CONCEPTUAL MODELS FOR DETERMINING INFORMATION REQUIREMENTS

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INTRODUCTION

For years, we who are interested in data processing have had a vague notion that one of the problems facing managers today is the lack of information. "If only I had known . . ." is a familiar phrase to all of us. Most of us would like to cause that phrase to become unfamiliar. Unfortunately, very few people, if any, have been able to state very explicitly how we should go about filling the information void. Progress in developing a methodology for designing management information systems has been slow.

So many people have written and said so much about management information systems that I would like to be sure that all of us have a similar notion in mind. Therefore, I would like to briefly define a management information system as—a collection of procedures, equipment, and persons associated together for the purpose of providing managers, who have the authority to make decisions that commit the firm or its resources, with descriptions of the elements relevant to the performance of their function. In other words, a management information system is a means of providing to the people who "need" it, information to guide them in the conduct of the business. An ideal management information system, then, would do at least these things:

1. Provide each level and position of management with all the information that can be used in the conduct of each manager's job.

2. Filter the information so that each level and position of management actually receives only the information it can and must act on.

3. Provide information to the manager only when action is possible and appropriate.

4. Provide any form of analysis, data, or information whenever it is requested.

5. Always provide information that is up to date.

6. Provide information in a form that is easily understood and digested by the manager.

Whether or not you can fully agree with this as a description of a managerial utopia, I hope that this will at least provide a frame of reference that will help you to understand the use of conceptual models.

PROGRESS IN MANAGEMENT INFORMATION SYSTEMS

Using this ideal as a standard toward which our efforts are directed, we must recognize that no one has an ideal management information system. Just because we have not yet reached our ideal, however, we should not be discouraged from attempting to make progress. It is not easy to produce a monumental improvement in the science of management. Nevertheless, considerable progress has been made. In fact, progress has been striking in the fields of hardware, software, mathematical techniques, and

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the integration of procedural systems. Computers are available that can produce information at fantastic rates. High-speed printers can generate reports fast enough to inundate an entire committee. Teleprocessing has been developed to the point where up-to-date information can be maintained in a central data file. All of these various types of hardware can and will be improved, and all of them will probably be made less expensive or more efficient. However, I believe that management is not utilizing the capability that is already available.

Software has been developed so that special requests or changes in procedures need not totally upset a system. I am not beating the drums for FACT, COBOL, or any other programming language; I am sure that all of these will be improved further. However, I believe that even software is available today to assist management more effectively than managers realize.

Mathematical techniques have been developed for many things. We can optimize inventories, we can model markets, and we can predict the outcome of an election when only a small percentage of the returns have been reported. Even so, this resource of mathematical techniques is neither well-understood nor fully utilized by managers.

Many systems and procedures people have made substantial progress in developing integrated data processing systems. These systems chew up customers' orders at one end and spew out bills of lading, invoices, and production orders from the other end. However, their primary focus of attention has been on the routine operating documents of the business. They have made a substantial contribution in that they have permitted many managerial tasks to be directed by management instead of being subject to the individual judgments of many operating people. In inventory control, for instance, stock clerks are no longer responsible for inventory levels; management has the key to the inventory control system and can adjust its mathematical judgment to management's will.

The point of all this is that in spite of tremendous progress on a countless number of fronts, managers are not truly helped. Generally speaking, managers are working with the same variety of reports that they had several years ago. We believe that a major area of systems design has not been given sufficient attention. The problem of developing and defining the proper content of an information system has been slighted in the general work of systems analysis and design. One of the reasons for its having been slighted is that it typically falls in a no man's land between the technician and the manager. The technician typically says to the manager, "All you need to do is tell me what you want, and I have the wherewithal to supply it." Whereupon the manager, out of desperation, lack of foresight, or overconfidence, usually supplies the pat answer: "Just what I am getting now only quicker and more current." Some managers will honestly say: "I don't know, but you're the systems expert; can't you tell me?"

This no man's land has created considerable difficulty, and very few people have risen to the challenge to try to do something about it.

Another reason for little having been done about the ability to define the content of an information system is that content is extremely difficult to work with.

Let me define content as the message or information that is contained in a communication or a record. Every report, analysis, or document has some meaning (or message) that transcends the actual format of the document or report. When we are concerned with defining the content of a management information system, our concern is to determine the subject matter of the messages that managers should receive. When I talk about content, I am referring to the subject matter of reports and documents, regardless of how the data is displayed or arrayed.

Information content is difficult to determine for managers. It is almost impossible to separate the content of managerial information from the field of organization theory. Organization theory and practice is thin ice; it is a subject that is emotionally charged for any manager in a real-life situation. It is also a subject on which highly qualified, reasonable men can be expected to disagree. This is an extremely difficult area for anyone to work in, and particularly for a person who is scientifically and analytically inclined. You cannot determine the

information that a manager needs without considering his responsibility and authority. You must concern yourself with what he is, in theory, held responsible for, and how he discharges his responsibility and delegates his authority.

Being concerned with the content of an information system forces us to be concerned with "how to manage well." We must concern ourselves with: How does a manager operate? How does he reach his decisions? How does he make his decisions effective? How does he manage?" And perhaps an even more appropriate question is: "How should he manage?" No one has an adequate description or an adequate set of principles to tell us how to manage well. At best, there are a thousand platitudes that are collectively exhaustive and mutually contradictory. As if the lack of knowledge and understanding of the subject (from any analytical point of view) were not bad enough, this is also a subject that managers have difficulty discussing rationally and on which respected authorities disagree.

In spite of the difficulty, we believe that this is one area in which substantial progress will be made in the next decade. If nothing else, managers and systems men will be forced to it by the availability of hardware, etc., and the fear that some competitor may do it.

We believe that much of this difficulty is mental, and that we can attempt to develop a method for determining information requirements by trying to make the job mentally easier. Therefore, what we have to suggest is not so earthshaking, but we believe it is a sound approach than can enable a poor, mere, mortal mind to somehow get around the subject of management and get into the business of defining information requirements. The approach that we have to suggest might be described as a research approach. It is an approach that should enable analytically-inclined people to develop a definition of their company's information needs. If they want to, they can complete the entire job in an ivory tower, but the job will be done better if they have frequent reference to the regular, operating facts. The analysts should not lose touch with reality, but in fact, we have used this technique when there has been no reality to get in touch with. We have developed information requirements for nonexistent firms, and we believe that the results were extremely satisfactory.

Of course, an approach that is frequently productive, but is not the research approach, is that of expertise. Most information systems and most informational improvements that are made today are made on the basis of expertise. Someone writes an article in a professional journal or a scholastic business review describing the types of reports that they use. Managers read these reviews, think that they are wonderful and try to apply them to their business. The formats of the reports are face-lifted, and the manager tries to use them. Sometimes he has great success, and sometimes no success at all.

There are many varieties of models, and they can be used in many different ways. Operations research people are accustomed to applying mathematical models to business problems. Some chemists and biochemists use physical models of what they imagine the structure of atoms to be. For now, we are interested in dealing with a conceptual model. It is a model that deals with words and imagery to enable us to focus our attention and communicate our impression about the operations and the management of an enterprise.

MODELS OF OPERATIONS

The first step in developing a conceptual model of an enterprise is to attempt to state the key operations that the enterprise must accomplish in order to continue to function. We might describe an operation as a "gross unit of work specialization that is essential to the functioning of the enterprise." The easiest way to determine the appropriate operations for a concern is simply to begin to list all operations. Once the initial top-of-the-head list has been compiled, it should be juggled, combined, expanded and organized until it consists of a number—probably between 10 and 20—of operations of approximately equal importance.

As an example, I have chosen a wholesaling business. We might think of this as being a typical wholesaling business rather than any one specific wholesaler. Figure 1 is an initial list of potential operations for a hardware, drug, or appliance wholesaler. Many of these

captions appear to be steps in a procedure, and they should. Most business operations follow a routine. On the other hand, very few of the captions suggest a department or organizational unit of a wholesaler. We believe that the major concern of management is the basic op-

STOCK CHECKING	MAINTAIN PRODUCT LINE
ORDERING	TELEPHONE SELLING
SCHEDULING	SALESMAN SELLING
RECEIVING	ADVERTISE AND PROMOTE
STOCKING - BULK	WRITE ORDERS
HOLDING	PICKING
STOCKING - SHELF	CHECKING
OK RETURNS	DELIVERY
PICKUP RETURNS	INVOICE
CREDIT RETURNS	BILL
STORE RETURNS	COLLECT
SHIP RETURNS TO MFR.	MAINTAIN ACCOUNTS
RESTOCK RETURNS	

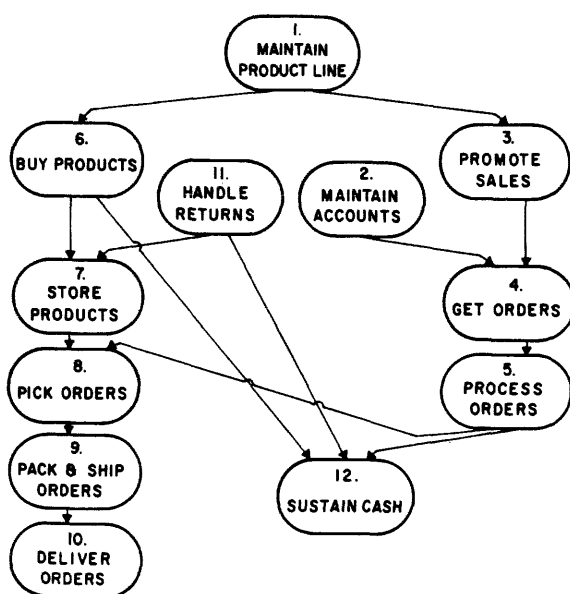Figure 1. Potential Wholesaling Operations.

Figure 2. Operations of a "Typical" Wholesaler.

erations of the business. If management loses sight of this and becomes preoccupied with people, the business can become a very nice place to work, but an extremely disorganized mass of human relations. We want to concentrate on the basic operations.

Figure 2 shows the operations that I finally selected as being the important ones for a typical wholesaler. They are arranged in a flow-chart format. The reasons for this will be explained later. Each block represents a job, task, function, mission, or as we have chosen to call them, operation of the firm. Take any one of these blocks out of the diagram and the business either ceases to exist, or is changed drastically in its methods of operation.

In effect, this diagram of the operations of a wholesaler is a macroscopic view of the business. Businessmen are already acquainted with other models of their business. They are accustomed to an organization chart and they are familiar with accounting statements. All of these are macroscopic views of the business.

The view of the firm that is illustrated in Figure 2 is specifically designed to focus our attention on the important things that must be managed. All of these things must be under the control and the close scrutiny of management. Each of these operations can be accomplished in a variety of ways. Each of these operations is a positive reason for spending money, not just an unavoidable expense—we have not included the payment of taxes or the negotiation with labor unions, nor, in fact, have we included the information system itself.

The next step is to try to provide meaning to each of the names that has been put in a box in our flowchart. Because these names mean different things to different people, it may appear that we have omitted a significant operation, or we might have difficulty agreeing that a certain activity is included in one operation rather than another. Before we go any further, we should provide a more careful delineation of each operation. This delineation should take two forms. The first form is a simple statement of the input and the output for each operation. Inputs and outputs are, in effect, the fences between the operations. They serve not only to help define the operations themselves, but also

to make us certain that we have not omitted some significant activities between the operations. Figure 3 shows the wholesaler's operations with their inputs and outputs. Notice that the only original input is product ideas and the only final outputs are: goods with customers, payment, cash, and collections. Having all the operations and all the inputs and outputs together in a single flowchart is a help, but it is still just a body of names which do not yet have sufficient meaning to enable us to probe the process of management.

The second form of delineation for operations is a description of the suboperations that are contained within the major operation. Figure 4 is a statement of the suboperations that are required to transform the demand for specific products, customers ready to buy, and preference for our services into orders. These lists of suboperations can easily appear to be a descrip-
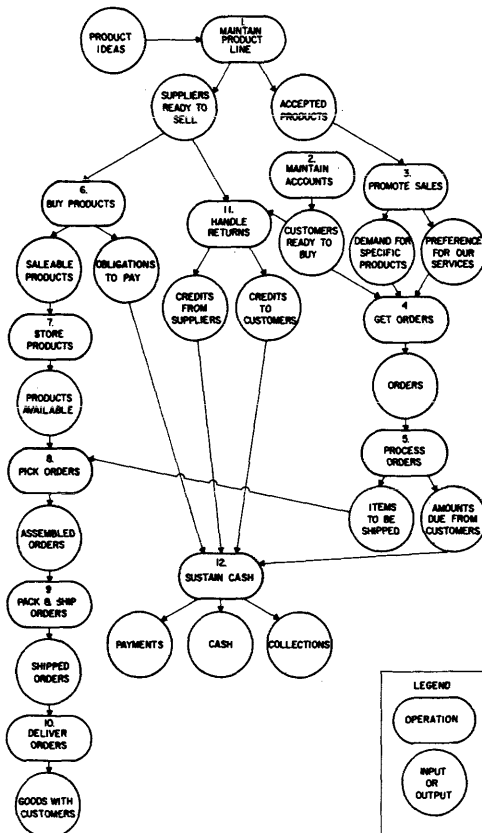

Figure 3. Wholesale Operations with Inputs
and Outputs.

OPERATION DESCRIPTION

4. GET ORDERS

ORDERS SHOULD BE SECURED FROM RECOGNIZED CUSTOMERS. THESE CUSTOMERS SHOULD BE GIVEN ANY APPROPRIATE ORDERING AIDS SUCH AS WANT BOOKS, ORDER BLANKS, PREPAID ENVELOPES, ETC. FOR FOR CUSTOMERS IN REMOTE CITIES, LEASED TELEPHONE LINES WITH LOCAL NUMBERS MAY BE PROVIDED TO ENABLE CUSTOMERS TO PLACE ORDERS WITHOUT PAYING LONG-DISTANCE TOLL RATES, OR CUSTOMERS MAY BE ENCOURAGED TO CALL COLLECT.

THE CUSTOMER'S INVENTORY MAY BE REVIEWED FOR HIM BY A REPRE-SENTATIVE OF THE WHOLESALER (POSSIBLY THE SALESMAN). THE WHOLESALER MAY MAINTAIN A PERPETUAL INVENTORY RECORD FOR THE WHOLESALER. AUTOMATIC DECISION RULES MIGHT BE PROVIDED AND REVIEWED BY THE WHOLESALER.

A TELEPHONE CALLING SERVICE MAY BE ESTABLISHED TO SOLICIT ORDERS FROM CUSTOMERS. THIS INCLUDES: (1) ESTABLISHING AND SUPERVISING A TELEPHONE SALES STAFF; (2) SELECTING THE CUSTOMERS TO BE CALLED AND ESTABLISHING A SCHEDULE FOR THE CALLS THAT IS GEARED WITH OTHER OPERATIONS OF THE WHOLESALER; (3) CALLING CUSTOMERS; (4) SUGGESTING ITEMS AND QUANTITIES TO BE ORDERED; (5) QUOTING PRICES; AND (6) PREPARING ORDER DOCUMENT.

ORDERS MAY BE SOLICITED DIRECTLY BY SALESMEN WHO PREPARE THE ORDER DOCUMENT, GET THE CUSTOMER'S APPROVAL, AND SEND IT TO THE WAREHOUSE.

"TURNOVER" ORDERS MAY BE SECURED BY ENCOURAGING CUSTOMERS TO SPECIFY OUR NAME TO MANUFACTURER'S SALESMEN. ALSO WORK WITH MANUFACTURER'S SALESMEN TO INCREASE THE PROPORTION OF THEIR ORDERS THAT ARE TURNED OVER TO US.

Figure 4. Description of an Operation.

tion of a general operating procedure. They are likely to include some of the things that we jotted down as potential operations in the very beginning. (See Figure 1.) If we were dealing with a specific firm, the description would be more detailed.

This (Figures 3 and 4) completes a conceptual model of the firm. Some of my associates and I have gone through this exercise for many firms and some command and control situations. We have found in every case that when two, three or four people sit down to prepare this conceptual model of an activity, they can, by constant negotiation give and take, agree upon a set of operations and definitions of operations. In short, a number of people with different backgrounds can follow this procedure to produce a single, well-defined, comprehensive view of the activities of a company.

MODEL OF MANAGEMENT ACTIONS

Now that we have a conceptual model of what the firm, as a whole, does, we would like to move on to a conceptual model of the functions

of management. We have an adequate statement of what the company does, but we must now decide how management manipulates the things that the company does in order to make it successful or unsuccessful. The basic question can be simply stated as: "How are the operations managed?"

Before getting too deeply involved in the conceptual model of management actions and their results, let's spend a little time poking into the lore of management. Many books have been written, from Frederick Taylor until the present time, about how managers can and should operate. The business reviews of our leading universities constantly publish articles about how to manage. We commend these sources to your attention. From our study of these sources, we have generalized and concluded that management must evaluate, organize, select, decide, train, and motivate. We can also recognize that management has at its disposal a number of resources. Resources can be summarized into the "four M's"—money, machines, manpower, and materials. Somehow, citing these names (evaluate, etc.) for the things that managers do, and citing the names for the resources that management manages seems to be helpful, but it cannot be the final conclusion. These names and labels are not sufficiently specific to help us decide what information management needs in order to manage effectively.

In addition to the lore of management, we can logically consider the things that a manager does in a typical work day. Those who are managers, and those who are familiar with the general operation of managers, can recognize that many of the things that a manager does do not have long-range significance for the company as a whole. For instance, a large part of the working day for a manager is spent communicating with those about him. This communicating is, of itself, not truly significant. It is an unavoidable expense. The decisions that may result from those communications, or the evaluations that can be made as a result of them, are significant, but the communications themselves are not. Similarly, a good manager spends a large part of his time studying and reading reports. In reality, this is simply another form of communication. The amount of time that a manager spends actually making

policy and making key decisions is a relatively small proportion of his total time. However, we believe that these are the significant things that a manager does that we would like to assist. With a good information system we might be able to reduce the amount of time that a manager must spend communicating and reading reports. But more significantly, we would like to assist him in making wise decisions about the truly important facets of the operations that he is managing.

One way to help cut out some of the chaff is to recognize that we are attempting to delineate those important managerial actions that are taken by management as a whole. We are not trying to find out the specific actions that any one manager takes. If we were, we would miss the significant managerial actions taken by committees. In many cases, a managerial action is taken at different levels of the organization. At each level, the manager has a different set of limitations within which he makes his decision. If we try to cope with all of these variations at once, we will be swamped. Our immediate concern is for the information that is required by management as a whole. We would like to postpone until much later the actual job of deciding exactly who should receive which information.

After many trials and errors, and considerable study, we have concluded that the most significant managerial actions can usually be stated as "selecting a course of action," "adjusting a rate of expenditure (or level of effort)," or "allocating resources." In a sense, allocation of resources is simply a combination or special case of selecting and adjusting.

To illustrate, a manager selects a course of action when he decides to use a particular channel of distribution, or decides to acquire a particular piece of production machinery. In general, these are discrete choices; the manager must select one or more out of a number of alternatives.

On the other hand, a number of elements can be adjusted over a continuous spectrum, such as prices or market area. These things can be adjusted up or down over a broad range.

Allocation consists of assigning particular resources to particular activities. The word

"allocation" suggests that the amount of the resource is limited in some way. The grandest sort of allocation is the allocation of money to each of the operations conducted by the firm. The general management of the firm must constantly reallocate its money among such activities as selling, delivery, and inventory.

Keeping in mind these general sorts of managerial actions, we can return to the conceptual model. We must examine each operation to determine the significant managerial actions that govern the quality of performance of each operation. If management acts wisely, the operations will be performed well. A management information system can not supply good judgment, but it can supply a sound base of facts to which managerial judgment can be applied. Figure 5 shows the managerial actions for the operation "Get Orders." Discovering these managerial actions for any operation is one of the most creative and imaginative steps in the process of constructing a conceptual model of a firm. It takes time and it takes stargazing. It is an iterative process that can be improved each time it is reviewed. It is also an extremely educational process. If the managers themselves can participate in the process, they can probably profit by it.
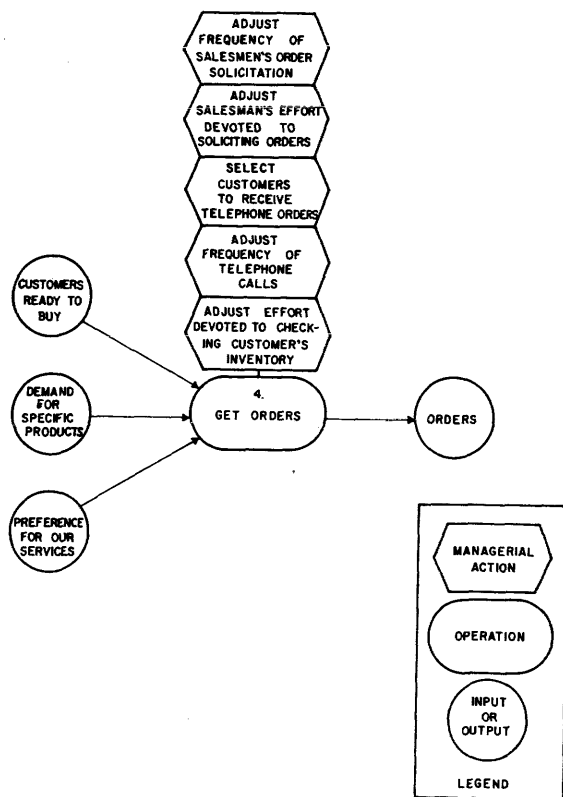
There are a few sources that we can look to for assistance in pointing out the key managerial actions. One of these is the detailed description of the operation. (See Figure 4.) We can review that description, looking for instances in which a manager must select from a number of alternatives, or for key decisions that are built into the regular conduct of the operation. We can also consider the resources that are required to perform the operation. It might pay to construct a list of the resources that are used in each operation. Resources might be:

> Particular skills
> Manual labor
> Existing facilities (physical capabilities)
> Known suppliers
> Existing public (customer) image
> Existing products

Figure 6 lists the major resources that are used to get orders. Some of these resources are subject to quantity manipulation. However, the rough proportions of the various resources are dictated by the nature of the operation itself. For instance, for a wholesaler, the selling activity cannot effectively use a large fixed capital investment; almost the sole resource for selling is the highly skilled ability of a salesman in personal contact with the customer.

In considering the resources required to perform an operation, there is a potential trap. That trap consists of considering money as a resource. No one can deny that money is a resource, but it is the one ultimate resource. Given sufficient time, it can be transformed into

Figure 5. Managerial Actions for an Operation.

. SALESMAN'S TIME

. TELEPHONE SALES CLERK'S TIME

. FAVOR OF MANUFACTURERS

. TELEPHONE FACILITIES

Figure 6. Resources Used in Getting Orders.

any of the other resources. Therefore, in determining the resources that are used in the performance of an operation, we should exclude money from our consideration. Otherwise, we run the risk of doing a superficial job.

Another potential source of help in discovering managerial actions are job descriptions, organization charts, financial statements, and interviews with managers. All of these aids should be used liberally.

Next we would like to consider the results of each managerial action. Usually, at least one result of every managerial action is obvious from the statement of the action itself. If the action selects or adjusts, one result of the action is a commitment to a course of action or a change in the level of something. However, we are interested not only in the direct effects of the action itself, but also in the ancillary effects. Almost every managerial action involves more than one result. Many managerial actions imply a trade-off between two potential results. Some managerial actions simply have more than one effect. Figure 7 shows two managerial actions and their results. In total, when taken for all managerial actions, these form a conceptual model of a management of the firm.
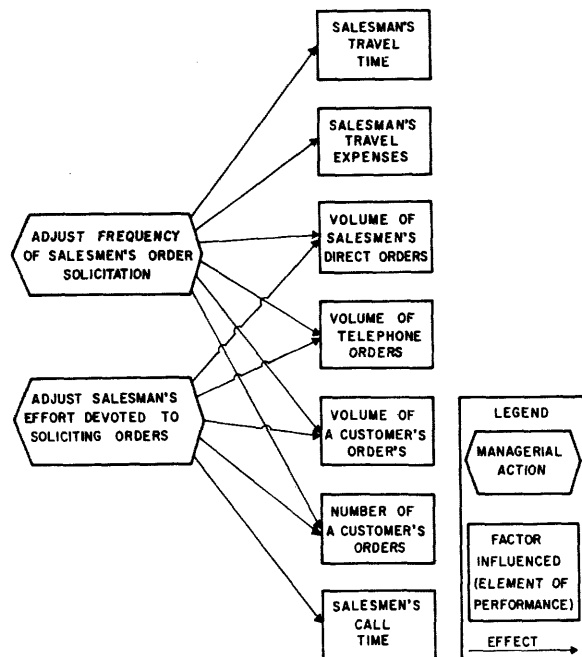

Figure 7. Action-Result Models.

We slipped into using the word "result" rather quickly. We might better call them elements of performance, or parameters of performance. These are the factors or elements in the business that are influenced by the managerial actions. It is important to think of the relationship between the action and its results as an influence. If you try to think of it as too direct a cause-effect relationship, you are likely to get bogged down. For instance, if you try to think of the purchase of particular delivery vehicles as directly causing the cost of delivery, you will get into trouble because delivery costs are also affected by wage scales paid to drivers, the distances the trucks are driven, and in fact, the number of deliveries that are made. Each of these things influences the cost of delivery, but none of them controls it. Similarly, in Figure 7, many of the results are influenced by both actions, and if we added the action "adjust frequency of telephone calls" it would influence many of these results also.

At this stage of the development of the conceptual model, we must be careful not to insert results that are too far-fetched. Moreover, we must recognize that some factors are influenced directly by a managerial action, and some are influenced only indirectly. For instance, almost all managerial actions have an influence on profit. Similarly, a number of managerial actions influence sales volume. To include these as results will be helpful for only a few managerial actions. We should concentrate on direct results. For instance, some managerial actions, such as "select products to sell," may directly affect the size of the market in which the firm competes. Others, such as "adjust advertising expenditures," may directly influence the share of the market that the firm enjoys. These actions have an indirect or derived effect on sales volume.

The results of managerial actions do not exist in a void. They influence one another also. For instance, to continue with the last example, sales volume is influenced directly by the size of the market and the penetration of the market. With diligence and care, we can determine which results are influenced by which other results, and, in total, we can develop a structure of results. Figure 8 represents a por-
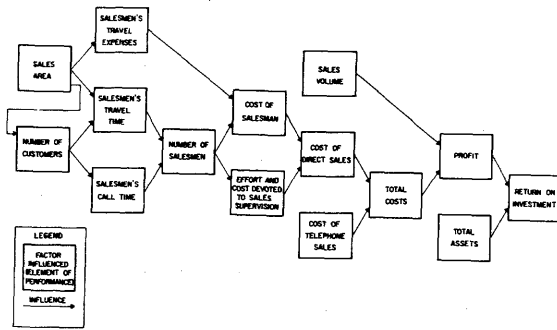
Figure 8. Structure of Results
(Partial and Simplified).

tion of such a structure. It is drawn in flow-chart form, and it has a natural progression from left to right. Observe that sales area is the most causal, basic element of performance, and return on investment is the most final, common element.

The preparation of this structure of results will assist in simplifying the statements of results of each managerial action. From the structure, we can infer that any one result has a chain of influences. Since we have the structure, it would be redundant to repeat the chain for each managerial action. It is enough to note the left-most element in the chain as a result of an action. For instance, Figure 7 does not show number of salesmen as a result.

Furthermore, the very exercise of trying to compile a complete structure of all results of managerial actions is likely to point out some results that have not been linked to any action. If the result stands at the beginning of a chain, we should try to find the managerial action that influences it.

Figure 9 shows the same structure of results as does Figure 8, but superimposed on it are the managerial actions that influence the results. This exercise can help us to understand how the results of one action can influence another action. It can also help us to see the managerial actions that are influenced by specific factors. For instance, the action "adjust working hours of salesmen" is affected by "salesmen's travel time" and "call time."

The flowchart is a very cumbersome device to display a complex structure of results. Figures 8 and 9 are simple only because they depict so few factors. We might try to simplify the job by using a precedence matrix such as Figure 10. A primary advantage of a matrix form of documentation is that it permits us to say something about the nature of the relationship between an action and its results, and between various results. Some of these relationships are clearly defined. After all, some of them are taken almost directly from accounting practice, and are, therefore, susceptible to the accounting definitions. We know that some other relationships are proportional, even though we may not know what the exact proportion is. The inter-
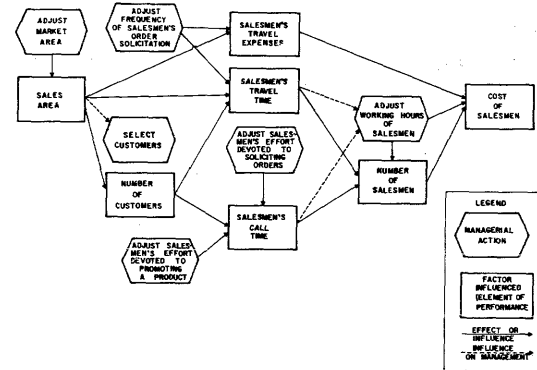

Figure 9. Managerial Actions Superimposed
on the Structure of Results.

Figure 10. Matrix of Cause-Effect Relationship.

sections of the matrix can contain all that we know about the nature of the relationship. If we could determine the exact mathematical function that relates each of the actions to its results and the results one to another, we would have a fabulous mathematical model of the firm. Unfortunately, the nature of many of the relationships is simply unknown.

This exercise completes the conceptual model of the firm, its management actions, and the results of those actions. The model can be used as a general guide to understanding how the firm works. It might be used as the basis for a mathematical model of the firm.

DETERMINING INFORMATION CONTENT

The major purpose of creating the model in the first place was to assist in determining the information that is needed by the management of the company to manage the company well. This can be done by simply reviewing the action/result models. (See Figure 7.) We can consider each element of the model as a requirement for managerial information. We would like to measure the managerial actions themselves—how much action is taken, when was it taken, etc.—and we would like to measure each of the results of the action. A comprehensive information system will contain each of these measurements. In addition, it will contain many similar measurements of competitors' business practices.

In order to be more specific, we need to return to the diagrams of actions and results. One of the actions in Figure 7 is "adjust frequency of salesmen's order solicitation." This automatically suggests the question, "How often do salesmen solicit orders?" The simplest answer to that question is the total number of calls made by all salesmen in a month. Of course, we might want a finer breakdown—number of calls made by each salesman, and number of calls made on each customer. A tally of the number of calls is a frequency from the firm's point of view, but we might want to turn it around and look at it from the customers' point of view. How many solicitations does the average customer receive in a month?

Call frequency is not hard to measure. In fact, if we tried a little bit, we might even be able to learn how frequently our competitors solicit orders. If we asked our customers who else they buy from, and how frequently each competitor's salesman calls, we can expect some customers to refuse to answer, and some customers to give us wrong answers. But if we carefully compile the data that we do get, we can expect to be better informed than we would have been otherwise.

If we dwell on the subject longer, we might think of some other significant measures of the action itself, but we should also be concerned with the results of the action. "Salesmen's travel time" would be fairly easy to measure. All we need to do is ask the salesmen to keep track, for a month, of the time of day at which they leave one account and arrive at another account. We might even ask the salesmen to take an hour or so and prepare a "typical" itinerary with an estimate of the travel time between accounts. Either way, this is not an onerous chore, and it might even be worthwhile for the salesmen to go through the exercise just for what they would learn from it. Then we will need to compile it to learn the travel time.

"Salesmen's travel expenses" are regularly measured by most firms. We should observe in passing that there is a close connection between travel time and travel expenses. Furthermore, both factors, time and expenses, cannot be attributed to individual customers. Any attempt to determine the amount of travel time or travel expense that is incurred on behalf of any one customer is bound to be arbitrary. Neither of these factors lend themselves to interpretation from the customers' point of view.

If possible, we would like to go beyond measuring the action and its results. We would also like to consider the characteristics of the relationship between them. For these particular actions and results, we have a pretty good notion of the basic relationship—as the calling frequency is increased, the travel time and expense increase also. Any information beyond this intuitive feel will be difficult to acquire. We might ask a few salesmen to play a game with us and prepare hypothetical itineraries for the manner in which they would cover their territories if they were to cut their number of calls

to one-third of their present frequency. Then do it again for two-thirds, three-halves, and double. A compilation of these estimates should give us pretty good information about the relationship between the action, "adjust frequency of salesmen's order solicitation," and the results ,"salesmen's travel time" and "salesmen's travel expenses."

Another important characteristic of information is that it must be related in time, and in many cases, it must be understood "through" time. Each action and each result must be thought of as a time series. We want more information than just the present status. We also want to know how frequently we called on customers last year and the year before; and we want to know what frequency is planned or expected in the future. In addition, we want comparable information about travel time and expenses. If we can get nothing better, we might even use an historical comparison to tell us about the relationship between call frequency and travel time and expense.

The process of defining information requirements—the content of an information system—is to find a way to measure each managerial action, each result, and each connection between an action and a result. Then see if a comparable measurement can be found for competitors. We must be certain that the information can give an historical perspective and a glimpse of the future. In many cases, this method will lead us to unexpected information requirements.

How many sales managers do you know who could give you a satisfactory, quantitative answer to the question, "How often do salesmen solicit orders?" Most management information systems pass up this information completely, and yet, if we have any faith in our model, we can see that the action that is measured by the answer to that question has a far-reaching effect upon salesmen's time and expenses, and upon sales volume.

The job of translating these information requirements into reports and files is no small job, but it is a more familiar one. Systems and procedures people have been doing this sort of thing for years. Anyway, we have not yet found a way to have conceptual models help with this part of the job.

CONSTRUCTING CONCEPTUAL MODELS

The procedure for developing a complete conceptual model is easy to work with mentally. It progresses from one stage to the next, and at each stage we can focus our attention on only a few factors at a time. In the early stages, these factors are abstract. They are so abstract that they can apply with little modification to a number of different economic enterprises. But, as the early framework is expanded and completed with more details, the conceptual model begins to apply only to the economic enterprise for which it is designed.

I would not mean to imply by these words that conceptual models are easy to develop. It is one of the most rigorous mental exercises that I have run into. To complete a model requires creativity, imagination, insight, and judgment. I firmly believe that no one person can construct a good conceptual model. The best way is to develop one through individual effort which is followed up with a review by one or more persons. If this review is not available, the next best alternative is to attempt to complete several stages of development of a model. Then, put it away in a desk drawer and come back to it in six months. By this time, you may be a different enough person to review your own work adequately.

Don't get fooled by all the flow charts and geometric shapes. They are not the conceptual model. The model exists in the mind. The lines, words, and shapes are only a means of communicating and permanently recording what the mind has conceived.

Recall that we are dealing with a model, and a model is something that simplifies reality. The model does not faithfully reproduce every attribute and characteristic of the original; if it did, it would be a duplicate not a model. A wind tunnel model attempts to reproduce the exterior shape of an airplane or flying object so that engineers can observe the performance of the shape in moving air. A mathematical model for inventory control does not reproduce all the characteristics of the real world; it reproduces only those characteristics which are

felt to be of primary importance in controlling inventory. This same sort of attention must be applied to conceptual models for determining information requirements. The developer must continually weed out and separate trivial details from important generalities. For instance, back in Figure 7, we might have shown "number of salesmen's direct orders" as an element of performance, but we cannot find anything significant about that number.

At each stage of the development of a model, the analyst should ask himself: "Is each of the elements or factors which I have written on this page of approximately equal importance?" Since there is no absolute scale of importance, this question cannot be answered conclusively. That is why our model is a conceptual one. It deals with words, abstractions, and impressions. As such, it is subject to arbitrariness and judgment. Even so, it is worth developing.