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VISUAL DATA IN ORGANIZATIONAL RESEARCH*

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This paper urges organizational researchers to collect data from subjects in the form of pictures, diagrams, computer graphics, and other visual representations. Drawing on theoretical and empirical work in cognitive psychology, neurophysiology, linguistics, and artificial intelligence, it presents a rationale for collecting visual data, provides examples, and suggests research questions and settings where visual data may be preferable to verbal data.
(DATA REPRESENTATION; VISUAL DATA; COMPUTER GRAPHICS)

Introduction

In the fall of 1854, a cholera epidemic broke out near the center of London. Dr. John Snow, a physician subscribing to the disputed theory that cholera was transmitted by contaminated drinking water, created the graphic shown in Figure 1 (Gilbert 1958). Starting with a London map, Snow drew black dots to plot the addresses of cholera victims, and crosses to plot the location of public water pumps. The map showed that nearly everyone who had died lived near the Broad Street water pump. Snow had the handle of the contaminated pump removed and halted the epidemic that had claimed over 500 lives. Given hard work and good luck, the connection between the pump and the disease might have been discovered without Dr. Snow's map. But, at least in this instance, "graphical analysis testifies about the data far more efficiently than calculation" (Tufte 1983, p. 24).

Organizational science is now assimilating a burst of innovation in research design and methodology. As structural equation models, historical analyses of archives, hazard functions, and ethnomethodology infiltrate our journals, a more complicated and diffuse set of paraphernalia becomes available for studying organizations. The new pluralism in methodology is likely to have a bracing effect on the field. However, one link in the chain of research—the collection of data from human subjects—remains virtually untouched by these developments (Webb and Weick 1979). Such data continue to come almost exclusively from subjects' verbal responses to our questions. The upshot has been described as an "emerging science of consistencies among verbal reports" (Campbell, Daft, and Hulin 1982, p. 30), that is "in danger of becoming an autoerotic fantasy" (Salancik 1979, p. 639), because "complexity of design and analysis has far exceeded complexity (and innovativeness) of data collection" (Faulkner 1982, p. 72).

This paper proposes visual reporting as an alternative to verbal reporting. Following Dr. Snow's lead, it advocates the use of pictures, diagrams, computer graphics, and other visual displays in representing information. The term "visual data" will be used throughout this paper to designate these and other methods that use meaningful graphic representations in the process of collecting primary data. Others have urged researchers to discern unobtrusive measures in visual outcroppings (Webb, Campbell, Schwartz, and Sechrest 1966), to educe shared meanings from visual symbols such as corporate logos (Dandridge, Mitroff, and Joyce 1980), and to capture behavior in videotaped and photographic images (Dabbs 1982, Van Maanen 1982). However, the

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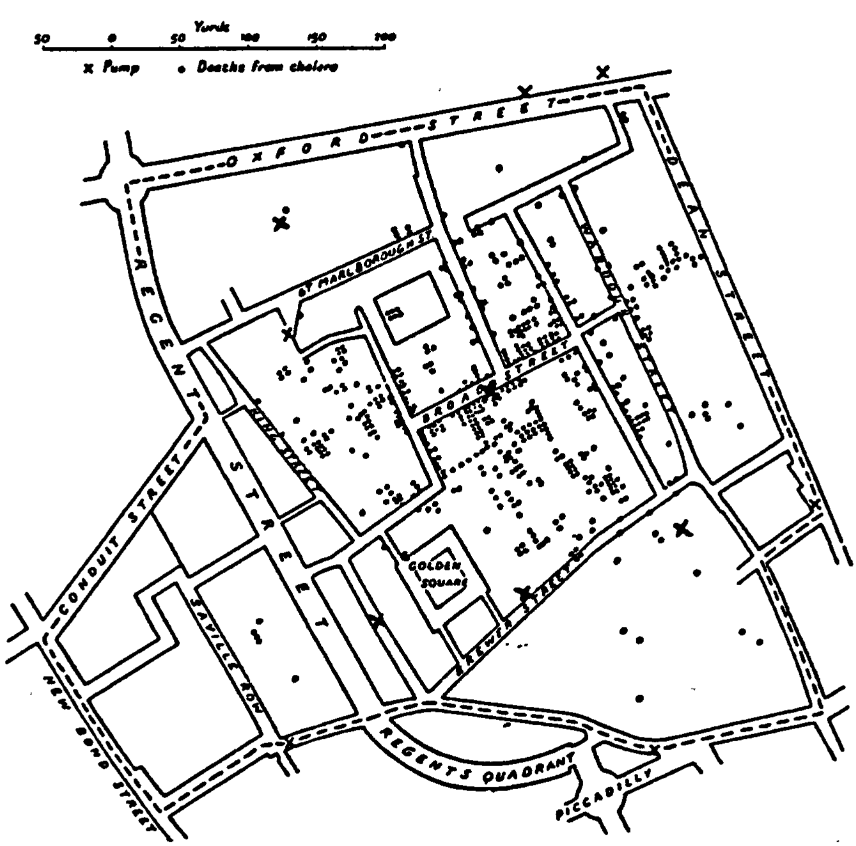


FIGURE 1. Dr. John Snow's Map.
Source: Tufte (1983, p. 24).

possibility of inviting organizational members to generate or respond to visual displays created expressly for research purposes has passed unnoticed.

This omission is curious, for researchers taking organizations as their principal units of analysis should readily appreciate the power of graphs and diagrams in conveying relationships among variables. After all, we sketch out conceptual models to help us invent good research designs; we sometimes use graphic techniques for analyzing data (e.g., Bougon, Weick, and Binkhorst 1977, Mintzberg and McHugh 1985, Tukey 1977); and in publishing our results, we include charts, graphs, and diagrams to help communicate the findings to our colleagues. But in gathering data, we almost always limit our subjects to counting, talking, and writing.

Although organizational researchers have virtually ignored visual approaches to gathering data, a number of pictoral and graphic instruments have been devised by clinical and developmental psychologists. Those using projective techniques such as the Rorschach (1921) or the TAT (Murray 1938) have inferred people's unconscious drives, emotions, and conflicts from their responses to ambiguous visual displays. Those using methods such as figure drawing (Adler 1970) or Aronson's (1958) analyses of doodles have coded data directly from subjects' own drawings. Graphics have also been used to calibrate attitude scales such as Kunin's (1955) faces scale for measuring job satisfaction.

But generally speaking, the psychology literature exhibits little confidence in graphic techniques (Chapman and Chapman 1969) and little enthusiasm for visual data. Most investigators seem to have adopted graphic approaches only as a last resort, using them when they suspect that subjects are unwilling or unable to provide accurate and honest verbal reports (Kidder 1981).

This paper presents a very different view. Pictures and graphics are seen as affording a means of communicating information about multidimensional organizational attributes with clarity and precision (Tufte 1983). Whereas visual data have traditionally been used to measure individual-level variables, this paper recommends them for measuring organizational variables. Whereas visual data have traditionally been used because subjects lack verbal skill or literacy, this paper recommends them because informants often possess more copious and meaningful information than they can communicate verbally.

Alphabetic Writing, Hierarchical Thinking, and Verbal Reporting

Three thousand years ago, two fundamentally different systems of writing emerged in two geographically isolated cultures (Gelb 1956). In the ancient metropolis of An Yang, Chinese artists were refining ideographic writing. In the Middle East, Ugariti linguists were simultaneously devising the first alphabet. Throughout the ensuing three millennia, both innovations have profoundly influenced how those adopting them formulate and communicate concepts.

Ideographic writing fosters richly interconnected conceptual networks incorporating fewer conceptual elements. By specifying a unique symbol for each concept, ideographs enable writers to transmit many concepts in a limited space. But writers can represent new concepts only as amalgams of a finite set of existing ideographs. Consequently, ideographic writers' cognitive maps contain evolving networks of mutually inclusive, overlapping conceptual elements.

In contrast, alphabetic writing fosters sparsely connected conceptual hierarchies incorporating larger numbers of conceptual elements. Writers can easily differentiate new concepts from existing ones by coining distinctive terminology. This encourages alphabetic writers to develop larger sets of mutually exclusive concepts that are separated into more rigid hierarchical categories.

Turning to human thinking, research findings suggest that visual and verbal forms of information are encoded and processed independently.[1] Dimond and Beaumont (1974), Kosslyn (1978), and Maruyama (1986) are among those who have argued that brains synthesize visual inputs into images preserving the spatial orientations and interrelationships of multiple components. Cognitive operations on images do not require their decomposition—the images remain intact while people process them.

Verbal information, on the other hand, is said to be encoded and processed in hierarchical categories (Abelson and Carroll 1965, Gregg 1967, Simon 1969). Verbally encoded information about an organization, for instance, would be arrayed like a topical outline, making it possible to represent detailed attributes of nested components such as divisions, departments, and persons. However, such arrays may overstate hierarchical orderliness and hamper efforts to process information cutting across categories (Feigenbaum and Simon 1963). In essence, performing cognitive operations on verbal representations of organizations may be an inherently reductionistic undertaking.

Western organization scientists seem to have a predilection for thinking of organizations as hierarchical systems composed of conceptually distinct elements. Whether this arises from hierarchical thinking, alphabetic writing, or verbal reporting is an epistemological question that lies beyond the scope of this paper. Instead, my

[1]Cognitive psychologists disagree about whether verbal and visual forms of information are *stored* independently. The dual-code theory (Paivio and Csapo 1973) claims that long-term memory contains separate visual and verbal registers; the propositional code theory (Anderson 1980) claims that both visual and verbal information are represented in the form of abstract propositions.

purpose will be to persuade researchers willing to see organizations as richly connected evolving networks to emulate ideographic writers and gather visual data.

Human Information Processing and Organizational Research

Drawing on research about how people process information, this section of the paper evaluates the cognitive tasks that organizational researchers create for their subjects. Methodologies commonly used to gather verbal data sometimes appear to overwhelm people's information processing capabilities. Heedful of the complexities of analyzing data, and implicitly acknowledging their own information processing limits, organizational researchers try to devise instruments that will elicit verbal data conforming to a limited set of coherent categories. When used to measure unidimensional properties of coherent phenomena, this approach works reasonably well. But often, especially in research taking the entire organization as an analytical unit, the phenomena of interest are fuzzy multidimensional constructs. In such cases, the coherence of respondents' verbal reports may be specious.

Memory

Everything that a person attends to must be stored in his or her short-term memory, and its capacity is very small indeed. Even when the contents are not being processed in any complex way, one's short-term memory is said to hold only about seven chunks of information (Anderson 1980, Miller 1956). When active information processing begins, the capacity may drop to two or three chunks (Lloyd, and Feallock 1960). Perusal of any social scientific journal will show that researchers' instruments routinely expect subjects to process many more than three chunks of information.[2]

What biases are introduced into the data as a result? In some cases, subjects apparently respond by "telling more than they know" (Nisbett and Wilson 1977). For instance, when insufficient space in memory precludes accurate information processing, respondents may fabricate plausible data by extrapolating from their tacit theories about how the world works. Such aberrations are extremely difficult to detect, for the respondents truly believe that their fabrications are factual reports. When forced-choice questionnaires and related verbal formats are invoked to ward off such bias, respondents are often thrust into the equally undesirable position of knowing more than they can tell.

Recoding to Increase Capacity

Fortunately, our brains can increase their short-term storage almost indefinitely by recoding many small chunks of information into fewer large chunks (Anderson 1980, Newell and Simon 1967). Seamon (1972) trained subjects to recode separate bits of information in two forms: images and verbal lists. He then displayed another bit, and subjects indicated whether or not it matched. When the inputs had been chunked into a unified image instead of being listed, the subjects made only one-third as many errors. Moreover, the number of bits incorporated in an image had no effect on how long subjects took to process the information—three bits could be examined as quickly as one. But when the same information was stored in verbal form, processing time was a positive linear function of the amount of information encoded. Appar-

[2] For example, questionnaires often ask respondents to mark a Likert scale to denote the "typical" degree of influence exerted by different classes of participants upon organizational decisions (e.g., Tannenbaum and Cooke 1979, Hinings, Hickson, Pennings and Schneck 1974). Implicitly, such instruments ask respondents to average across all incumbents of a given role and across all decision issues wherein these incumbents are potentially influential.

ently, verbal representations evoke serial processing of information whereas imagistic representations evoke parallel processing (Cohen, 1973).

These findings have implications for organizational science. Seeing how readily the fōrm in which people encode information can be experimentally manipulated implies that our verbal instruments compel subjects to utilize verbal representations. Discovering that the form in which information is encoded limits how it can be processed implies that our subjects' verbal representations limit them to using serial processes. But organizational researchers searching for answers to complex questions ought to prefer instruments that transform subjects into informants by encouraging them to integrate diverse inputs quickly and process them simultaneously.

Processing Visual Displays

Experimental research in cognitive psychology shows that in multidimensional information processing tasks, graphical feedback leads to faster and more complete learning than numerical feedback (Hammond 1971, Hoffman, Earle, and Slovic 1981). Studies by information systems researchers suggest that graphical displays improve decision makers' performances in relatively simple multidimensional tasks such as detecting and comparing trends, or discovering patterns of relationships among variables (DeSanctis 1984, Dickson, DeSanctis and McBride 1986, Jarvenpaa and Dickson 1988).[3] Tufte (1983, p. 96) advocates graphic displays only for large sets of data, because "in reporting on sets of 20 numbers or less, tables usually outperform graphics." Collectively, the literature implies that visual displays representing variables separately afford few advantages over tabular presentations. On the other hand, displays assimilating multiple variables into a single graphic representation seem to expedite multidimensional information processing.

A good illustration comes from accounting research, where several investigators (MacKay and Villarreal 1987, Moriarity 1979, Nibbelin 1988, Stock and Watson 1984) have used computer-generated schematic faces (Chernoff 1971) to display relationships among accounting ratios. In these studies, ratios that accountants regard as most indicative of a firm's fiscal well-being were depicted by facial features that people in general find most salient. Trends that accountants view with alarm were depicted by changes in features that people associate with fear or sadness. Figure 2, for instance, portrays W. T. Grant & Company's slide from financial health into bankruptcy.

In lab experiments, students and practitioners of accounting examined time series data for firms displayed in schematic form (faces), in graphic form (bar graphs), and/or in tabular form (financial ratios). They then predicted which firms had actually filed for bankruptcy or had experienced changes in their bond ratings. In two studies (Moriarity 1979, Stock and Watson 1984), classifications based on the schematic faces were significantly more accurate; in two others (MacKay and Villarreal 1987, Nibbelin 1988), accuracy was unrelated to the form of data display. In all four studies, accountants who examined the schematic faces processed the same information more rapidly. Researchers operationalizing multidimensional concepts like executive succession, organizational effectiveness, and organizational decline might find this methodology useful.

[3]Graphics do not improve decision makers' performances across the board. Tabular displays generally yield equally good performance in tasks involving higher level cognitive processes like comprehending information and identifying problems (Jarvenpaa and Dickson, 1988). Tables seem to yield better performance when people grapple with extremely complex problems (Zmud, Blocher, and Moffie 1983). However, most techniques for collecting visual data in organizational research are likely to present informants with relatively simple problems.

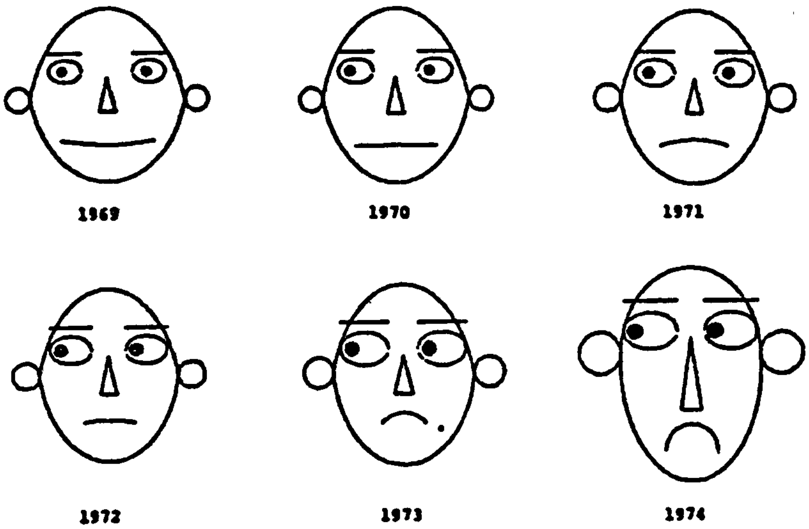


FIGURE 2. Financial Variables Represented as Schematic Faces.
Source: Moriarity (1979, Figure 1).

Hemispheric Specialization

More than a century has passed since Jackson (1874) extrapolated from neurological examinations of brain damage to hypothesize asymmetries in hemispheric functioning, most notably, the location of speech on the left side. More recent evidence indicates that the left and right hemispheres of the normal brain tend to represent information in different forms.[4] The prevalent view is that the left hemisphere typically employs verbal and symbolic representations, the right pictoral and holistic representations (Robey and Taggart 1981, Taggart and Robey 1981).

The form in which information inputs are presented seems to influence where and how they are encoded. Hatta (1977) reported that Kanji, the ideographic system for writing Japanese, enjoys a right hemisphere advantage in visual recognition. This contrasts with a left hemisphere advantage found for Kana, the alphabetic system for writing Japanese. Biederman and Tsao (1979) reported that ideographic and alphabetic writing appear to be processed in different cortical locations.

Studies conducted with subjects whose hemispheres were separated surgically in order to control severe epileptic seizures have led to the most extreme conjectures about the bilateralization of information processing. Levy has summarized this line of research as follows:

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

Of course, research results obtained from subjects with neurological dysfunctions may not generalize beyond that population. After all, most participants in organizational research have intact brains whose hemispheres can communicate. Perhaps questionnaire items evoke images when visual displays become expedient. Perhaps

[4]Recent research suggests that the left and right hemispheres are distinguished by a gradual gradient in abilities rather than a sharp dichotomy (Hines 1987).

judgements reached on the right side are shunted over to the left for linguistic encoding. However, interhemispheric communication is probably subject to individual differences, and experiments suggest that it does not occur automatically or inevitably (Dimond, Gazzaniga, and Gibson 1972, Levy and Trevarthen 1976).[5]

These studies suggest that when organizational researchers' queries lead subjects to expect verbal problems to solve, the left hemispheres of subjects' brains may be activated. When the queries call for difficult perceptual analysis, subjects may have difficulty accessing right hemisphere cognitions. Whether these conjectures are correct or not, much of what we think we know about organizations arises from data mediated by our subjects' verbal processes, in whichever hemisphere they actually reside. No matter if the data are gathered on questionnaires or in impromptu conversations; no matter if the methods are termed quantitative or qualitative. The data are confined to those which people can report verbally.

Advantages of Dual Representations

Research in artificial intelligence and cognitive psychology shows the merits of representing information in two forms simultaneously. Computer simulations demonstrate that dual representations of problems facilitate heuristic search: programs written to alternate between diagrammatic and syntactic representations of problems are capable of discovering verbal proofs for geometry theorems (Gelernter 1963) and solving physics problems presented in natural language (Novak 1976).

Laboratory experiments have consistently found that people process information more quickly and more accurately when the information is presented in visual and auditory forms simultaneously (Miller 1982, Kahneman 1982). Other experiments have found that verbal and image-based memory codes are independent and additive in their effect on recall (Paivio and Csapo, 1973).

These findings suggest that organizational researchers need not abandon rating scales, questionnaires, interview protocols, or regression models in order to collect visual data. Instead, they can combine these time-honored methods with visual ones.

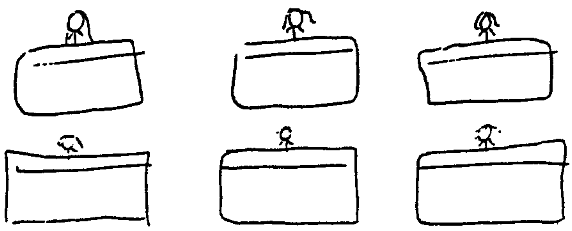
Collecting Visual Data in Organizations

This section of the paper considers how researchers might enlist informants' assistance in developing visual representations of their organizations. Collecting visual data is a process with two stages: (1) encoding information to produce graphic representations of organizational life, and (2) decoding the graphic representations to produce visual data for analysis. According to the broad definition of visual data used in this paper, the encoding and decoding tasks may be divided between researchers and informants in various combinations. Whereas informants' drawings might be interpreted by researchers in one inquiry, researchers' graphics might be interpreted by informants in another. A few of the possible combinations are illustrated below.

Informants' Freehand Drawings

Informants can take primary responsibility for encoding information by making freehand sketches. For instance, in a qualitative study of the diffusion of information

[5]Dimond et al. (1972) reported that people seem unable to transfer information from one hemisphere to the other while they are engaged in difficult perceptual analyses. Levy and Trevarthen (1976) found evidence for a "metacontrol system" that forms expectations about the nature of the problem to be solved, and then selectively activates one side of the brain or the other. They manipulated subjects' expectations prior to information processing, and found that the activated hemisphere "remains in control even if its performance, for whatever reasons, is considerably worse than that which could have been produced by the opposite side of the brain" (Levy and Trevarthen 1976, p. 300).



Before

After

"No talking, no looking, no walking. I have a cork in my mouth, blinders for my eyes, chains on my arms. With the radiation I have lost my hair. The only way you can make your production goals is give up your freedom."

FIGURE 3. Representation of Clerical Work before and after Computerization. Source: Zuboff (1988, p. 145).

technology, Zuboff (1988) invited clerical workers to draw pictures showing how they felt about their jobs before and after conversion to a new computer system. Informants created visual displays without receiving assistance or cues. Zuboff found that drawings like those in Figure 3 "functioned as a catalyst, helping them to articulate feelings that had been implicit and were hard to define" (Zuboff 1988, p. 141). A similar example is the sketch of a Model-T grafted onto a race car shown in Figure 4. The artist was an executive who had been asked to draw a picture of his company, which was "struggling to get into another field" (*The Wall Street Journal*, Oct. 31, 1984). Notice that in this instance, by instructing informants to represent their firms as "vehicles of any kind," researchers have partially structured the visual encoding process.

Dual Representations of Organizational Constructs

How can organizational researchers obtain the advantages that cognitive scientists attribute to dual representations? A straightforward approach is to have people

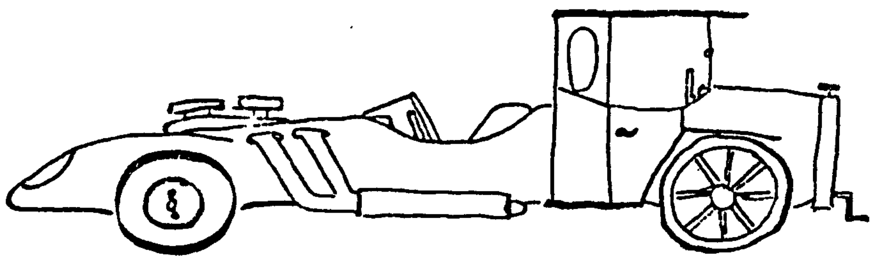


FIGURE 4. Executive's Representation of His Firm as a Vehicle.
Source: *Wall Street Journal*, October 31, 1984.

report verbally on drawings they have made of their organizations. For instance, Meyer (1978) obtained data on differences between 22 hospitals' enacted environments (Weick 1979) from diagrams generated by their CEOs. The objective was to obtain data of high quality, that honored idiosyncratic environmental enactments, and could be scaled for multivariate analyses.

An instrument was devised to guide the CEOs in creating diagrams such as the one reproduced in Figure 5. The instrument alternated between pictures and words, so as to trigger shifts between the CEOs' mental representations of their environments. An informant began his or her diagram in a verbal mode by: (1) labeling a pyramid printed in the center of a sheet of paper with the hospital's name, and (2) surround-

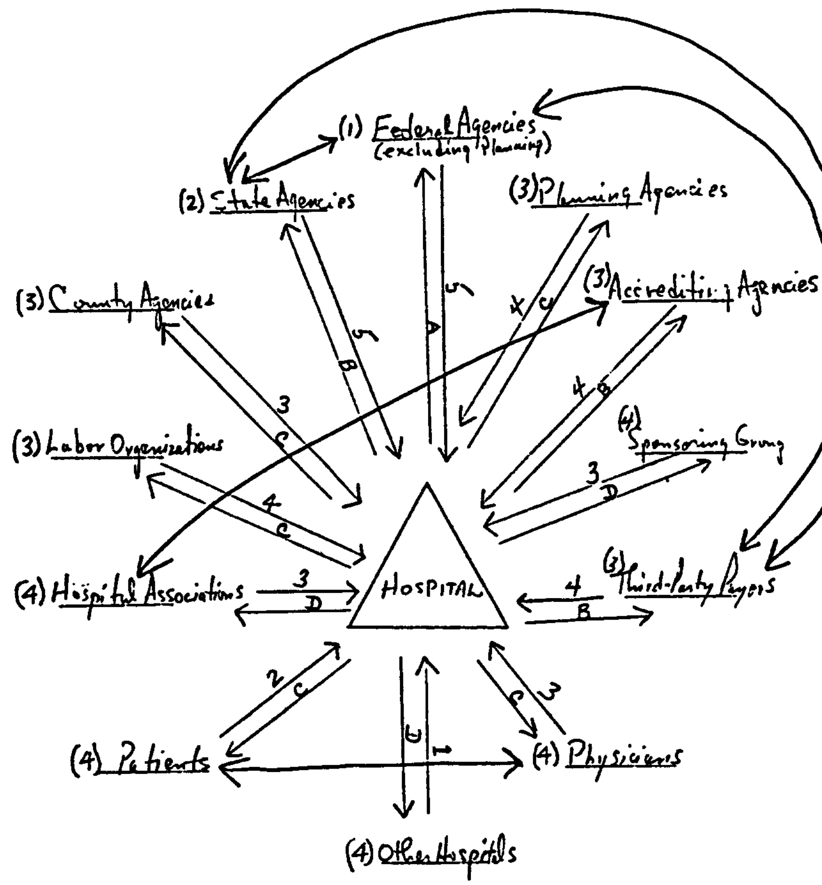


FIGURE 5. CEO's Representation of His Hospital's Enacted Environment.

ing the pyramid with a circular array naming those components of the environment that the informant regarded as most important. Next, the informant consolidated his or her latent visual image by: (3) drawing arrows radiating into the pyramid to depict the impact of each component on organizational decisions, (4) drawing arrows radiating outward to depict the organization's influence upon each component, and (5) drawing double-headed arrows to depict interactions among environmental components believed to affect the organization. Finally, five-point Likert scales were used to quantify: (6) each environmental component's impact on organizational decisions, (7) the organization's influence upon each component, and (8) the predictability of each component's preferences and actions.

In this fashion, informants were induced to synthesize their own perceptions into concrete, unified images, and then to classify relationships among the images' constituent parts in terms of a researcher's abstract theoretical concepts. Note, however, that by explicitly structuring the task of producing the diagrams, the researcher became more deeply involved in the visual encoding process than in the previous examples.

Some diagrams contained multiple erasures, indicating that as they took shape, informants had cycled back to revise their initial judgements. Follow-up interviews confirmed this, and also suggested that the revisions had increased the data's internal validity. Observations showed that CEOs found diagraming their environments to be an engaging activity, and response rates corroborated this. All 22 CEOs contacted completed a diagram. However, seven of them failed to return an accompanying questionnaire, and after three ignored repeated requests to do so, their organizations were excluded from subsequent analyses.

In those analyses, ratings of environmental actors' impact, predictability, and amenability to influence gleaned from CEOs' diagrams were used to create indexes of the extent to which decisions were contingent upon environments.[6] These indexes correlated significantly with the organizations' ideologies (Meyer 1982a), and they accounted for considerable variance in the organizations' subsequent adaptations to an environmental jolt (Meyer 1982b). These analyses have several implications. One is that members of ostensibly similar organizations in the same objective environment nevertheless inhabit socially constructed realities that differ dramatically. Another implication is that organizations whose members enact more volatile environments tend to espouse more adaptive ideologies, and to adjust more readily to sudden external changes.

Measuring Ill-Structured Concepts Iteratively

Human beings create and inhabit organizations. Yet, as Pondy and Mitroff (1979, p. 17) point out, researchers often treat their members as "in-place metering devices designed to register various abstract organizational properties like complexity or formalization." Consequently, members' capacities for making sense of things and attributing meaning to events are slighted (Barley 1983). Collecting visual data is one means for researchers to tap informants' higher mental capabilities and enlist their active participation in the research enterprise.

Visual methods can involve informants in several iterative rounds of data collection. This extended involvement is likely to yield better data, particularly when researchers are trying to operationalize ill-structured concepts. As studies of decision making have shown, depriving people of active involvement with ill-structured problems seriously impedes their ability to solve the problems (Connolly 1982).

[6]For a description of these procedures, see Meyer (1978).

For instance, as part of a comparative study of organizational innovation (Meyer and Goes 1988), verbal descriptions of formal capital budgeting structures in 25 hospitals were gathered during 355 interviews. But these data could not be used. Accounts were fragmentary, and they were constrained by each informant's vantage point in the budgeting process. In fact, the amount of variance reported by informants belonging to the same organizations approached the amount reported by those belonging to different organizations. Apparently, budgetary structures are so complex as to defy verbal description.

Nonetheless, by piecing together different informants' accounts, the researchers managed to develop their own rough cognitive map of each hospital's budgeting system. The researchers' maps were transformed into flowcharts and they were mailed back to the informants for correction. Note that in this approach to collecting visual data, the lead role in creating the visual display has shifted from the informant to the researcher.

The corrected flowcharts (see Figure 6) afforded two measures of budgetary structure: (1) Budgetary complexity was assessed by counting the number of evaluation points, decision points, and feedback loops in each chart. (2) Budgetary decentralization was assessed by counting the number of potential routes to the abandonment of a proposed investment. In a multiple discriminant analysis (Choe and Meyer 1985) these variables proved to be significant predictors of the adoption of technological innovations. Innovations were most likely to be adopted in organizations whose budgeting structures were simple and decentralized.

Next, the flowcharts were used as vehicles for collecting further data about decision-making processes. The chief executive officers examined their organizations' flowcharts and answered a standard set of questions. They identified critical decision-making stages by estimating the proportion of proposed investments screened out at various decision points. They singled out key decision makers, and they assigned weights reflecting the relative importance of medical, fiscal, political, and strategic considerations at different decision-making stages. In this fashion, additional data were generated by getting informants' help in interpreting the visual displays. These new data were used in constructing quantitative measures[7] of the process by which "innovations infiltrate organizations . . . passing through such phases as awareness, evaluation, adoption, utilization, and institutionalization" (Meyer and Goes 1988, p. 899).

Anecdotal evidence shows that the informants also found considerable value in the budgetary flowcharts. When the researchers wrote requesting a final clarification concerning one hospital's budgeting system, the Chief Financial Officer responded, "I have enclosed a chart that shows exactly how we process requests for medical equipment here at St. Michaels." The enclosure turned out to be a professionally redrafted facsimile of the researchers' original flowchart.

This incident underscores the inherently reflexive relationship between social scientists and the social systems they study (Albrow 1980). It also implies that collecting visual data may help increase the relevance of organizational research (Thomas and Tymon 1982) and promote its utilization (Beyer and Trice 1982). Organizations routinely resort to maps, diagrams, flowcharts, and other visual devices for their communication richness and emblematic value. If researchers enlisted practitioners' assistance more extensively in producing visual data, the results of scholarship might percolate back into practice more readily.

[7]See Meyer and Goes (1988) for a description of scale construction and other methodological details.

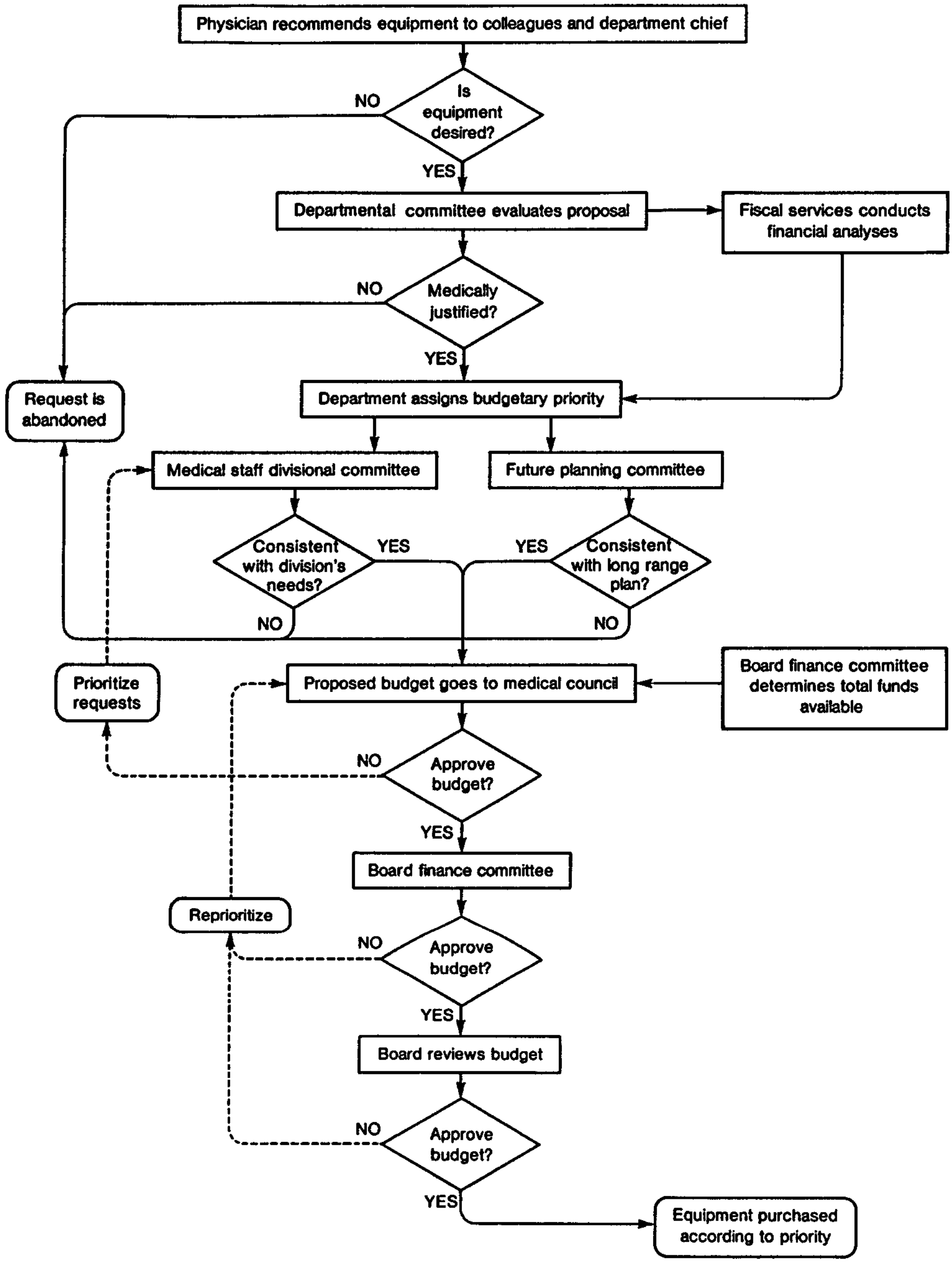


FIGURE 6. Flowchart Representing a Budgetary System.

Computer Generated Schemata

Scientists in fields ranging from astrophysics to molecular biology have discovered that by transferring mental images onto the screen, computer graphics can add to their understanding of black holes, cancer cells, and other natural phenomena. A key advantage is that graphic imagery allows for simultaneous perception of parts as well as a grasp of interrelations between parts (Maruyama 1986).

Computer graphics may prove equally fruitful for researchers interested in representing mental images of social phenomena. This potential is underscored by recent

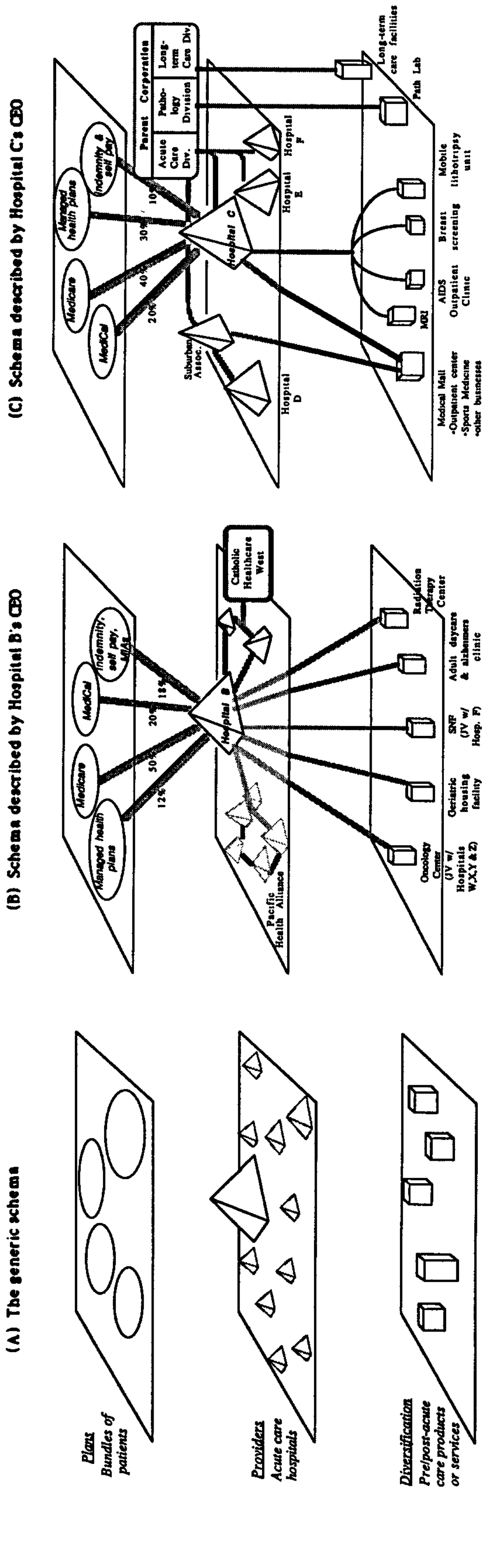


FIGURE 7. Computer Generated Schemata of Industry Environments.

research on schemata and scripts. Schemata are large, complex units of knowledge thought to organize much of what people know about general categories of objects, classes of events, and types of people (Schank and Abelson 1977, Minsky 1975, Rosch 1978). Schemata help people make judgements, comprehend their environments, and otherwise cope with the information processing demands of a complex world (Anderson 1980). Schemata, however, are incomplete knowledge structures in the sense that they leave certain features unspecified.

Using microcomputers to collect visual data may be one means of tapping informants' organizational schemata. For instance, in an ongoing longitudinal study of hospitals, Meyer, Brooks, and Goes (1990) discovered during the very first week of fieldwork that fundamental changes were overturning the industry's competitive structure and relocating its boundaries. Hospital CEOs were formulating different strategic responses, but interviews indicated that they were interpreting the environment within a common schema. This generic schema of the industry environment contained three categories of elements: (1) *providers*, the set of hospitals competing to supply acute care in the local market area, (2) *plans*, the fast growing set of patient groups amalgamated by some form of insurance vehicle, and (3) *diversifications*, the set of pre- and post-acute care products and services into which hospitals potentially could diversify.

The microcomputer graphics shown in Figure 7 were created in the field to help each CEO map his or her organization's position within the evolving industry. The schema's three categories were depicted as planes floating in three-dimensional space, and different icons were used to represent elements contained by each category. Part (a) of the figure shows the generic schema that was presented initially to all CEOs; parts (b) and (c) show how this generic schema was customized to depict the specific schemata that two CEOs described during field interviews. In order to ascertain how each hospital's position in the industry changes over time, every six months the researchers are mailing out copies of the most recent schemata and asking the CEOs to update them. At the end of the study, this method will have elicited a time series of snapshots showing schematically how each organization evolved within its environment.

Visual Data: Benefits and Liabilities

This paper has urged organizational researchers to exploit the power of graphics, arguing that people possess more complex, subtle, and useful cognitive maps of their organizations than they can verbalize. The discussion so far has emphasized the advantages of visual data and ignored their liabilities. However, all methods are flawed, and visual techniques present some unique validity threats and potential sources of bias.

First of all, people vary in graphic aptitude (Robey 1983), and visual techniques carry a risk of overgeneralizing the responses of artistic informants. This could, of course, be seen as an appropriate correction for our longstanding tendency to overgeneralize responses of those with greater verbal fluency. A more insidious risk is that visual data can be enormously compelling, even if their validity is low. Seasoned clinical psychologists, for instance, have been shown to cling steadfastly to illusory correlations between personality characteristics and Rorschach interpretations (Chapman and Chapman 1969). Thus the face validity of a visual display should not allay an organizational researcher's skeptical stance.

Another downside is that researchers face inescapable methodological tradeoffs in selecting procedures for encoding and decoding visual data. The central encoding issue turns on the relative involvement of researcher and informant in creating visual displays. Minimizing the researcher's involvement reduces the likelihood that his or her preconceived beliefs will bias the display produced. But if unassisted, informants are apt to create ambiguous and idiosyncratic displays. This increases opportunities for researcher biasing in their interpretation, it reduces the comparability of data across informants and organizations, and it increases the likelihood that measurement of organizational variables will be confounded by individual differences among informants. These considerations suggest that informant-generated visual displays (e.g., Figures 3 and 4) are most appropriate for ideographic inquiries treating each informant or organization as a unique entity. Researcher-generated displays, on the other hand (e.g., Figures 6 and 7), appear more suitable for nomothetic inquiries seeking to draw comparisons across informants, organizations or time.

Perhaps the most fundamental guarantor of valid visual data is not to rely solely on visual methods. Although every data gathering method is fallible, the weaknesses of one method are often the strengths of another (Denzin 1978). Thus, visual techniques should be combined with questionnaires and interviews. These verbal methods remain "the most flexible and generally useful devices we have for gathering information" (Webb et al. 1966, p. 172). Verbal data measure many variables more rigorously and less expensively, so visual data should be gathered selectively. But in the not-too-distant future, advances in computer technology may mitigate these liabilities and allow researchers to incorporate visual techniques in multimethod batteries. Electronic mail systems are already being used to gather questionnaire data (Sproull 1986). Future researchers may be able to access an organization's microcomputer network, use its graphical capabilities to administer visual instruments, use its word processing capabilities to ask open-ended interview questions, use its numerical capabilities to administer fixed-response questionnaires, and use its interactive capabilities to clarify any ambiguous or inconsistent responses.

But whatever media researchers use, they should never assume that their instruments render them passive observers of social facts (Astley 1984). Their own images of organizations remain encapsulated in those instruments, where the method may become the message. As Salancik (1979, p. 639) observed, "many understandings accumulated in the field are self-generated images induced by its methodologies."

Conclusion

In his remarkable book, *The Visual Display of Quantitative Information*, Edward Tufte (1983, p. 9) says that "of all methods for analyzing and communicating statistical information, well-designed data graphics are usually the simplest and at the same time the most powerful." He argues that graphic representations excel at communicating complex quantitative ideas, at revealing the data at several levels of analysis, and at inducing the viewer to think about substance rather than about methodology.

In studying organizations, visual instruments seem uniquely suited to situations where a researcher aspires to some precision in measurement, but prefers not to force informants into his or her cognitive framework prematurely. Such occasions include investigations of amorphous concepts, efforts to build theory, and research focusing on human awareness, interpretation, and consciousness. Visual data seem especially worthwhile in efforts to move beyond mechanical and biological models of organizations to view them as systems for creating meaning (Daft and Weick 1984).

The merits of such undertakings have been presented cogently elsewhere (Daft and Wiginton 1979, Pondy and Mitroff 1979, Starbuck and Nystrom 1981, Weick 1979). The arguments developed here suggest that researchers interested in pursuing them should consider emulating writers of Chinese. The evidence implies that Chinese ideographs are processed as images, and thus afford more direct access to meaning than English words (Biederman and Tsao 1979). Wang (1973, p. 55) describes it like this:

> The sequence of letters spelling 'horse' has meaning only through the mediation of the sounds they represent.... [but] to a Chinese the character for 'horse' means horse with no mediation through the sound *ma*. The image is so vivid that one can almost sense an abstract figure galloping across the page:

If organizational researchers began collecting data by asking informants to generate and interpret pictures, diagrams, and other visual displays, would their data break into a gallop? Perhaps not, but the data might reveal attributes that are normally fragmented by hierarchical thinking, verbal reporting, and alphabetic writing.

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