

# **Impediments to the Use of Management Information**

by

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## Foreword

This booklet stands apart from other works published by the National Association of Accountants (NAA) and The Society of Industrial Accountants of Canada (SIAC). Never have the two organizations experienced such a close cooperation with each other or with any other organization. Not only have they co-sponsored a research project, but they also intend to release the findings as joint publications. This monograph is the initial release from research on the project titled Business Decision Models.

The Business Decision Models project originated in 1972 from an analysis of research in management accounting and from the resulting proposition that a new research program be formulated on the basis of an exhaustive study of managerial information needs. The project, developed by the NAA research staff to provide for such a study, was designed as a set of several works.

It is expected that this initial release will be followed in the near future by two publications: (1) research methodology in decision-making and accounting and (2) normative models in managerial decision-making. Other anticipated publications within the project will consist of empirical investigations conducted in various areas of decision-making to the extent required for the concluding analysis designed to serve as a research framework for the discipline of management accounting.

The work presented here highlights the main theme of the project — information consistent with the decision processes and compatible with the organizational and individual patterns of using accounting information in making decisions. Dr. Mintzberg's spirited discussion offers a fresh look at a problem of vital concern to management accountants.

Guidance in the preparation of this report was kindly and generously supplied by the Project Committee:

William L. Ferrara (Chairman)  
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Prior to the formation of the Project Committee in August 1973, Charles W. Lamden (Peat, Marwick, Mitchell & Co., New York, N.Y.), then Chairman of the NAA Committee on Research, acted as the project chairman pro tem. He encouraged the undertaking in its inception.

The report reflects views of the researcher and not necessarily those of the co-sponsoring organizations or the Project Committee.

Both the NAA and the SIAC are pleased with the spirit of cooperation reflected in the co-sponsorship and joint direction of the project. Much work remains to be done in management accounting research. Joint undertakings such as this are indicative of more effective use of research resources in the future.

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## Introduction

In recent years, those specialists concerned with the design of the formal management information system (MIS) — notably accountants, MIS specialists and management scientists — have shown considerable interest in how the manager makes use of the information such systems provide. More to the point, these specialists are concerned that the manager does not use their information as they believe he should, and they would like to know why.

Clearly the explanations must derive from empirical research, especially from systematic studies of how managers use information. In fact, a number of such studies have been carried out. These have been reported in a wide range of literature, from cognitive psychology to management.

This paper reviews the literature in the search for answers to the question, "Why do managers not use information as they apparently should?" Ten answers are proposed which fall into three domains — the information, the organization and the brain. In effect, this paper suggests that the "blame" lies in three areas: inappropriate information, problems in the functioning of organizations, and design features of the human brain. The basic premise of this paper is that the use of management information is determined by the complex relationships between the information made available to the manager, the pressures imposed upon him by the organization in which he works, and the ways in which his brain receives and processes the information available.

The first section of the paper contrasts the formal with the informal information system in order to explain why managers often favor the latter. Four basic weaknesses of the MIS are highlighted:

1. *The formal information system is too limited.*
2. *Formal information systems tend to aggregate data; as a result much of the information produced is too general for the manager.*
3. *Much formal information is too late.*
4. *Some formal information is unreliable.*

There is a tendency on the part of specialists to lay all the blame for misuse of information on the manager. Thus, the faults in the formal information system are discussed first to emphasize that problems exist on both sides of the issue — the way information is provided as well as the way it is used.

In the second section, the organization is treated as the problem. Specifically noted are:

5. *Organization objectives are often rigid and dysfunctional and encourage the manager to use inappropriate information.*
6. *The power and political situation within the organization may cause the manager to ignore or distort information related to overall effectiveness.*
7. *The nature of his work drives the manager to favor verbal channels and neglect documented sources for information.*

In the third section, we delve briefly into cognitive and personality psychology and treat the brain as the difficulty. The three conclusions are:

8. *The manager suffers from cognitive limitations that restrict the amount of information he can consider in complex decision processes.*
9. *The brain systematically filters information in line with predetermined patterns of experience.*
10. *Psychological failures and threats further impede the brain's openness to information.*

The body of this report discusses these ten points in some detail. Two final sections then present a summary review of the impediments to the use of management information and some implications for the design of MIS. Before proceeding with this description, we must clarify the use of the term *formal* information. As is evident above, a clear (perhaps overly sharp) distinction is made between the information provided by formal systems and the rest of the information to which the manager has access. Such formal information includes accounting, manufacturing, marketing and other reports, is typically presented on a regularly scheduled basis, and is largely quantitative in nature. This information normally is produced by an in-house MIS and is designed and operated by specialists who often rely extensively on computer processing. The manager's other information may include a vast array of inputs — gossip, ideas, news and so on, provided through less formal (and irregularly reporting) channels. These may include personal contacts, trade organizations and informal subordinate contacts. This distinction between formal and informal information becomes especially useful in the following section.

### I. The Formal Information at Fault

#### 1. *The formal system is too limited.*

This first point is addressed not so much to impediments in the use of information, but to impediments in formal systems which drive managers to favor other channels. Despite talk of "total systems" in the normative literature of MIS, there is, in fact, considerable evidence that managers find formal systems of almost any type far too limited for their purposes. Instead they turn

to what they perceive as richer sources of information. Specifically, there is considerable evidence that managers favor verbal channels — face-to-face contact and the telephone — and, to a lesser extent, direct observation, as means of supplementing (and often replacing) formal sources of information (Aguilar, 1967; Mintzberg, 1973). Their reasons for doing so are many:

(a) First, the *data itself* in the formal system may not be sufficiently rich. For example, Davidson and Trueblood point out that: "Information regarding lost sales is apt to be more significant for many decisions than are carefully quantified data on completed sales transactions" (1970: 22). Yet formal systems often shy away from such intangible data. Or, as the American Accounting Association's Report of the Committee on Managerial Decision Models pointed out, managers may need to know not only the reports of sales and cash flows, but also how such data are affected by random events — weather, vagaries of the calendar, changes in economic and political conditions (1969: 22). And Johnson and Derman (1970) list a variety of factors that the MIS often misses — threats to the firm, risks associated with information, future resource costs, and so on.

(b) Second, the formal system often ignores important *non-economic* and *non-quantitative* data. In a paper titled "Administrative Rationality," Pfiffner (1960) explores this issue in a most interesting way. He discusses the *economic* or classical model of rationality which "takes a mechanical attitude toward human motivation and regards human behavior as conditioned by considerations of self-interest, mainly financial" (p. 130). In contrast, *administrative* rationality "takes into account an additional spectrum of facts. These are the facts relative to emotions, politics, power, group dynamics, personality and mental health" (p. 126). These additional facts must, of course, be found outside the typical MIS which generally collects and feeds to the manager the information that can be easily measured and processed, namely that which is quantitative and which focuses on economic efficiency. But as Hoos (1971) points out in her intriguing analysis of the difficulty of using MIS in government: "Data selected because they are machine processable provide a shaky foundation, indeed, for community planning" (p. 669). And Wilensky, who conducted a sophisticated study of information-gathering behavior in government, points to the dramatic example of Vietnam:

... analysis of the easy-to-measure variables (casualties suffered by the Viet Cong and the South Vietnamese) was driving out consideration of the hard-to-measure variables and long-run costs (the nature of popular support for a South Vietnam government, the effect of the war on the Western Alliance and on domestic civility, the effect of bombing on the will to resist) ... kill ratios and the like represent a touch of spurious certainty in a highly uncertain world ... (1967: 188-189)

(c) A third weakness of the MIS is that in relying on documentation it loses much information *verbal channels* can provide. Specifically, in face-to-face

contact the manager can "read" facial expression, gesture, tone of voice, and so on.<sup>1</sup> Documents are sterile by comparison. Furthermore, verbal channels allow for the immediate feedback and interaction which managers apparently find so important (Mintzberg, 1973).

(d) A fourth limitation of formal systems is that they often are weak in the area of *external information* which, again, managers apparently find so useful. Aguilar (1967), Gore (1956) and Mintzberg (1973) all point this out. Gore, for example, notes in his study of decision-making in Federal government field offices:

... it appears that information about external reactions to agency programs is the stuff which individuals in a field office use in thinking about policy problems and that it must be secured from so many sources that everyone in an office must rely heavily upon its intelligence system for this kind of information. (p. 285)

To borrow a phrase from Argyris, we find that in the worst of all possible worlds, the MIS produces "*valid* information for the *unimportant* and programmed problems and *invalid* information for the important and non-programmed problems" (1971: 277). In other words, while the MIS may effectively serve the routine operations of the organization, it may be too limited to serve the organization's higher level managers. Experienced managers in turn develop their own information systems — networks of contact men, informers, customers, trade organizations and other personal sources who feed them external information on an informal, ad hoc basis. In addition, they train subordinates to bring them information via verbal channels (Aguilar, 1967; Mintzberg, 1973). Aguilar notes in his study of external information managers use that personal sources exceeded impersonal sources in perceived importance by 71% to 29%, and he illustrates this with the comment of a senior partner in an investment banking firm:

Probably the most important source of external information for any successful executive in a large corporation is the informal network of contacts which he has outside the company. ... These are the people on whom the executive will rely for information, advice, and reactions. You could think of them as constituting a kitchen cabinet for the executive. (p. 76)

## 2. Formal systems tend to aggregate data; as a result much of the information produced is too general for the manager.

In addition to its gaps and limitations discussed in point 1, the MIS also can provide the correct information in the wrong form. Swanson (1973) recounts an

<sup>1</sup> Meissner (1968) points out three additional forms of nonverbal, non-documented information that workers (and presumably also managers) can use on the job — signs (e.g., tapping someone on the shoulder), signals (e.g., pushing a button to turn on a light), and objects (e.g., sending work along, throwing rotten avocados). Direct observation is another important medium managers can use.

amusing parable about a botany professor who spent a sabbatical year studying flora on a remote island. He communicated with his family only through a real-time terminal. His "MIS" allowed him to ask one question — "How are things going?" The question posed at the end of the first and second weeks met with the responses "Groovy." The response after week three was "Fine," and then there were no further responses. Rushing home, he found his house had burned down, and his family was in chaos. He subsequently discovered that technical constraints (the signal had to be bounced off the moon) limited the available messages to two bits — one negative and the other positive. Swanson completes his story:

During the first two weeks of the Professor's absence, the family situation worsened steadily. The cat fell off the roof, for example. And Dr. Quigly's eldest daughter dropped out of school to join a Hare Krishna troupe. But his wife did not wish to alarm him. She answered his question with the all-purpose message. "Groovy!" she responded, although she hardly felt that way!

But, at the end of the third week, just as the Professor's query was flashed to his wife on the family video display unit, the bedroom curtains in his youngest daughter's room were set ablaze by the accidental explosion of her boyfriend's homemade bomb. The flames spread quickly through the house. Mrs. Quigly was distressed, but composed. "How appropriate," she thought. And she responded with her all-purpose negative message. "Fire!" she replied. Of course, something was lost (or gained) in the translation process.

Now as Professor Quigly pieced together the story, he suddenly realized what had happened. "If only I had understood!" he cried. Alas, this insight was somewhat late. (1973: 53)

The obvious difficulty lies in the fact that there is the perceived need to aggregate information in an MIS so as not to flood the manager. But doing so may make the information output so bland that it is of no use to him. The essence of this difficulty lies in the filtering process. Because the MIS typically uses clerical or automated procedures, the filtering process is a simplistic one. "Computers proceed laboriously, while the human mind can discern a pattern and immediately guess the answer" (Alexander, 1969: 168). In other words, while the manager cannot tolerate information overload (see point 8), he may need a more intelligent filtering system than the usual MIS provides. As a number of researchers have found, the manager needs specific detail rather than general aggregation. Neustadt, who studied the information-collecting habits of three U.S. presidents, summarizes the argument succinctly:

It is not information of a general sort that helps a President see personal stakes; not summaries, not surveys, not the *bland amalgams*. Rather . . . it is the odds and ends of *tangible detail* that pieced together in his mind illuminate the underside of issues put before him. To help himself he must reach out as widely as he can for every

scrap of fact, opinion, gossip, bearing on his interests and relationships as President. He must become his own director of his own central intelligence (1960: 153-154; italics added).<sup>2</sup>

Managers need such tangible detail for two reasons. First, they require triggers to action — tangible stimuli that will evoke decision-making activity (Mintzberg, Raisinghani and Theoret, 1973). As one executive commented: "The many tidbits of information that an executive picks up through informal conversations with other businessmen serve . . . in alerting the businessman that *something* has changed . . . that there is something more to be learned" (quoted in Aguilar, 1967: 103). Second, managers describe their worlds in terms of conceptual models that they develop in their brains (Allison, 1971; Holsti, 1962); as Neustadt suggests, such models are built from tangible scraps of identifiable information.

Thus we see a second reason why managers may not favor the formal MIS — their informational needs simply drive them to less formal systems where they can find more intelligent filtering processes.

### 3. Much formal information is too late.

Three problems arise with the timeliness of formal information. First, formal reporting often means regular reporting, and reports cannot come so frequently that they continually interrupt the manager. Hence, information must await a schedule. Second, aggregation (as discussed above) takes time. Data must be accumulated. Third, the reliance on factual (and quantitative) data further slows down the MIS. It takes time for events to become "facts" as reported in a formal system. Events may be reported first as rumors and gossip, later as isolated facts, finally as data in the MIS's aggregated reports. Thus although data can be machine-processed quickly, the nature of the MIS is such that these data are delayed as they become measurable fact, as they get aggregated with other data, and as they are reported to the manager on schedule.

But the manager often cannot wait. A military commander wants to know when the enemy is moving as the movement takes place, not later in terms of some official measure like casualties in a battle. Similarly, the corporate manager wishes to know about lost sales when the customer is thinking of switching brands, not long after he has established a new brand loyalty.

As a result, we have evidence that managers spend a great deal of their time collecting grapevine information — gossip, hearsay, speculation (Mintzberg,

<sup>2</sup> The AAA study cited earlier makes a similar point: "Almost all data-gathering processes involve some degree of aggregation. The economics of information accumulation usually necessitates a level of aggregation that results in a considerable loss of detail and information potential. As a result, accounting information specifies average relationships over specified segments of some variable (such as time), whereas usually the optimization criteria of managerial decision models logically require incremental data." (1969: 56)

1973). This information may not be precise, but it is likely to be useful and timely. (It also may be inexpensive.) Guthrie and Kennedy (1969) discuss an example of factual information that is useless because it is too late — the annual budget of the U.S. Federal government:

Probably one of the severest limitations on using the budget for management decision purposes is that the president must arrange for budgets to be drawn up at least two years in advance. Even the current revision of the operating budget in the Federal government must be made during the fall for presentation to the Congress in the spring. The budget in its final form, as approved by the Congress, is usually not available until mid-summer or later! In the meantime, another budget for the following year has been developed in detail, along with a five-year forecast. (pp. 27-28)

In contrast, Davis (1953), who has conducted extensive empirical research on grapevine communication, finds it to be fast and selective.

#### 4. *Some formal information is unreliable.*

Finally, in addition to its sometimes being too limited, too general and too slow, there is evidence that the MIS sometimes is simply unreliable.<sup>3</sup> First, something may be lost in the quantifying process. The most well-known contemporary example is what Wilensky refers to as the “ghoulish statistics” of Vietnam — the body counts and kill ratios. The numbers were tangible, but how were the counters to distinguish the enemy from the innocent bystander? The reality of the situation was misrepresented by a simple quantitative *surrogate* measure that was ill-chosen.

The nature of surrogate measures is discussed by Ijiri, Jaedicke and Knight (1970), who “emphasize that accounting data are generally surrogated inputs” (p. 424). They point out that surrogates sometimes can be unstable, for example, where

a value of 15 per cent means that the real rate of return of the project is 19 per cent per year at one time and the same value of 15 per cent means that the real rate of return of the project is 12 per cent per year at another time. When this *unstable* condition arises, the decision-maker can no longer rely upon the value of the surrogate in making his investment decision. (p. 425)

There is evidence that other “ordinary” management information — that regularly collected by most firms, generally thought to be accurate, and used in many management science techniques — may, in fact, be unreliable. For example, Shapiro and Aronchick (1972), in studying the new product decision process in 27 Canadian companies, found that 20 of them had doubts about the

reliability of the quantitative data, particularly market data.

It presumably could be argued that with the use of a number of good surrogates, careful measures of each, and, if necessary, the attachment of uncertainty measures, the quantitative data that is now questionable could be made reliable. But the obvious question is: At what cost? And can the manager be convinced, or will he find his own channels more reliable for certain kinds of data that the specialist thinks he should provide?

To conclude this section, it is emphasized that a major reason managers do not use formal information as specialists think they should is that managers find difficulties with the MIS — too limited and often too general, too late and too unreliable. Instead, managers turn to ad hoc, informal information systems that they design and prove for themselves.

## II. The Organization at Fault

#### 5. *Organizational objectives are often rigid and dysfunctional and encourage the manager to use inappropriate information.*

To operationalize their goals and measure managerial performance, organizations select objectives (quantitative representations of goals, such as a 10% annual increase in sales to represent the goal of growth). But objectives can be selected only in those areas where quantitative performance information is available. As a result, objectives can turn out to be poor surrogates for the goals they purport to represent. These surrogate goals can induce the manager to attend to inappropriate information rather than to that which would serve the true goals of the organization.

Ackoff (1967), in his well-known paper, “Management Misinformation Systems,” presents a curious example in which different objectives of a purchasing manager and a merchandising manager in a department store would in theory drive the store to buy and sell nothing. He concludes: “When organizational units have inappropriate measures of performance which put them in conflict with each other, as is often the case, communication between them may hurt organizational performance, not help it.” (p. 152)

Such *dysfunctional* goals or objectives (as these inappropriate surrogates are known in the literature of organizational behavior) are quite common. Perhaps the most well-known case is the manager who suspends consideration of long-run profit, for example by foregoing research, in order to satisfy a short-run profit measure. Buckley discusses

a department head who got promoted to the presidency of his organization because he showed the most impressive departmental profits over a three-year period. It was his successor who faced the deferred maintenance that created the “profits” in the first place. By that time, the person who should have been axed had become the executioner. (1972: 21)

<sup>3</sup> Ijiri defines a system as reliable when it works the way it is supposed to. (1967: 137)

Ridgeway (1970) points out a number of examples from the literature: employment interviewers who were appraised by the number of interviews they conducted and so tried to complete many interviews rather than spend adequate time placing people in jobs; law enforcement investigators who had a quota of eight cases per month and, if behind schedule, would process the shortest cases (a situation known as "storming"); factory supervisors who fed their machines easy jobs at the end of the month for the same reason. Ijiri, Jaedicke and Knight (1970) cite one amusing case of Russian surrogate measures:

Smolinsky reports how the project of the Novo Lipetsk steel mill . . . comprises 91 volumes totaling 70,000 pages. (One is not surprised to learn that the designers are paid by sheet. . . .) Literally, everything is anticipated in these blueprints; the emplacement of each nail, lamp, or washstand. Only one aspect of the project is not considered at all: its economic effectiveness. (p. 432)

These authors cite other studies of dysfunctional goals in Soviet industry, including cases of storming, and conclude:

The result of the limited accounting information available to the Russian managers shows how these accounting systems greatly influence the behavior of the decision-maker in an ill-structured situation. Phenomena similar to that observed in Russia frequently are found in the United States, where surrogates, such as direct cost as a percentage of total cost, scrap costs, maintenance costs, return on investment, etc., are used to define the manager's goals and alternatives. (p. 432)

The broadest result of this phenomenon occurs in highly bureaucratic organizations where the very presence of so many objectives (regardless of what the measures are) evokes dysfunctional and rigid behavior — clients are dealt with inflexibly and impersonally, and the organization cannot adapt to changes in its environment.<sup>4</sup> Argyris (1960) points out the price of bureaucratic rigidity in human terms — a lack of congruence between individual needs and organizational goals which leads to frustration, failure, short-term perspective, conflict and hostility, and a focus on parts rather than the whole.

Interestingly, Argyris claims in a later paper (1971) that the MIS itself may lead to precisely the same behavior for many of the same reasons. He sees formal information systems as vehicles for reducing the space of free movement and control over the work environment, which in turn leads to psychological failure. In effect, to him the MIS is yet another rigid bureaucratic mechanism. And he argues that MIS specialists are not equipped to cope with the emotional problems their systems cause. Further, their inability to cope with the executives' behavior causes them to react "overrationally," which Argyris also considers an "emotional" response! Further support for this position comes

<sup>4</sup> March and Simon (1958) review the important work of Merton, Selznick and Gouldner in this regard.

from within the accounting profession, as Caplan argues:

Many management accounting techniques intended to control costs, such as budgeting and standard costing, may virtually defeat themselves because they help to create feelings of confusion, frustration, suspicion, and hostility. These techniques may not motivate effectively because they fail to consider the broad spectrum of needs and drives of the participants. (1970: 418)<sup>5</sup>

6. *The power and political situation within the organization may cause the manager to ignore or distort information related to overall effectiveness.*

Management information systems and management science techniques are built largely on the premise that organizations wish to maximize their efficiency (profit, ratio of benefits to costs, etc.). However, managers have goals independent of the organization — to move ahead quickly in the hierarchy, to build an empire within a department, perhaps simply to live the good life. They also relate to a coalition — "the group of people who influence what the manager attends to" (Churchman, 1970: 441). The result is that managers often make decisions in light of their own interests and those of their coalition, and they use the information that will help *them* if not necessarily their organizations (Churchman, 1970: 441).

Many researchers cite evidence of biased or distorted analysis (Whitehead, 1967; Cyert and March, 1963; Carter, 1971; Halberstam, 1972). Halberstam closes his insightful analysis of the Kennedy-Johnson years with the explanation by McNamara of why the costs of the Vietnam war were deliberately miscalculated in the 1965-67 period: "Do you really think that if I had estimated the cost of the war correctly, Congress would have given any more for schools and housing?" (1972: 610)

Researchers who have studied capital budgeting have noted the biases that sponsors exhibit to ensure acceptance of their projects (Bower, 1970; Carter, 1971). When these sponsors encounter heavy resistance, they often engage in bargaining with the opponents, with choices ultimately determined not by the logic of the arguments but by the power each side can muster. And so analysis gets subverted, even though the parties may try to explain their final choices in analytical terms (March and Simon, 1958: 131).<sup>6</sup>

In addition to biasing decision processes, people in political situations often distort the flow of information up and down the hierarchy. Upward biasing is well known — managers often tell their superior only that which protects their positions and puts them in a good light (with the result that much information

<sup>5</sup> Caplan cites the Stedry (1960) study as an example of behavioral implications of budgets.

<sup>6</sup> For further discussion of bias and distorted analysis in strategic decision-making, see Mintzberg, Raisinghani and Theoret (1973).



flowing upward is bland and noncommittal). Guetzkow (1965) cites some impressive evidence of this phenomenon, including one study where

The average number of messages with critical content sent by lows to highs, when no power was involved, was three times the quantity sent when the highs had both desirable position and power over the advancement of the lows. . . . Critical comments were simply omitted by those whose fortunes depended upon those with higher hierarchical rank. (p. 555)

Downward biasing is less well known, but Davis (1968) cites evidence from his study and one other in which the information that managers chose to tell subordinates was so lacking in detail or distorted as to be ineffective for use at the lower level.

### 7. *The nature of his work drives the manager to favor verbal channels and neglect documented sources for information.*

Various empirical studies of managerial work suggest a number of its important characteristics, including the following:

1. Because of the open-ended nature of his job, the manager feels compelled to perform a great quantity of work at an unrelenting pace. Little free time is available and breaks are rare. Senior managers, in particular, cannot escape from their jobs after hours because of the work they take home and because their minds tend to be on their jobs during much of their "free" time.
2. In contrast to activities performed by most non-managers, those of the manager are characterized by brevity, variety, and fragmentation. The vast majority are of brief duration, on the order of seconds for foremen and minutes for chief executives. The pattern among subsequent activities, with the trivial interspersed with the consequential, requires that the manager shift moods quickly and frequently. In general, managerial work is fragmented and interruptions are commonplace.
3. The manager actually appears to prefer brevity and interruption in his work. He becomes conditioned by his workload; he develops an appreciation for the opportunity cost of his own time; and he lives continuously with an awareness of what else might or must be done at any time. Superficiality is an occupational hazard of the manager's job.
4. The manager gravitates to the more active elements of his work — the current, the specific, the well-defined, the non-routine activities. . . . Time scheduling reflects a concern with the definite and the concrete, and activities tend to focus on specific rather than general issues. The pressure of the job does not encourage the development of a planner, but of an adaptive information manipulator who works in a stimulus-response environment and who favors live action. (Mintzberg, 1973: 51-52)

This type of workload and orientation to action drives the manager to prefer very current, action information, and to disfavor formal reports and other documented sources. These simply do not match his action orientation. As a result, we find in the same study that the manager views mail processing as a burden and favors the verbal media — face-to-face and telephone channels. He

would rather hear than read. (As noted earlier, he favors these channels because they are faster, allow for richer information and immediate feedback, and can more easily carry speculative information. Also, documentation may be risky for sensitive information.)

But just as the MIS is limited, so, too, are the verbal channels. The incoming data may be random and superficial, and the channel may not allow for the intensive and systematic probing that can be done in written reports. The result is that by favoring the verbal channels, the manager inevitably filters out important information. (Contemporary managers can, however, take heart. Even President Thomas Jefferson, in reply to a friend who had sent some books, wrote: "While here (Washington), I have time to read nothing." [Quoted in Guthrie and Kennedy, 1969: 25])

To conclude, the second culprit that impedes the use of management information is the organization — its dysfunctional objectives and rigid design, the political situations it breeds, and its effect on the nature of its managers' work.

## III. The Brain at Fault<sup>7</sup>

### 8. *The manager suffers from cognitive limitations that restrict the amount of information he can consider in complex decision processes.*

Previously we saw the effects of time limitations on the way managers process information. Here we add cognitive limitations — the capacity of the brain to receive, process, store and retrieve information. The evidence from cognitive psychologists who have studied such processes is that the brain is severely limited in its ability to handle complex decision-making tasks. It simply cannot cope with the quantity of information relevant to such decisions. Simon, who has studied a variety of game decision situations (such as chess), concludes: "Lack of information is not the typical problem in our decision processes. The world is constantly drenching us with information through eyes and ears — millions of bits per second, of which, according to the best evidence, we can handle only about 50." (1968: 622)<sup>8</sup>

Our ability to handle information is a function of what we see and what we retain. We can select only a few elements in the environment on which to focus (Norman, 1969); once we focus, we can hold a complete *sensory representation* of the stimulus just long enough for attention and pattern recognition forces to take effect, and as a result much detail is lost before its trace can be stored more permanently; then information is stored in coded form in *short-term memory* (Newell and Simon, 1972; Miller, 1956); and finally, some

<sup>7</sup> Some of the material of this section is drawn from an unpublished paper by Danny Miller (1973).

<sup>8</sup> The authors do not define bit, but presumably they are referring to the smallest unit of information, namely a variable which can take on only two values (that is, a binary digit typically represented by 0 or 1).



of this enters *long-term memory* where it is stored permanently (but slowly) in an effectively infinite data bank (Newell and Simon, 1972). Anywhere along this line information may be lost as shown in Figure 1.

In a famous paper published in *The Psychological Review*, "The Magical Number Seven, Plus or Minus Two: Some Limits on our Capacity for Processing Information," George Miller (1956) reviews a number of empirical studies which suggest that short-term memory, through which all environmental information must pass before entering long-term memory, has a limited capacity — about seven "chunks" of information. He then concludes with an amusing passage:

What about the seven wonders of the world, the seven seas, the seven deadly sins, the seven daughters of Atlas in the Pleiades, the seven ages of man, the seven levels of hell, the seven primary colors, the seven notes of the musical scale and the seven days of the week? What about the seven-point rating scale, the seven categories for absolute judgment, the seven objects in the span of attention, and the seven digits in the span of immediate memory? For the present I propose to withhold judgment. Perhaps there is something deep and profound behind all these sevens, something just calling out for us to discover it. But I suspect it is only pernicious, Pythagorean coincidence. (p. 96)

What do managers do when faced with a complicated strategic issue where there is the greatest amount of information, ambiguity and dynamic uncertainty? The evidence is that they grope and cycle quite a lot and attempt to simplify the issue by factoring one decision into many smaller subdecisions and by trying to use standardized programs to deal with each (Mintzberg, Raisinghani and Theoret, 1973). And, of course, they must filter out much of the "relevant" information in order to focus on a subset they can handle.

However, the great quantities of information that many managers are forced to consider<sup>9</sup> become even more of a concern when we introduce the dramatic finding of cognitive psychologists that subjects in a situation of information *overload* use less information in decision-making than do those with some near optimal amount of information (Driver and Streufert, 1969). In other words, more information is not necessarily better. There is a "curvilinear relation between input complexity and the output of the optical cortex in the brain" (p. 273), so that beyond some upper limit the brain uses less and less information as more and more is provided. For example, Driver and Streufert cite one study in which it was found that when the number of notes per bar "was steadily increased, the quality of musical output in accomplished pianists first im-

<sup>9</sup> Not only managers — business school academic Russell Ackoff estimates that he receives an average of 43 hours of unsolicited reading material each week! (1967: B148)

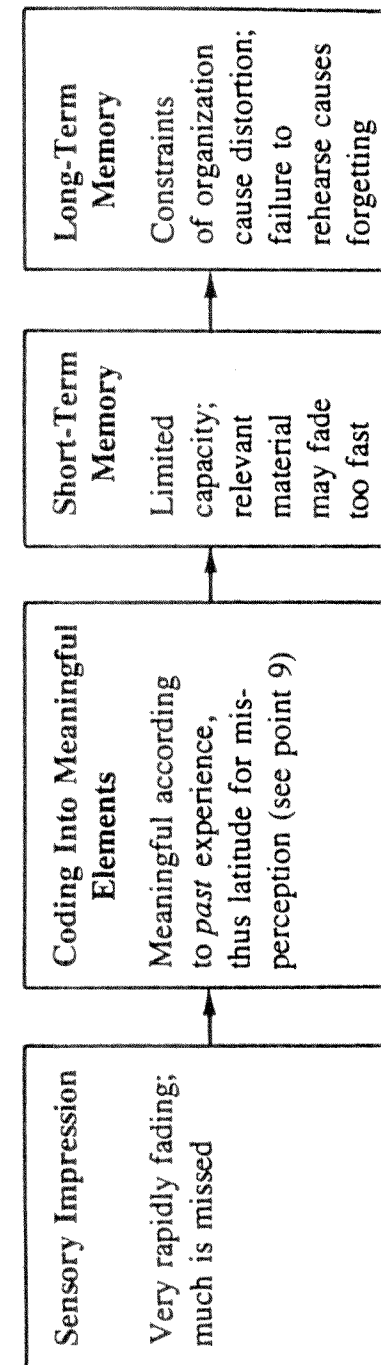


Figure 1: INFORMATION LOSS IN COGNITION  
Adapted from Miller (1973: 137)

proved, but then deteriorated." (p. 273). One is led to wonder what happens to accomplished managers who are overloaded by their information systems.

In fact, there is evidence that information overload leads to many forms of dysfunctional behavior, of which Miller cites seven:

(1) omission, failing to process some of the information; (2) error, processing information incorrectly; (3) queuing, delaying during periods of peak load in the hope of catching up during lulls; (4) filtering, neglecting to process certain types of information, according to some scheme of priorities; (5) approximation, or cutting categories of discrimination (a blanket and non-precise way of responding); (6) employing multiple channels, using parallel channels, as in decentralization; and (7) escaping from the task. (cited in Katz and Kahn, 1966: 231)

Unfortunately, sometimes the response of the MIS specialist is not to filter the formal information but to automate it. Simon cites a newspaper report to tell a common story:

"The U.S. State Department, drowning in a river of words estimated at 15 million a month to and from 278 diplomatic outposts around the world, has turned to the computer for help. Final testing is under way on a \$3.5 million combination of computers, high-speed printers and other electronic devices. Officials say these will eliminate bottlenecks in the system, especially during crises when torrents of cabled messages flow in from world troubled spots.

"When the new system goes into full operation this Fall, computers will be able to absorb cable messages electronically at a rate of 1,200 lines a minute. The old teletypes can receive messages at a rate of only 100 words a minute.

Simon concludes:

A touching faith in more water as an antidote to drowning! Let us hope that Foreign Ministers will not feel themselves obliged to process those 1,200 lines of messages per minute just because they are there. (1968: 622)

#### 9. *The brain systematically filters information in line with predetermined patterns of experience.*

The brain tends to perceive stimuli in terms of its own past experiences and may systematically filter out information not in accordance with these experiences. Such selective perception and attention reflects that the structure of long-term memory may influence the acquisition of new information. When such information is received, it is integrated with existing memory in terms of

this structure. The most common forms of mental set in business organizations relate to function. Hammond (1973) cites a common example:

There are two aspects of *cognitive filtering* worth emphasizing for our purposes. First, different people with different filters can be exposed to the same external stimuli and end up with different resultant information in their thought processes. For example, a production and a marketing manager might each read the same consultant's report regarding a particular new product and one would "see" information regarding production and the other marketing. Each has an internal "cognitive map" that is heavily colored by his experience and role in the organization. Thus what "clicks" with one person is largely ignored as being irrelevant by the other. (p. 6)

In one empirical study, Cyert, March and Starbuck (cited in Guetzkow, 1965) found that graduate students who were asked to make estimates from identical figures, first as "chief cost analyst" and then as "chief market analyst," tended to overestimate costs in the former job and underestimate sales in the latter. (p. 55)<sup>10</sup> Hammond summarizes the literature on this phenomenon as follows:

... human memory is an associative one, in that ideas and information are stored by related concepts as opposed to physical location in memory ... This means to bring past experiences, information, and problem-solving approaches to bear on a particular current problem requires establishing a conceptual relationship between the current problems and the past information.

The process of establishing the required relationship has been dubbed by psychologists, "cueing." For instance, the recognition that the opening of a new medical clinic is in fact a marketing problem allows all one's previous experience and knowledge related to marketing to be brought to bear on the problem. The realization or "cue" of this relationship might have come through a conversation with a colleague, reading an article, etc. (1973: 6)

But although selective perception and cueing serve the useful purpose of reducing the cognitive strain on the brain and aid the storage process, they also result in rigidities. These may cause the brain to consider new problems in terms of previous ones and thereby to systematically filter out relevant information.

#### 10. *Psychological failures and threats further impede the brain's openness to information.*

The personal biases of individual brains also color the information they receive. Kakar (1971-72), for example, tells the story of how Henry Ford eventually came to block out great quantities of information, in Kakar's view,

<sup>10</sup> In his study of how managers collect information, Aguilar (1967) found that functional area explained more of the information they collected and the sources they used than did other factors such as level in the hierarchy, size of the organization, and so on.

because of Ford's earlier relationship with his father. Argyris (1971) points out how managers may resist formal information because they perceive it as a threat to control over their work environments, and Festinger (1957) discusses the phenomenon of cognitive dissonance — how people adjust their goals (and filter information) to rationalize decisions they have made. Halberstam (1972) describes such a case — how Lyndon Johnson increasingly and systematically filtered out negative information about the progress of the Vietnam war after he made the decisions to escalate in 1965.

In effect, individual brains and their memories must adjust to difficult past experiences and the threat of future failures — compensating for pain that was or might be. Part of this compensation process involves filtering out threatening (though perhaps relevant) information.

To conclude this section, we note that brains have difficulty processing all the relevant information — there is too much, it may not fit with expectations and previous patterns, and some of it simply may be too threatening to accept.

### A General View of Impediments to the Use of Management Information

These ten points now can be drawn together into a general view of impediments to the use of management information. In essence, it has been argued that somewhere between the vast bank of information that exists in the manager's environment and the information that actually gets used in the making of decisions and in other tasks are numerous losses of relevant information. Figure 2 shows a summary of the points that have been made. In essence, from the large data base, losses take place due to limitation in the information system (A), the favoring of verbal channels (B), dysfunctional and rigid objectives and power and politics (C), and cognitive limitations, mental set, and the effects of psychological failure and threat (D). Finally, we see that a subset of the information actually used is either not directly relevant (i.e., misused) or simply inaccurate. To put all of this in a different way: of all available information, the system captures only a subset; of what is captured, the manager actually receives only a subset; of what the manager chooses to use, the brain absorbs only a subset; and of what the brain absorbs, only a subset is relevant and accurate anyway. With all these impediments, it may seem remarkable that managers are *ever* able to make effective decisions!

### Implications for the Design of the MIS

1. Managers need broad-based formal information systems, in large part independent of the computer.

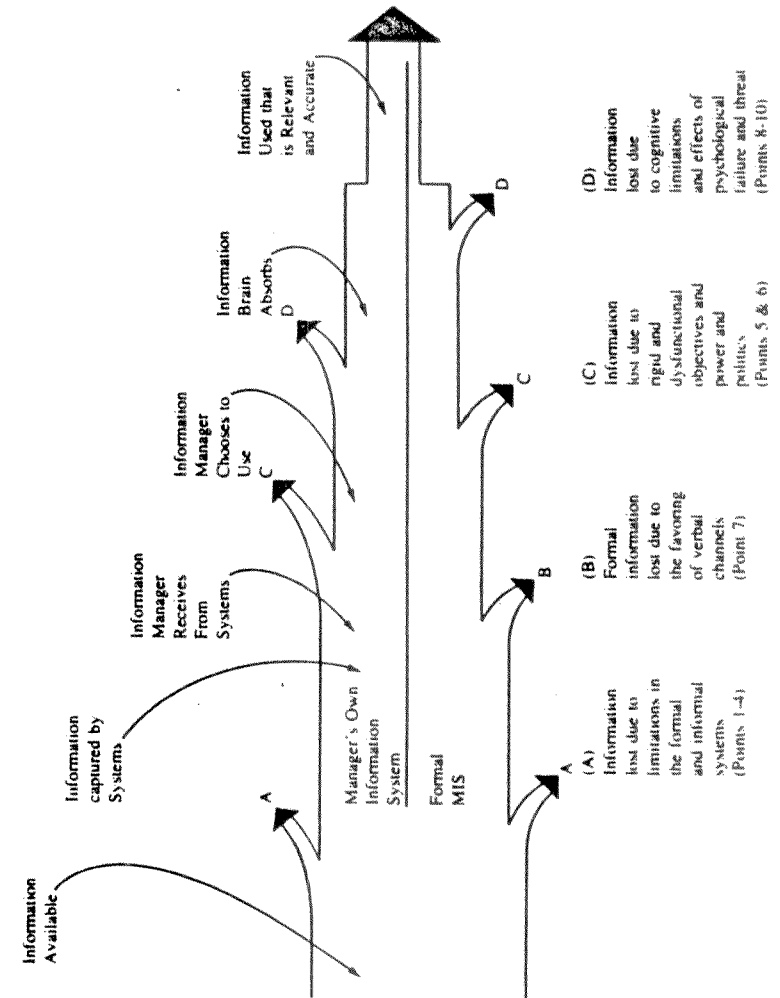


Figure 2: A GENERAL VIEW OF IMPEDIMENTS TO THE USE OF MANAGEMENT INFORMATION

Today the manager is forced to collect much of his information in ad hoc, informal systems he designs for himself. Such systems may provide what he needs, but they are time-consuming and crude. Clearly there is a role to play for formal systems in collecting some of this non-quantitative, behavioral, external, speculative and current information.

The inclusion of such data in formal systems will likely require two major shifts in the thinking of information specialists. First, they will have to cease to think of the manager in abstract terms, as a planner, coordinator, and so on. As noted earlier, the manager is not a reflective planner, the classical literature notwithstanding. To reiterate, he is "an adaptive information manipulator who works in a stimulus-response environment and who favors live action." Like the manager, the MIS designer will have to roll up his sleeves and get his hands dirty with gossip, with the information relevant for handling crises, and so on.

Second, the MIS must be detached conceptually from the computer. The MIS is a broad-based reporting system for managers; the computer is a convenient machine for handling large quantities of quantifiable information. The computer is not convenient for processing behavioral and external data, especially that which is speculative and is to be circulated among a few managers.<sup>11</sup> The MIS should treat the computer as an incidental tool for processing only that subset of the information for the manager which lends itself to quantification and machine processing. And the MIS should encompass a large base of other information which is processed by other means.

## **2. In an ideal MIS, the rate of information bombarding the manager would be carefully controlled.**

The finding of cognitive psychologists that information overload leads to inefficient use of information (the curvilinear relationship discussed earlier) suggests there is some optimum rate of information flow. Clearly, a sophisticated MIS should be designed to consider all the information the manager receives — the mail and the periodicals as well as reports and verbal inputs — so that he is not overloaded on any issue.

## **3. Concentration on intelligent filtering of information is a key responsibility of the MIS.**

The dilemma noted earlier is that by aggregating information to deal with the problems of overload, the MIS provides bland, sterile inputs to the manager. But here, again, the problem is excessive reliance on the computer, which generally reduces information in simplistic ways (e.g., by aggregating it). In fact, managers need far more sophisticated means of reducing information,

specifically, filtering processes that will systematically and carefully select the relevant facts from the mass of incoming data (e.g., not costs aggregated by quarter, but specific reports when specific costs are above normal and the reasons for the increases). The manager also needs help in pattern recognition; he needs processes that will detect changes in streams of incoming data.

There is reason to believe that the best filters and pattern recognizers are intelligent human beings — bright specialists (and alter egos) who can stand between the manager and mass of data out there and pick out that which they know to be really important to him. (There has been considerable discussion in the literature of intelligent computer-based information systems, but virtually all of this is abstract and conceptual. I am not aware of any empirical study that indicates that existing computer programs are sophisticated enough to filter appropriately the rich array of data currently available to managers.)

Such intelligent filters will present the manager with *highlighted* information — the trigger for decision-making, the surprising fact and the discontinuity in a trend that changes a preconception. The filters will also make sure that the information provided the manager is rich enough to be meaningful (in many cases, this means in raw form with associated detail). In the case of surrogate measures, limitations or inaccuracies will be clearly highlighted.

## **4. Careful determination of channels is necessary in MIS design.**

Clearly the MIS should not rely exclusively on documentation channels. Verbal channels (e.g., a briefing session) should be used where at all possible — they better fit the managerial orientation and allow for interplay between the manager and the source of input. Even documented information should, where possible, be geared to the manager's way of working — it should come in short, dramatic bursts. Those intent on MIS design with fancy hardware might visualize the organization of the future with teletype terminals in the office of each senior executive. Upon receiving some important information, the executive would decide which of his colleagues were to receive it, would key in the code to open the proper channels, and would then enter the message (hopefully verbally) which would appear simultaneously in the appropriate offices. Perhaps, as in a newspaper office, the urgency of the item coming in on the terminal would be signaled by the use of one, two or three rings of a bell!

The channel chosen also must match the use of the information. As Davis (1968) points out, information should be documented where an official record is needed and where filtering may occur as it is passed between more than one level of the hierarchy. Alternately, verbal channels should be used for confidential information and where informality and flexibility are necessary. Careful study of how managers use different channels is clearly in order for MIS design.

There probably is a critical volume in a channel below which managers will

<sup>11</sup> The reader may be tempted here to think of the impressive projections for computer technology. Unfulfilled promises have made me skeptical of such projections.

not use it. For example, it makes no sense to install in the manager's office a fancy console connected to a real-time computer system and then make available on it only limited information. Below some critical volume, the manager probably will not bother to use it at all. Hence the MIS should concentrate only on a few regular usage, high-volume channels.

**5. The formal information system should encourage the use of alternative and in-depth sources of information.**

The impediments of mental rigidity, power and politics, psychological threat and failure, and information unreliability, as well as the tendencies toward superficiality in managerial work, suggest that the MIS should encourage in every way possible the use of multiple and competitive sources of information. The manager needs different points of view and contrary opinions. He also needs in-depth probes of issues, preferably from unbiased observers (e.g., informed outside specialists, independent task forces) to counter his biases and mental sets. As Wilensky notes:

... the alert executive is everywhere forced to bypass the regular machinery and seek firsthand exposure to intelligence sources in and out of the organization. In matters delicate and urgent, more imaginative administrative leaders typically move to points along the organization's boundaries: looking toward the bottom, they rely on internal communications specialists such as education directors and auditors; looking outward, they rely on contact men such as press officers, technical salesmen, foreign service officers, lobbyists, mediators. They talk to reporters and researchers investigating their organizations; they establish study commissions or review boards comprised entirely of outsiders, like the members of British Royal Commissions; they institutionalize complaints procedures and thereby subject themselves to systematic, independent criticism from below, as in the case of the Ombudsman; they assemble ad hoc committees, kitchen cabinets, general advisors, personal representatives. These unofficial intelligence agents, some of them defined as peripheral, may constitute the most important and reliable source of organizational intelligence. They are sufficiently sensitive to the culture of the executive to communicate, independent enough to provide detached judgement; they bring to bear the multiple perspectives of marginal men. (1967: 189-190)

A sophisticated MIS can help the manager in the development of all these sources of information.

**6. Stored information must be conveniently available to the manager.**

Information must be in the manager's brain at the time he makes decisions if it is to be used. Hence, the ideal storage for information is in the manager's long-term memory. (Short-term memory holds only about seven "chunks" of information.) But, of course, not all information can be stored there; some must remain in the official storage of the organization until it is necessary for decision-making. At that time it can be acquired and moved into the manager's

memory. Stored data must be accessible in a place that is both convenient and known to the manager. Some information is kept best in fingertip storage (e.g., on or in the desk), some in paper files or the computer, some in the brains of different members of the organization. The MIS designer should analyze storage media and their uses and select them in line with how the manager seeks and uses the information under consideration.

**7. The information specialist must be sensitive to the manager's personal and organizational needs.**

This statement seems self-evident, but there is a tendency on the part of some specialists to belittle the manager for not using information as they think he should. Power and politics, non-economic goals, cognitive limitations are part of every manager's reality. The MIS must be designed with these factors in mind. The onus is on the specialist to design a system that will attend to the manager's needs. It is not the role of the specialist to decide in the abstract what information the manager needs and then to force it on him. The specialist must study the decisions the manager makes and how he uses the information. Then he will know what information the manager finds most useful and can give it to him in timely form. Simon makes the point nicely:

There is no magic in "comprehensiveness." It may be sufficient motive to climb a mountain "because it is there," but the mere existence of a mass of data is not a sufficient reason for collecting it into a single, comprehensive information system. Indeed, the problem is quite the opposite: of finding way [sic] of factoring decision problems in order to relate the several components to their respective relevant data sources. Analysis of the decision-making system and its data requirements must come first; only then can a reasonable approach be made to defining the data systems that will support the decision-making process. (1973: 271)

**8. The MIS should be designed to minimize some of its disruptive behavioral effects.**

As noted earlier, the MIS may be a vehicle for bureaucratic control — it may promote rigidity, narrowness and a lack of free movement. It may also be so sterile and detached that the manager feels uncomfortable using it. Hence, the MIS should first and foremost be for the manager — and that means he must have a full understanding of every part of it and full control over it (see Ackoff, 1967). The MIS should be flexible and responsive, and the information it generates, as well as its limitations, should be fully understood by the manager. If not, the manager may use information inappropriately, out of context.

To complete this paper we can borrow the closing paragraph of perhaps the

most sophisticated book on the subject under discussion, *Organizational Intelligence* by Harold Wilensky:

To read the history of modern intelligence failures is to get the nagging feeling that men at the top are often out of touch; that good intelligence is difficult to come by and enormously difficult to listen to; that big decisions are very delicate but not necessarily deliberative; that sustained good judgment is rare. Bemoaning the decline of meaningful action, T.S. Elliot once spoke of a world that ends "not with a bang but a whimper." What we have to fear is that the bang will come, preceded by the contemporary equivalent of the whimper — a faint rustle of paper as some self-convinced chief of state, reviewing a secret memo full of comfortable rationalizations just repeated at the final conference, fails to muster the necessary intelligence and wit and miscalculates the power and the intent of his adversaries. (1967: 191)

## BIBLIOGRAPHY

- Ackoff, R.L. "Management Misinformation Systems," *Management Science*, (Dec., 1967: B147-156).
- Aguilar, F.J. *Scanning the Business Environment*, (N.Y.: Macmillan, 1967).
- Alexander, T. "Computers Can't Solve Everything," *Fortune*, (October, 1969: 126-129, 168, 171).
- Allison, G.T. *Essence of Decision*, (Little, Brown, 1971).
- Allport, G.W. and L.J. Postman. "The Basic Psychology of Rumor," in H. Proshasky and B. Seidenberg (eds.) *Basic Studies in Social Psychology*, (Holt, 1960).
- American Accounting Association Report of the Committee on Managerial Decision Models. *The Accounting Review Supplement*, (1969: 43-76).
- Argyris, C. *Understanding Organizational Behavior*, (Tavistock, 1960).
- Argyris, C. "Management Information Systems: The Challenge to Rationality and Emotionality," *Management Science*, (Feb., 1971: B275-292).
- Bower, J.L. *Managing the Resource Allocation Process*, (Division of Research, Graduate School of Business Administration, Harvard University, 1970).
- Buckley, J.W. "The Empirical Approach to MIS Design," *Organizational Dynamics*, (Winter 1972: 19-30).
- Caplan, E.H. "Behavioral Assumptions of Management Accounting," in A. Rappaport (ed.) *Information for Decision-Making*, (Prentice-Hall, 1970: 421-435).
- Carter, E.E. "The Behavioral Theory of the Firm and Top Level Corporate Decisions," *Administrative Science Quarterly*, (16: 4, December 1971: 413-428).
- Churchman, C.W. "Management Acceptance of Scientific Recommendations," in A. Rappaport (ed.) *Information for Decision-Making*, (Prentice-Hall, 1970: 435-443).
- Cyert, R.M. and J.G. March. *A Behavioral Theory of the Firm*, (Prentice-Hall, 1963).
- Davidson, H.J. and R.M. Trueblood. "Accounting for Decision-Making," in A. Rappaport (ed.) *Information for Decision-Making*, (Prentice-Hall, 1970: 20-25).
- Davis, K. "Success of Chain-of-Command Oral Communication in a Manufacturing Management Group," *Academy of Management Journal*, (December 1968: 379-387).

Davis, K. "Management Communication and the Grapevine," *Harvard Business Review*, (Sept.-Oct., 1953: 43-49).

Driver, M.J. and S. Streufert. "Integrative Complexity: An Approach to Individuals and Groups as Information-Processing Systems," *Administrative Science Quarterly*, (June, 1969: 272-285).

Festinger, L. *A Theory of Cognitive Dissonance*, (Stanford University Press, 1957).

Gore, W.J. "Administrative Decision-Making in Federal Field Offices," *Public Administration Review*, (1956: 281-291).

Guetzkow, H. "Communications in Organizations," in J.G. March (ed.) *Handbook of Organizations*, (Rand McNally, 1965: 534-573).

Guthrie, C.L. and T.R. Kennedy. "Informing the Nation's President," *Advanced Management Journal*, (January, 1969: 25-34).

Halberstam, D. *The Best and the Brightest*, (Random House, 1972).

Hammond, J.S. *The Roles of the Manager and Analyst in Successful Implementation* (paper presented at the TIMS XX Meeting, Tel Aviv, 1973).

Holsti, O.R. "The Belief System and National Images: A Case Study," *Journal of Conflict Resolution*, (1962: 244-252).

Hoos, I.R. "Information Systems and Public Planning," *Management Science*, (June, 1971: B658-671).

Ijiri, Y. *The Foundations of Accounting Measurement*, (Prentice-Hall, 1967).

Ijiri, Y., R.K. Jaedicke and K.E. Knight. "The Effects of Accounting Alternatives on Management Decisions," in A. Rappaport (ed.) *Information for Decision-Making*, (Prentice-Hall, 1970: 421-435).

Johnson, R.J. and J.H. Derman. "How Intelligent is your 'MIS'?" *Business Horizons*, (Feb., 1970: 421-435).

Kakar, S. "Rationality and Irrationality in Business Leadership," *Journal of Business Policy*, (Winter 1971-72: 39-44).

Katz, K. and R.L. Kahn. "Communication: The Flow of Information," Chapter 9 in *The Social Psychology of Organizations*, (Wiley, 1966).

March, J.G. and H.A. Simon. *Organizations*, (Wiley, 1958).

Meissner, M. "Non-Verbal Communication on the Job," in R. Dubin (ed.) *Human Relations in Administration*, (Prentice-Hall, 1968).

Miller, D. *A Cognitive Theory of Organizational Adjustment*, (Ph.D. paper McGill University, 1973).

Miller, G.A. "The Magic Number Seven, Plus or Minus Two: Some Limits on our Capacity for Processing Information," *The Psychological Review*, (March, 1956: 81-97).

Mintzberg, H. "The Myths of MIS," *California Management Review*, (Fall, 1972: 92-97).

Mintzberg, H. *The Nature of Managerial Work*, (Harper and Row, 1973).

Mintzberg, H., D. Raisinighani and A. Theoret. *The Structure of Unstructured Decision Processes*, (Faculty of Management, McGill University Working Paper, 1973).

Newell, A.L., and H.A. Simon. *Human Problem Solving*, (Prentice-Hall, 1972).

Norman, D. *Memory and Attention*, (N.Y.: Wiley, 1969).

Neustadt, R.E. *Presidential Power: The Politics of Leadership*, (Wiley, 1960).

Pettigrew, A.M. "Information as a Power Resource," *Sociology*, (May 1972: 187-204).

Pfiffner, J.M. "Administrative Rationality," *Public Administration Review*, (1960: 125-132).

Ridgway, V.F. "Dysfunctional Consequences of Performance Measurements," in A. Rappaport (ed.) *Information for Decision-Making*, (Prentice-Hall, 1970: 395-400).

Shapiro, S.J. and D. Aronchick. *The New Product Evaluation Process*, (Faculty of Management, McGill University Working Paper, 1972).

Simon, H.A. "Applying Information Technology to Organization Design," *Public Administration Review*, (May/June, 1973: 268-278).

Simon, H.A. "The Future of Information Processing Technology," *Management Science*, (May, 1968: 619-624).

Stedry, A.C. *Budget Control and Cost Behavior*, (Prentice-Hall, 1960).

Swanson, E.B. "A Parable on the Understanding of a Management Information System," *TIMS Interfaces*, (Feb., 1973: 51-53).

Whitehead, C.T. *Use and Limitations of Systems Analysis*, (Ph.D. Thesis, Sloan School of Management, MIT, 1967).

Wilensky, H.L. *Organizational Intelligence: Knowledge and Policy in Government and Industry*, (Basic Books, 1967).