under conditions of high uncertainty, the organization acquires data to answer a variety of

EQUIVOCALITY	Low	High
High	1. High Equivocality, Low Uncertainty Occasional ambiguous, unclear events, managers define questions, develop common grammar, gather opinions.	2. High Equivocality, High Uncertainty Many ambiguous, unclear events, managers define questions, also seek answers, gather objective data and exchange opinions.
Low	3. Low Equivocality, Low Uncertainty Clear, well-defined situation, managers need few answers, gather routine objective data.	4. Low Equivocality, High Uncertainty Many, well-defined problems, managers ask many questions, seek explicit answers, gather new, quantitative data.

UNCERTAINTY

FIGURE 1. Hypothesized Framework of Equivocality and Uncertainty on Information Requirements.

objective questions to solve known problems. The vertical axis in Figure 1 represents equivocality. Under conditions of high equivocality, managers exchange opinions to clarify ambiguities, define problems, and reach agreement. As a framework for analysis and discussion, equivocality and uncertainty are treated as independent constructs in Figure 1 although they are undoubtedly related in the real world. High levels of equivocality may require some new data as well as clarification and agreement. Circumstances that demand new data may also generate some need for additional interpretation and definition. However, as independent constructs the two dimensions in Figure 1 provide theoretical categories that can help explain both the amount and form of information processing in organizations.

Cell 1. This cell is typified by a stream of only a few events that are equivocal and poorly understood. Managers encounter occasional situations for which they may not know what questions to ask or what problem to solve. Managers rely on judgment and experience to interpret these events. They exchange views to enact a common perception. Answers are obtained through subjective opinions rather than from objective data. One example would be the feasibility of acquiring Corporation X. Would it fit strategically and organizationally and accomplish the desired outcomes? No one knows; no data can say for sure. Managers can only discuss this equivocal issue until they define whether a problem exists and that acquiring Corporation X is their solution. Goal setting is another example. Managers from engineering, marketing, and production may disagree about goal emphasis for the company, and no outside data will resolve this issue. Approaches to resolve Cell 1 equivocality are the Delphi technique (Delbecq, Van de Ven, and Gustafson 1975) and dialectical inquiry (Mitroff and Emshoff 1979). These techniques arrange for the exchange or even clash of subjective opinions when no objective data are available to predict an event or formulate strategy. Through the process of formally exchanging information, a common grammar and judgment evolves, equivocality is reduced, and a common perspective emerges.

Cell 4. This cell represents a situation where uncertainty is high. The equivocality of events confronting managers is low, but managers need additional information about many issues. They know what questions to ask and the source of external data. For example, if turnover among clerical employees is increasing, managers might conduct a survey of reasons for leaving. If the question pertains to the reaction of customers to certain product colors and labels, a special study may provide the answer. If inventory outages cause customer alienation, data about customer ordering patterns may lead to an algorithm for inventory management. Information processing in this situation involves data acquisition and systematic analysis. Cell 4 uncertainty represents the absence of explicit information. The organization is motivated to acquire and process data to answer important questions.

Cell 2. Both equivocality and uncertainty are high in Cell 2. Many issues are poorly understood and participants may be in disagreement. Issues also may be amenable to the gathering of new data that may influence managers' interpretation of events. A special study might be undertaken to gather data that can be combined with discussion and managerial judgment to reduce both equivocality and uncertainty. A Cell 2 situation would probably be characterized by rapid change, unanalyzable technology, unpredictable shocks, and trial and error learning (Daft and Weick 1984). Cell 2 could occur during times of rapid technological development, within emerging industries, or during the launching of new products. Some answers can be obtained through rational data collection, and other answers require subjective experience, judgment, discussion, and enactment.

Cell 3. A Cell 3 situation represents a low level of both equivocality and uncertainty. New problems do not arise with sufficient frequency to require significant

additional data. Issues are well understood, so extensive discussion is not required to resolve and clarify issues. An organization in this situation would tend to rely on a standing body of standards, procedures, policies, and precedents. Routine schedules, reports, and statistical data would be the primary information base used by the organization. A Cell 3 situation is typified by an organization that uses a routine technology in a stable environment.

Figure 1 represents an attempt to combine the concepts of equivocality and uncertainty into a single framework. The quadrants in Figure 1 represent patterns of problems and issues that influence organizational information responses and ultimately the structural design of the organization. Structure can be designed to facilitate equivocality reduction, or to provide data to reduce uncertainty, or both, depending on organizational needs.

5. Structuring Organizations

We have argued that information processing in organizations is conceptually more than simply obtaining data to reduce uncertainty; it also involves interpreting equivocal situations. The next question is how can organizations be designed to meet the needs for uncertainty and/or equivocality reduction. Organization structure is the allocation of tasks and responsibilities to individuals and groups within the organization, and the design of systems to ensure effective communication and integration of effort (Child 1977). Organization structure and internal systems facilitate interactions and communications for the coordination and control of organizational activities. Previous work by Galbraith (1973) and Tushman and Nadler (1978) has shown how organization structure and support systems can be tailored to provide the correct amount of information to reduce uncertainty. We propose to take this line of reasoning one step farther by arguing that organizational design can provide information of suitable richness to reduce equivocality as well as provide sufficient data to reduce uncertainty.

Amount of Information

With respect to uncertainty, structural design can facilitate the amount of information needed for management coordination and control. For example, Galbraith (1973) described how formal management information systems have greater capacity to carry useful data to managers than do standing rules and procedures. Formal systems can provide data about variables such as production work flow, employee absenteeism, productivity, and down time, and they can provide systematic data about the external environment and competition (Parsons 1983). Other structural mechanisms include task forces and liaison roles. A task force can provide a greater amount of information within an organization than can a single face-to-face meeting. Liaison personnel can actively exchange data between divisions to reduce uncertainty. A number of studies have indicated that information processing increases or decreases depending on the complexity or variety of the organization's task (Tushman 1978, 1979; Daft and Macintosh 1981; Bavelas 1950; Leavitt 1951). Specific structural mechanisms can be implemented by the organization to facilitate the amount of information needed to cope with uncertainty and achieve desired task performance.

Richness of Information

With respect to reducing equivocality, structural mechanisms have to enable debate, clarification, and enactment more than simply provide large amounts of data. Managers work under conditions of bounded rationality and time constraints. The key factor in equivocality reduction is the extent to which structural mechanisms facilitate

the processing of rich information (Daft and Lengel 1984; Lengel and Daft 1984). Information richness is defined as the ability of information to change understanding within a time interval. Communication transactions that can overcome different frames of reference or clarify ambiguous issues to change understanding in a timely manner are considered rich. Communications that require a long time to enable understanding or that cannot overcome different perspectives are lower in richness. In a sense, richness pertains to the learning capacity of a communication.

Communication media vary in the capacity to process rich information (Lengel and Daft 1984). In order of decreasing richness, the media classifications are (1) face-to-face, (2) telephone, (3) personal documents such as letters or memos, (4) impersonal written documents, and (5) numeric documents. The reason for richness differences include the medium's capacity for immediate feedback, the number of cues and channels utilized, personalization, and language variety (Daft and Wiginton 1979). Face-to-face is the richest medium because it provides immediate feedback so that interpretation can be checked. Face-to-face also provides multiple cues via body language and tone of voice, and message content is expressed in natural language. Rich media facilitate equivocality reduction by enabling managers to overcome different frames of reference and by providing the capacity to process complex, subjective messages (Lengel and Daft 1984). Media of low richness process fewer cues and restrict feedback, and are less appropriate for resolving equivocal issues. However, an important point is that media of low richness are effective for processing well understood messages and standard data.

Structural characteristics that facilitate the use of rich media are different from characteristics that facilitate a large amount of data. Rich media are personal and involve face-to-face contact between managers, while media of lower richness are impersonal and rely on rules, forms, procedures, or data bases. For example, Van de Ven, Delbecq, and Koenig (1976) found that coordination mechanisms varied along a continuum from group, personal, to impersonal. When task nonroutineness or interdependence were high, information processing shifted from impersonal rules to personal exchanges including face-to-face and group meetings. Lengel and Daft (1984) found that rich communications were used by managers for difficult and equivocal messages. Rich information transactions allowed for rapid feedback and multiple cues so that managers can converge on a common interpretation. When messages were unequivocal, media such as written memos or formal reports were sufficient to meet information needs. Finally, Daft and Macintosh (1981) found that qualitative, face-to-face techniques were preferred in equivocal situations.

Structural Characteristics

Taken together, these ideas and findings begin to suggest how organizations handle dual information needs for uncertainty and equivocality reduction, for both obtaining objective data and exchanging subjective views. We propose that seven structural mechanisms fit along a continuum with respect to their relative capacity for reducing uncertainty or for resolving equivocality for decision makers. This continuum is illustrated in Figure 2. The continuum reflects the relative contribution of design characteristics for uncertainty reduction and equivocality resolution, and suggests that structural mechanisms may also address both needs simultaneously.

1. *Group Meetings.* Group meetings include teams, task forces, and committees (Galbraith 1973; Van de Ven et al. 1976). Project and matrix forms of structure utilize frequent group meetings as a means of coordination. The comparative advantage of group meetings is equivocality reduction rather than data processing. Participants exchange opinions, perceptions and judgments face-to-face. Some new data are processed, but the advantage of group meetings is the capacity to reach a collective

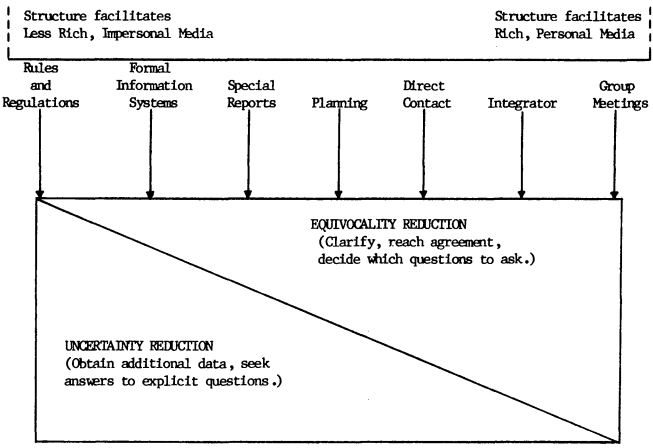

FIGURE 2. Information Role of Structural Characteristics for Reducing Equivocality or Uncertainty.

judgment. Through discussion, a cross-section of managers from different departments reach a common frame of reference (Weick 1979). Managers can converge on the meaning of equivocal cues, and are able to enact or define a solution. The strength of group meetings is the ability to overcome differences and to build understanding and agreement. Group discussion is a subjective process rather than the collection of hard data for rational analysis.

2. *Integrators.* Integrators represent the assignment of an organizational position to a boundary spanning activity within the organization. Full-time integrators include product managers and brand managers (Galbraith 1973; Lawrence and Lorsch 1967). Part-time integrators include liaison personnel whose responsibility is to carry information across departments, such as might be done by a manufacturing engineer (Galbraith 1973; Reynolds and Johnson 1982). The integrator role includes the transmission of data, but it is primarily a way to overcome disagreement and thereby reduce equivocality about goals, the interpretation of issues, or a course of action (Lawrence and Lorsch 1967). When managers approach a problem from diverse frames of reference, equivocality is high. Integrators and boundary spanners use face-to-face and telephone meetings to resolve these differences.

3. *Direct Contact.* Direct contact represents the simplest form of personal information processing. When a problem occurs, Manager A can contact Manager B for a brief discussion, such as how to get production back on schedule (Galbraith 1977). Direct contact can occur laterally among departments or vertically between hierarchical levels. Direct contact often uses rich media, thus is similar to group meetings and integrator roles, although written memos and letters also are used. Direct contact allows managers to exchange views and disagree, hence this mechanism facilitates subjective information as well as objective data. Through discussion and exchange of viewpoints, equivocality is reduced. Some new data also can be exchanged to reduce uncertainty about specific questions.

4. *Planning.* Planning is a dynamic process that includes elements of both equivocality reduction and data sharing. In the initial stages of planning, equivocality is high. Managers often meet face-to-face and in groups to decide overall targets and a general course of action (Steiner 1983). Once plans are set, equivocality is reduced, and the plans become a data processing device. Schedules can be defined and feedback mechanisms established. Comparing actual performance to targets provides managers with data to evaluate performance (Lorange and Vancil 1976). Planning is placed near the middle of the scale in Figure 2 because the ongoing process involves both

equivocality reduction and data processing. Initial planning resolves equivocality, while plans, schedules, and feedback provide data for uncertainty reduction.

5. *Special Reports.* Special reports include one-time studies and surveys. The purpose of special reports is to gather data about an issue, synthesize it, and report it to managers (Lengel and Daft 1984). This process is expected to involve some equivocality reduction, but its primary role is to obtain data, interpret it, and thereby reduce uncertainty. Managers know which question to ask before a study is initiated. Special studies tend to be undertaken for problems about which objective data are not currently available but can be obtained through systematic investigation and analysis.

6. *Formal Information Systems.* Formal information systems include the periodic reports and computer data bases that make up an organization's information support system (Saunders 1981). Information systems include computer reports, performance evaluations, budgets, and statistical information on such things as scrap rates, credit defaults, or market share (Daft and Macintosh 1981). The purpose of these reports is to provide data to managers, and they are moderate to low in richness. The reports reduce managers' uncertainty about how well a new product is selling, or whether scrap rates are within the standards for each machine shop. Periodic reports typically pertain to the better understood and measurable aspects of organization and, hence, do not serve to reduce equivocality. Minor disagreements about interpretation may occur, in which case managers could either request additional data or resolve the issue through discussion.

7. *Rules and Regulations.* Rules and regulations are perhaps the weakest and least rich information processing device (Galbraith 1973; Tushman and Nadler 1978). They are generally established to provide a known response to problems that have arisen in the past. Rules and regulations typically apply to recurring, well understood phenomena, and they reduce the need to process data on a continuous basis. Rules and programs therefore play almost no part in equivocality reduction. Equivocality is reduced before rules and procedures are written. Rules, procedures, standards, and policies provide a fixed, objective knowledge base from which employees can learn to respond to routine organization phenomena.

The placement of structural alternatives along the Figure 2 continuum is tentative and hypothetical. The information role of each structural characteristic may vary across organizations. The point of Figure 2 is to identify structural characteristics from the literature that pertain to the dual needs for equivocality and uncertainty reduction. The relationship between structure and the reduction of equivocality and uncertainty has not been empirically tested, but the Figure 2 pattern is consistent with previous research. Van de Ven et al. (1976) found group, personal, and impersonal mechanisms used according to interdependence and task nonroutineness. Daft and Macintosh (1981) reported qualitative information was used for equivocal issues and quantitative information was used for unequivocal issues. Galbraith (1973) and Tushman and Nadler (1978) argued that some mechanisms have greater information capacity.

One insight from Figure 2 is that information processing mechanisms may not be readily substituted for one another. For example, task forces and management information systems both have the capacity for high levels of information processing (Galbraith 1973; Tushman and Nadler 1978), but the underlying purpose of each form of information processing is radically different. Management information systems provide objective data, while task forces and group meetings are a rich medium that can serve the purpose of reducing equivocality and reaching agreement. Information systems do not reduce equivocality because equivocal issues are not easily measured and communicated through impersonal systems. Likewise, task force meetings are not efficient mechanisms for disseminating large amounts of quantitative data.

6. Application to Organization Design

The final step in answering the question of why organizations process information is to translate the ideas from Figures 1 and 2 into organizational applications. Three sources of organizational uncertainty and equivocality are technology, interdepartmental relations, and the environment (Galbraith 1977; Tushman and Nadler 1978; Daft and Macintosh 1981; Weick 1979). These sources represent the transformation process, the linkage and coordination required between departments, and the events and problems external to the organization (Duncan 1972; Weick and Daft 1983). Structural mechanisms similar to those in Figure 2 can be used to reduce equivocality or uncertainty arising from the technology, interdependence, or to interpret the external environment.

Technology

Technology is the knowledge, tools, and techniques used to transform inputs into organizational outputs. Perrow (1967) proposed a technology model that defined two underlying task characteristics—task variety and task analyzability. Task variety is the frequency of unexpected and novel events that occur in the conversion process. High variety means that participants typically cannot predict problems or activities in advance. Task analyzability concerns the way individuals respond to problems. When the conversion process is analyzable, employees typically follow an objective, computation procedure to resolve problems. When work is not analyzable, participants have

ANALYZABILITY	Low VARIETY High
Unanalyzable	1. Unanalyzable, Low Variety (Craft Technology) Structure: a. Rich media to resolve unanalyzable issues b. Small amount of information Examples: Occasional face-to-face and scheduled meetings, planning, telephone.
	2. Unanalyzable, High Variety (Nonroutine Technology) Structure: a. Rich media to resolve unanalyzable issues b. Large amount of information to handle exceptions Examples: Frequent face-to-face and group meetings, unscheduled meetings, special studies and reports.
Analyzable	3. Analyzable, Low Variety (Routine Technology) Structure: a. Media of low richness b. Small amount of information Examples: Rules, standard procedures, standard information system reports, memos, bulletins.
	4. Analyzable, High Variety (Engineering Technology) Structure: a. Media of low richness b. Large amount of information to handle frequent exceptions Examples: Quantitative data bases, plans, schedules, statistical reports, a few meetings.

FIGURE 3. Relationship of Department Technology with Structure and Information Required for Task Accomplishment.

difficulty developing exact procedures, and hence rely on judgment and experience rather than on rules or computational routines. Perrow's model of technology is in Figure 3, along with proposed structural methods for processing information.

Based upon the work of Van de Ven et al. (1976), Daft and Macintosh (1981), Tushman (1978), (1979), Lengel and Daft (1984), and the ideas proposed here, different modes of information processing are proposed to occur for each type of technology. For craft technology in Cell 1, tasks are not analyzable, but few problems arise. These equivocal issues can be handled by personal contact and occasional discussions between managers. Experience is also used to interpret equivocal cues. Planning may be useful to reduce equivocality and anticipate problems. For nonroutine technology in Cell 2, group meetings will be a primary source of information processing. Uncertainty is high because of frequent unanalyzable problems. People will use rich media in the form of frequent unscheduled meetings to resolve issues ad hoc, as well as scheduled meetings to coordinate departmental activities. In the case of engineering technology in Cell 4, management information systems and special studies will be important. Tasks are analyzable, so they can be studied and problems thereby solved. Periodic reports from the formal information systems will cover many activities, and special projects and surveys can be used for issues not covered by the regular information system. Management information in both written and statistical form will provide data of appropriate richness for this kind of activity. In the case of a routine technology in Cell 1, a standard body of rules, regulations, and policies can guide the routine activities. Occasional scheduled meetings may also be relevant here, but organization design should tend to facilitate impersonal data.

Of course every form of information processing will be used occasionally in each technology. But the emphasis on information form and frequency is expected to reflect the information requirements of each technology. Formal statistics and management information systems may not be of value in a basic research setting or for a craft technology, because "numbers" do not capture the intangible nature of these activities. Likewise, personal and group meetings will play a smaller role in the engineering and routine technologies where tasks are more clearly defined and quantifiable.

Interdepartmental Relations

The second source of uncertainty and equivocality is the need for integration across departments. Galbraith (1973) called this lateral information processing and recommended techniques such as direct contact, liaison roles, and integrators to achieve interdepartmental coordination.

The interdepartmental characteristic that influences equivocality is differentiation (Daft and Lengel 1984). Each department develops its own functional specialization, time horizon, goals, frame of reference and jargon (Lawrence and Lorsch 1967; Shrivastava and Mitroff 1984). Bridging wide differences across departments is a problem of equivocality reduction. People come to a problem with different experience, cognitive elements, goals, values, and priorities. A person trained as a scientist may have a difficult time understanding the point of view of a lawyer. A common perspective does not exist. Coding schemes are dissimilar. Interdepartmental communications thus can be complex, ambiguous and difficult to interpret (Allen and Cohen 1969; Gruber et al. 1974). Equivocality is high when differentiation is great. The structural devices should enable participants to confront and resolve disagreement and misunderstanding that can arise between departments.

The characteristic that influences uncertainty and hence the need for data processing between departments is strength of interdependence. Interdependence means the extent to which departments depend upon each other to accomplish their tasks (Thompson 1967). Some departments work independently while other departments

must continuously adjust to one another. Interdependence increases uncertainty because action by one department can unexpectedly force adaptation by other departments in the production chain. Frequent adjustments are needed when interdependence is high, and hence more information must be processed (Van de Ven et al. 1976). When interdependence is low, departments experience greater autonomy, stability and certainty with respect to coordination.

Figure 4 combines the dimensions of differentiation and interdependence into a framework. Differentiation is associated with equivocality reduction, and interdependence with uncertainty (Daft and Lengel 1984). In Cell 1, departments have different frames of reference but are relatively independent so information processing will be infrequent. When coordination does occur the primary aim will be to resolve equivocality and achieve a common grammar. For these occasional interactions, rich face-to-face or telephone discussions may resolve the issue, and some things can be handled by personal memos or anticipated in the planning process.

When departments are both highly differentiated and interdependent, as in Cell 2, all information processing mechanisms of the organization will be utilized. Wide differences must be resolved and a high volume of data must be processed to enable mutual adjustment. The organization will have to use structural mechanisms that allow both a high volume of data and rich media. Structures will include full-time integrators, task forces, and project teams. Direct contact in the form of coalition building may also be used to negotiate across department boundaries (Cyert and March 1963; Gantz and Murray 1980). Matrix organization structure may apply because it is designed to encourage frequent face-to-face meetings to ensure coordination laterally across the organization (Davis and Lawrence 1977).

DIFFERENCE BETWEEN DEPARTMENTS		
High	1. High Difference, Low Interdependence Structure: a. Rich media to resolve differences b. Small amount of information Examples: Occasional face-to-face or telephone meetings, personal memos, planning, self contained units.	2. High Difference, High Interdependence Structure: a. Rich media to resolve differences b. Large amount of information to handle interdependence Examples: Full time integrators, task forces, teams, matrix structure, special studies and projects, confrontation.
Low	3. Low Difference, Low Interdependence Structure: a. Media of lower richness b. Small amount of information Examples: Rules, standard operating procedures, reports, budgets.	4. Low Difference, High Interdependence Structure: a. Media of lower richness b. Large amount of information to handle interdependence Examples: Plans, reports, update data bases, formal information systems, pert charts, budgets, schedules.
	Low	INTERDEPENDENCE BETWEEN DEPARTMENTS High

Source: Based on R. L. Daft and R. H. Lengel (1984).

FIGURE 4. Relationship of Interdepartmental Characteristics with Structure and Information Required for Coordination.

When differentiation is small, such as between an industrial engineering and mechanical engineering department, but interdependence is high, as in Cell 4, a different form of coordination will apply. These departments can rely more heavily on a high volume of data processed through impersonal communications. Information can be exchanged through plans, reports, schedules, updated data bases, charts, budgets and memos. Much coordination can be achieved through less rich media because equivocality is low.

Finally, in Cell 3 interdependence and differentiation are both low, so the information needed for coordination will be minimal. Cell 3 is similar to the pooled interdependence described by Thompson (1967). A series of branch banks have similar perspectives and little need for interaction, so they can be coordinated through standardized rules and operating procedures. Personal or group contact is infrequent because there is little equivocality to be resolved and little need for mutual adjustment.

Environment

The final source of organizational information processing is interpretation of the external environment. The environment is a major factor in organizational structure and internal processes (Duncan 1972; Pfeffer and Salancik 1978; Leblebici and Salancik 1981). As an open system, an organization cannot seal itself off from the environment (Thompson 1967). The organization must have mechanisms to learn about and interpret external events.

Weick's (1979) discussion of equivocality emphasized that many events in the environment are inherently unclear. Managers discuss these events and enact a definition and common grammar so that organizational action may follow. Likewise, data can be accumulated to reduce uncertainty about objective indicators such as market share and customer demographics. Information processing about the external environment must meet the dual needs of equivocality and uncertainty reduction.

Figure 5 is adapted from Weick and Daft (1983) and illustrates the relationship between the organization's environment and the dual information processing needs. Equivocality is related to the analyzability of cause-effect relationships in the external environment (Thompson 1967; Tung 1979). When environmental relationships are clear and analyzable, equivocality is low, and managers can rely on the acquisition of explicit data to answer questions that arise. For example, research by Wilensky (1967) and Aguilar (1967) found significant differences among organizations in the extent the environment was seen as rationalized and objective data collected. When the cause-effect relationships are unclear, information processing must reduce equivocality. Managers must discuss, argue, and ultimately agree on a reasonable interpretation that makes action sensible and suggests some next steps.

The variation in uncertainty along the horizontal dimension in Figure 5 is related to the amount of data collected about the external environment. Organizations range from being passive with respect to data collection to those that actively search the environment on a continuous basis (Fahey and King 1977; Aguilar 1967). When the environment is perceived as hostile, competitive, rapidly changing, or when the organization depends heavily on the environment for resources, the organization gathers more data about the environment (Pfeffer and Salancik 1978; Wilensky 1967). Organizations develop multiple lines of inquiry into the environment because managers feel uncertainty. Organizations in benevolent, stable, noncompetitive environments have less incentive to gather data (Wilensky 1967; Hedberg 1981) because uncertainty is low.

Based upon these ideas, organizations in Cell 1 of Figure 5 do not actively seek environmental data, but do reduce equivocality. Rich media are used to interpret events, and insights are obtained from personal contacts with significant others in the

environment. Data tend to be personal, nonroutine and informal, and are obtained as the opportunity arises. In Cell 2, organizations are more active. Organizations combine the acquisition of new data with the creation of new interpretations about the environment. Managers may reduce equivocality through trial and error experimentation as well as by acquiring more data about the external environment. Frequent meetings and debates will occur. In Cell 4, formalized search is the primary information vehicle. This organization has a well-defined environment which can be measured and analyzed through questionnaires, surveys, and other means of data collection. Managers reduce a high level of uncertainty by asking questions through management information systems, special purpose reports, and scanning departments. In Cell 3, neither equivocality nor uncertainty is high. The organization has established rules, procedures, reports, and information systems that reduce the need for external information. The environment is not hostile and the organization has little need to collect large amounts of environmental data.

7. Summary and Conclusion

This paper began by asking the question, "Why do organizations process information?" The proposed answer is to effectively manage both uncertainty and equivocality. Uncertainty and equivocality represent two forces identified in the literature that influence the information processing required for organizations to attain adequate

ASSUMPTIONS ABOUT ENVIRONMENT		
Cause-Effect Relationships Unanalyzable	1. Unanalyzable, Certain Structure: a. Rich media to resolve equivocal cues b. Small amount of information Examples: Irregular external contacts, casual information, professional associations, occasional meetings, delphi.	2. Unanalyzable, Uncertain Structure: a. Rich media to resolve equivocal cues b. Large amount of information to reduce uncertainty Examples: Send agents to field, frequent meetings, project teams, trial and error, separate scanning position or department, dialectical inquiry.
Cause-Effect Relationships Analyzable	3. Analyzable, Certain Structure: a. Media of lower richness b. Small amount of information Examples: Regular record keeping and reports, rules, procedures, newspapers, trade magazines.	4. Analyzable, Uncertain Structure: a. Media of lower richness b. Large amount of information to reduce uncertainty Examples: Special department, surveys, studies, formal reports, scanning services, bulletins, trade magazines.
	Passive	ORGANIZATIONAL INTRUSIVENESS Active

Source: Based on K. E. Weick and R. L. Daft (1983).

FIGURE 5. Relationship of Environmental Characteristics with Structure and Information Required for Scanning and Interpretation.

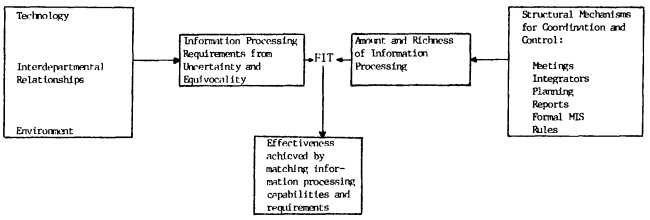

FIGURE 6. Summary Model of Information Processing and Organization Design.

performance. Organizations can be structured through the use of personal or impersonal mechanisms to manage equivocality and uncertainty. Depending on the type of the technology, degree of required interdepartmental integration, and the nature of the environment, structural mechanisms can be adopted to meet management's need for additional data or the need to create a common grammar and interpretation about ambiguous events.

The purpose of this paper was to tie together a number of threads from the organizational literature, which are summarized in Figure 6. The notions of uncertainty and equivocality, structural mechanisms to reflect information needs, media richness, and of technology, interdependence, and environment as causes of information processing, have been discussed in the literature. This paper attempted to integrate equivocality with uncertainty and argue that structural characteristics are used to help organizations cope with these two factors. Research pertaining to technology, interdepartmental relationships, and environment was shown to have common themes consistent with the equivocality/uncertainty framework. Figure 6 is adapted from Tushman and Nadler (1978), and illustrates how organizational context influences uncertainty and equivocality, and that effective design will provide the appropriate amount and richness of information.

This paper also offered a preliminary answer to a second and related question, "How do organizations process information?" Figure 2 and the frameworks for technology, interdepartmental relationships, and environment in Figures 3, 4 and 5 proposed specific structural mechanisms to enable the correct amount and type of information processing. Each structural characteristic—from rules and procedures to group meetings—was proposed to have a specific role that enabled the reduction of equivocality and uncertainty.

The frameworks developed in this paper suggest specific themes about organizational information processing that can be tested in future research. For example, the ambiguity confronting managers in organizations may be as important to structural design and information processing as the need to obtain explicit data to reduce uncertainty. Previous research has measured information processing by counting communication activities such as the number of letters, phone calls, or oral communications, or by examining the geometry or frequency of data flow between specific points in the organization (Tushman 1978; Bavelas 1950; Leavitt 1951; Allen and Cohen 1969). These studies have made important contributions, but they assume a reasonably well-defined field for managers and that data flow is sufficient for understanding information processing. The frameworks in this paper imply that data counting may oversimplify information management within organizations. A major problem for organizations is lack of clarity, not lack of explicit data. The approach to equivocality is for managers to develop and agree upon a definition of the situation. The nature of equivocality and its impact on managers represent a new and potentially important avenue of research into information processing. Some preliminary studies have already been undertaken (Putnam and Sorenson 1982), but additional research is needed to understand equivocality within organizations.

In the case of environmental scanning, an interesting research question is how organizations obtain a clear view of where it fits within the environment and where it is going. Organizations could be simulated in a laboratory (Cameron and Whetten 1981) and monitored for the types of information mechanisms that evolve to reduce ambiguity and manage uncertainty. Different levels of uncertainty and equivocality could be designed into the simulated environment. Field studies that explore how organizations scan and interpret the external environment, and how information feeds into decision making (Huber and McDaniel 1986) could also make a valuable contribution.

In summary, a feature that distinguishes human social systems from lower level mechanical and biological systems is equivocality (Boulding 1956). Social systems do not work with machine-like precision; human beings have the capacity to interpret and respond to ambiguity. Yet the concept of equivocality has not been included in most studies and models of organizational design and information processing. Bringing equivocality into future studies of organizational design may provide richer and more accurate assessments of organizational behavior. Future research may be able to elaborate and test the ideas presented in this paper, and especially to define the underlying relationships between patterns of equivocality/uncertainty and their fit with organization structure and design.[1]

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