STRUCTURING THE MANAGEMENT ENVIRONMENT --
THE INFORMATION SYSTEM DESIGN PROCESS

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Management Planning and Decision Support System development is an iterative process. Managers and system designers must cooperate in structuring the decision environment and establishing increasingly refined and valid measures of management action and environmental response. The initial objective of system development is to establish a management perspective on the decision environment and to insure that subsequent analysis focuses on actionable processes in the environment -- processes influenced by management controlled variables. The continuing goal is to model, refine and validate or reject management understanding of the decision environment and to relate relevant measures of behavior and response to management action alternatives.

It is seldom possible to implement a pre-packaged management information system. There are no generalized management systems. Each company's management has unique information requirements; a unique perspective on the environment within and outside of their firm; unique priorities; and a style of management which is the unique product of the particular personalities making up the management group. Effective management system development requires that management and system specialists learn to communicate, structure problems, and achieve a joint focus on increasingly broad information needs.
The process of designing and a management information system to meet the requirements of a particular management's decision style makes significant demands on management time and thought. If the resulting product is to be compatible with management's perspective, priorities, and systems of measures, management's models of the decision environment must be made explicit and used as the basis of system design. In addition, management must evaluate the implications of alternative system structures in terms of criteria which only they can supply. Intelligent choice among alternatives must be based on management's understanding of the implications of available structures. In order to achieve understanding the manager must take the time necessary to become familiar with the management implication of basic system design concepts.

Management's Conception of the Environment

If a system is to provide meaningful information to a particular management it must reflect that management's priorities and provide information of a type and in a form which is assimilable in the context of existing management decision processes. In most situations this requirement specifies that the information must be selectively generated-management is simply incapable of assimilating reams of paper-and must be based on accepted measures-output must relate directly to management conceptions of processes occurring in the monitored environment.
In order to meet this requirement an information system must be based on explicit models of the decision environment provided by management. In most instances management's initial system definition is stated in qualitative "business terms." Before meaningful specifications can be established this frequently vague and ambiguous initial statement must be refined and restated in explicit terms. Factors considered relevant must be defined and differentiated from those to be excluded.

Achieving Management Understanding

Management must be involved in the quantitative specification of system boundaries. They must understand and accept the conceptual structuring of system requirements in terms sufficiently explicit to define the measures and analytic procedures to be encompassed by the system. If this level of communication is not achieved, it may be impossible for those concerned with system formulation to develop a system which will be used.

The process of explication often uncovers the not altogether surprising fact that various members of management have different implicit conceptual models of the decision environment. Making these models explicit removes the ambiguities which permit vague words to mean different things to different people. Alternative representations are proposed and necessitate the creation and validation (or rejection) of more than one model.
Management Organization for System Development

One approach to management system development used by the author with substantial success involves a policy management Task Force and operation management Project Group.

The Task Force is composed of managers having authority to speak for the company in matters of policy. This group normally includes from six to eight members of the company's top management team. Their initial objective is to structure the environment -- to identify:

1. Major elements and interactions within the planning or decision environment;
2. Important elements and interactions within the action environment -- the environment controlled or influenced by the plans and decisions;
3. Planning and decision making processes to be supported by the system;
4. Behavior or responses to be monitored by the system.

Once the environment has been explicitly structured, the Task Force establishes management oriented system objectives, priorities, and performance criteria. The Task Force is particularly active during the initial stages of system development activity. It continues to review the project status at preplanned points in system development and resolves questions involving priorities and alternative means of achieving objectives. Under normal conditions members of the Task Force will devote between 50 and 80 hours to Task Force meetings during the first 6 to 8 months of project activity.
The Project Group consists of company operating personnel concerned with the design and implementation of a planning and decision support system meeting Task Force specified objectives. This group becomes deeply involved with data organization and analysis, model design and validation, and detailed hardware, operating system, and programming specifications. Project Group members are particularly active during the later stages of system development. Project Group activities also require the full time participation of supporting staff personnel.

At periodic intervals joint Task Force-Project Group meetings are held to evaluate progress and verify conformance with Task Force objectives.

An organization structure designed to obtain management involvement is a prime prerequisite of successful management system design. The second requirement is an orderly development plan.

A Six Phase Program

Orderly system specification, design, and implementation can be achieved by dividing system development activity into a sequence of six phases. Each phase is designed to achieve limited and specific objectives. This multiphase project approach assures that progress can be measured at planned intervals and that resources are not allocated to subsequent phases until preceding objectives have been met and results evaluated.
Phase 1 - The Project Plan

The first project phase is devoted to the development of a detailed project plan. During this phase preliminary Task Force members work with designated Project Group level personnel to:

- establish preliminary statements of planning and operating goals
- review alternative criteria for project and system evaluation
- determine the scope and detail of processes to be examined in Phase II
- establish Task Force and Project Group memberships
- develop minimum and maximum time schedules and budgets for project Phases II thru VI
- prepare and gain concurrence on schedules, budgets, and personnel allocation for Phase II.

Phase 1 tasks may be expected to extend over a six week period.

Phase II - Environment Specification

The second project phase begins with Task Force structuring of processes identified in Phase I. The structure developed provides a conceptual framework for later system design and development.

Specific objectives of this phase are to:

1. Identify major elements (individuals and institutions within the company and market environments.
2. Describe major interactions among environmental elements.
TERM:  THEOREM  TREATISE

Theorem 1:  Theorem's proof is presented in the Appendix.

Theorem 2:  Theorem's proof is presented in the Appendix.

Theorem 3:  Theorem's proof is presented in the Appendix.

Theorem 4:  Theorem's proof is presented in the Appendix.

Theorem 5:  Theorem's proof is presented in the Appendix.

Theorem 6:  Theorem's proof is presented in the Appendix.

Theorem 7:  Theorem's proof is presented in the Appendix.

Theorem 8:  Theorem's proof is presented in the Appendix.

Theorem 9:  Theorem's proof is presented in the Appendix.

Theorem 10:  Theorem's proof is presented in the Appendix.

Theorem 11:  Theorem's proof is presented in the Appendix.

Theorem 12:  Theorem's proof is presented in the Appendix.

Theorem 13:  Theorem's proof is presented in the Appendix.

Theorem 14:  Theorem's proof is presented in the Appendix.

Theorem 15:  Theorem's proof is presented in the Appendix.

Theorem 16:  Theorem's proof is presented in the Appendix.

Theorem 17:  Theorem's proof is presented in the Appendix.

Theorem 18:  Theorem's proof is presented in the Appendix.

Theorem 19:  Theorem's proof is presented in the Appendix.

Theorem 20:  Theorem's proof is presented in the Appendix.
3. Establish measures to be used to monitor significant interaction.

4. Determine criteria for evaluating alternative system functions and structures.

5. Ascertain data requirements and establish priorities for data collection.

6. Determine data availability.

7. Specify functional characteristics and supporting resource requirements for a management planning and control system incorporating the relationships, measures and criteria defined in this phase.

8. Document conclusions reached in Phase II.

9. Prepare and obtain concurrence on final schedules, budgets, and personnel allocations for Phase III.

10. Refine minimum and maximum schedule and budget estimates for Phases IV thru VI.

Phase III - Management Oriented System Specification

The third project phase produces explicit management oriented system specifications establishing
- Planning & decision procedures to be supported by the system
- The environment to be monitored
- Models and measures to be used
- Functions to be performed by the system
- Criteria for system performance evaluation.
Conclusions reached in this phase are summarized in a formal set of management oriented system specifications. Final schedules, budgets, and resource allocation for Phase IV are also established and Phase V and VI estimates are refined.

**Phase IV - Computer Oriented System Specification**

The fourth project phase produces detailed system specifications for implementation by programmers and system analysts. This document determines

- System organization
- Hardware and software requirements
- Program structures
- Measurement & Data processing procedures
- Manager/System interfaces.

The computer oriented specifications generated in this phase provide an explicit master plan controlling all programming, testing and implementation activities. At the conclusions of Phase IV final schedules, budget and resource allocations are established for Phases V and VI.

**Phase V - System Development**

The system development phase begins with detailed micro level personnel and facility scheduling. The remainder of this phase is then devoted to programming, testing, and program and system evaluation.
The ultimate product of phase V is an operating system meeting management requirements defined in Phases II and III as well as system criteria established in Phase IV.

**Phase VI - System Implementation**

The final project phase focuses on system implementation on in house equipment to perform specified functions. Personnel and equipment are scheduled. Support personnel are trained and oriented toward operating procedures and management is familiarized with the specifics of system utilization. Procedures for continuous system review and modification are also established during phase VI.

**Management Involvement in Environment Structuring**

It is important to maintain the perspective of the six phase approach while considering the remainder of this article. However, our present focus is on phase II of this process. As indicated earlier Phase II is directed toward establishing an explicit framework within which members of the Task Force can examine their perceptions, objectives, and performance criteria. This crucial first stage of system development involves management in a highly creative process through which they attempt to make explicit the insights and assumptions underlying their planning and decision processes. This activity cannot be delegated to system analysts or computer programmers.
Management's role in the process may best be illustrated with an example. One of the first applications of this approach to system development involved the management of a corporation producing a diversified food product line. This management was interested in developing a market oriented planning and decision support system.

A Task Force consisting of the president and functional vice-president of this organization devoted approximately 10 days over an eight month period to Task Force activities associated with phases one and two of the System Development sequence. The individuals involved in these meetings represented the top level marketing management of the company -- the planners and decision makers responsible for establishing marketing policy and evaluating marketing strategy for the firm.

The following description drawn from transcripts of these meetings illustrates the process through which this management group developed an explicit, quantitative framework encompassing major elements and interactions within their action environment and specified objectives for a planning and decision support system focusing on that environment.

The first Task Force meeting opened with a series of questions. "How can we establish boundary limits for this system? How much detail should it encompass? How extensive should it be? What factors should it include?"
The Vice President for Production responded with the suggestion that, "it should certainly include our operation. After all, we make the product, it's a fine product, and . . ."

After some discussion of the relative merit of competitive offerings and the company's outstanding quality control program, the project coordinator drew a rectangle on the first page of a large pad of paper and wrote "Producer".

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Producer
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"Is there anything else we should include in the system?"

"How about the distributors?"

"We make it. They distribute it."

The project coordinator drew a second box connected to the first by a straight line and wrote "Distributor".

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Producer

Product

Distributor
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At about this point someone suggested that we called this meeting to define a Planning and Decision Support System but seemed to be spending the time drawing boxes. The project coordinator asserted that the group was, in fact, making real progress toward model development. They had now identified two important elements of the action environment; the company and its distributors.

With a few mumbled references to "sophomoric academics" the discussion continued. Four hours later the group had produced a flow chart description of the type illustrated in Figure 1. Government; retailer; distributor; consumer and distributor-competitor- and company-sales forces were identified as major market elements. Interactions among these elements were described by lines representing product and information flow. At a later stage, basic cash flow relationships were also considered.

One often hears the assertion that it is impossible to model marketing relationships simply because "there are so many factors involved". The first objective of this process was to identify a limited number of elements and interactions. Much remained to be done. Much complexity was added in later steps. The objective is not to deny complexity; but to establish a structure within which management can work with realistic complexities in an orderly and systematic way.

Once a "Macro Structure" of the type illustrated in Figure 1 had been established, attention focused on processes associated with each interaction point. Backlogs, delays, and transfer points at which the rate of product, information, or dollar flow could be measured were identified.
Returning to our company meeting, one of the managers was anxious to "make things more realistic". He suggested that we start by identifying key points in the distribution (product flow determined) system.

"Those nice neat black lines have been bothering me. They make things look too simple. Now, let's take our manufacturing operation. Every time we get above a certain raw material inventory level our spoilage rate goes wild. We also have a problem with packaged product. Can't move it fast enough. Keep getting spoilage. On the other hand, whenever we try to back off on production the sales people start screaming about stockouts. The distributors have a real inventory control problem, and most of the retailers don't even know what inventory control is."

"As far as the consumer is concerned, we ought to be spending some of that advertising money to get the consumer to buy only when he is ready to use. Some of our promotions have actually featured multiple package deals and I don't think the average customer gets through one container without a little mold starting to show up."

"The point is these straight lines you're drawing just don't tell the whole story."

During the course of the ensuing discussion the initially simple system structure was expanded to encompass realistic complexity. Figure 2, for example, illustrates a product flow description developed to take account of the spoilage problem.

In a similar fashion, the previous "straight line" description of information flow was expanded to take account of advertising exposure and response. Five key steps in the response process were identified in the course of this discussion.

1. Exposure to a media type (e.g., news magazines).

2. Exposure to a particular ad in one medium of the type (e.g., Time Magazine).
3. Assimilation of the advertisement.
4. Change in awareness.
5. Acquisition of specific knowledge — memory update.

Exposure to the media type was considered to be a function of consumer media habit. In this sense the marketing executive could do nothing to influence consumer media exposure. He could, however, select media offering high exposure probabilities for his target market.

Within the media type a particular medium (e.g., Time Magazine) was selected and a desired rate and frequency of presentation were established. The manager influenced consumer exposure probabilities for a particular advertisement by the extent and allocation of his advertising expenditures.

Management concluded that four factors determined consumer interest in and subsequent assimilation of a particular advertisement once exposure had occurred. These were:

1. The size or time extent of the advertisement.
2. The use of color.
3. Appeals communicated by the advertisement.
4. Consumer predisposition toward appeals content.

The consumer's ultimate response to assimilated communication was judged to be a function of:

1. Content described by communicated product characteristics and appeals.
2. Existing consumer predisposition.
3. The extent of brand identification in the promotion.

This process description is illustrated in Figure 3.
After four more meetings totaling 12 hours Task Force members agreed that relevant interactions among elements had been described. The next problem was to identify major decision points associated with each element. When examining the company sector, the objective was to identify major decisions affecting actions taken in the marketing environment. This process followed naturally from the discussion of interaction relationships. Management was concerned with decisions affecting the rate, distribution, and content of media promotion; use of point-of-sale material; pricing; and sales force utilization.

Definition of key decision points associated with elements in the market environment was oriented toward decisions affected by the company and their competitors. These included trade channel decisions to order, inventory, place point-of-sale material, provide differential shelf space, advertise, and participate in various types of "deals".

This process of management specified system definition uncovered key points of dissention. One might argue, in fact, that if differences of opinion had not been encountered, the modeling process was probably insufficiently explicit.

Definition of major consumer decisions evoked substantial discussion.

"There are millions of things that can happen at the consumer level and we can never ..."

"We know we are getting media exposure. But we haven't a very good handle on response. We've got some ideas for measuring orientation change so our model should cover exposure to advertising, some kind of 'noting', and orientation change. We really need to tie this one down. We're spending 20% of gross on media and simply don't know what it's buying us."

"We know one important thing about our consumers. There are two kinds. There is the one who makes a decision to go shopping. And, there is the one who gets accidentally exposed to the product while shopping for something else. If we're going to influence both types of customer, we need to know how they are affected by point-of-sale displays, retailer tie-Ins, deals, and competition."

"What we really need to know is what makes some people buy our brand, some people buy the competitor's, and some people never buy. The only decision that's really worth worrying about is the purchase decision."
"And after they buy we have to worry about how they like it. If they take it home and it turns green, they're not going to buy any more."

The key concept is explication — specification of elements, management actions, distributor and retailer decisions, and consumer responses. Management is defining the market in terms which they consider relevant. Many assumptions are made. But, they are explicit assumptions.

Major elements of the manufacturer, retailer, and consumer decision structure established by these Task Forces discussions are summarized in Figure 4.

**Description of a Decision Process**

Once decision and response elements had been identified, the discussion turned to factors influencing specific decisions and responses. Management's intuitive understanding of market processes was converted to explicit and testable behavioral models. Each decision and response point was examined. Relationships between inputs and observable behavior were formulated in terms of measures which permitted model validation against available market data.

As an example, let's consider one consumer decision point — the decision to shop. Management has indicated that some consumers make a definite decision to shop for the product. The question now becomes, what factors influence this "decision to shop"? Which management actions and characteristics of the market place influence a consumer to go shopping for a product?

"Well, ... people who think they could use the product -- people who believe they have a need for it -- are most apt to go shopping. It's a matter of perception. People who have a high perceived need for the product will shop for it."

"Perceived need yields shopping. Fine. But how do you measure perceived need?"

"We have been using 'buying-intentions' data. We have interviewers going around asking people what they intend to purchase. Someone who has a high perceived need is going to say that they intend to go shopping. It doesn't make any difference whether they actually shop or not, it's their intentions that we're concerned with."
"Assuming that we use this perceived need concept, how do management actions affect an individual's perceived need?"

"Much of our advertising tells the consumer things he can do with our product -- makes him aware of all the opportunities he has to use it. This is a key idea. The more opportunity the consumer has and is aware of, the more apt he is to think he needs the product. Someone who is always giving cocktail parties has many more opportunities to use prepared hors d'oeuvres."

"Now wait a minute. That's not really true. There are quite a few folks around who have lots of opportunities to use our product. The problem is they have already had some of it and it turned green! And now they won't touch the stuff. Attitude is important here, too. We have to take into account how the customer feels about the product."

"We are forgetting something very basic. Someone who has already gone shopping and bought the product and has it in the refrigerator isn't going to want any more. Once someone owns it, he has no need to get more. We have to take into account the consumer's current supply of product."

"There is something else we forgot. There are many people around, probably the majority, who don't even know about the product. They don't know enough to know whether they like it or not. They aren't even aware of it."

Through this process the Task Force has developed a theory. In its initial forms, it is a rather qualitative theory. But with appropriate attention to measurement, it can be refined to an explicit set of equations.

The Perceived Need Concept -- An Example of Quantification

Management hypotheses regarding the decision to shop led to a qualitative concept of "perceived need". This concept which was initially expressed in terms of intention to buy might be viewed as an extension of utility theory. When formulating this model management proposed that the consumer's motivation to take action to acquire a particular brand is related to his perceived need for that brand which increases with:

1. Positive attitude toward the brand.
2. Opportunity for brand use.
3. Time since purchase.

The Project Group then began working within the structures provided by Task Force to refine and test these key behavioral assumptions.
The Effect of Attitude

Using a modified Osgood scale consumer orientation (attitude) toward a brand was measured by asking a respondent to rate the brand on an eleven point scale from +5 (strongly favor) through 0 (indifferent) to -5 (strongly dislike). The observed relationship between attitude (measured using the scale shown in Figure 5) and "Perceived Need" is illustrated in Figure 6.

Use Opportunity

Use opportunity was measured in terms of the number of times that the consumer had an opportunity to use a brand within the product class being studied during the preceding quarter. This information was obtained by direct interview as well as diary maintenance. As illustrated in Figure 7, a linear association was established between the use opportunity and perceived need measures.

Time Since Purchase

The time since purchase was measured, as the name suggests, by determining the time (in weeks, or average product life) since the consumer last purchased a brand in the product class being studied. Figure 8 illustrates the general form of this relationship expressed in multiples of average product life for the current perishable food product example.

Income Stratification

Initial attempts to validate the perceived need construct produced evidence that the relationship between the three perceived need measures and actual shopping behavior was income dependent. Further investigation revealed that behavior could be differentiated by population sub-segments established on the basis of income level stratification as illustrated in Figure 9.
Probability of Shopping Function

Combining the three elements of perceived need with income stratification produced a function of the type illustrated in Figure 10 relating the probability of shopping for the food product to perceived need and income. This figure specifies the perceived need based relationship for each of the income levels stratified in Figure 9.

Additional Function Formulation

In a similar manner each decision and response concept developed by Task Forces was tested and evaluated by Project Group members. In some instances initial theoretical constructs were validated without difficulty. In others empirical evidence suggesting alternative constructs was obtained and Task Force and Project Group members met to develop and evaluate alternative structures.

The Management Role

Through this process the Task Force and Project Group achieved the objectives of Phase II. Major elements and processes were identified. Measures and models describing relevant interactions were specified and validated.

The manager's role as Task Force member did not involve new or strange activities. It did, however, place new emphasis on already familiar concerns. Little or no time was spent in routine analysis, evaluation, or allocation. The Task Force members were concerned with broader policy problems which they approached with increasing effectiveness due to the availability of more meaningful data and increased (model based) understanding of their environment. They were concerned with
problem definition and devoted substantial time to the broader planning functions which are too often relegated to low priority positions on the executive agenda to make way for fire fighting and crisis curtailment. Much of their time was spent in increasing their understanding of the environment in which their company operated and in refining their insights into the planning and communication processes which are their area of expertise. They spent substantial time building models -- making explicit, testing and validating or rejecting hypotheses regarding the nature of the environment and their impact on it.

The Task Force deliberations produced an environment in which these executives were free to experiment with creative ideas and to employ imaginative approaches to the structuring and solution of management problems. And this was only the beginning. The process did not end with Phase VI. The system which their efforts produced freed these executives from many of their routine commitments and provided the ability to study the implications of new concepts and approaches in Phase I of a new management oriented system development program.
FIGURE 1

A "MACRO DESCRIPTION"
FIGURE 2

MACRO DESCRIPTION OF PRODUCT FLOW BASED PROCESSES
Consumer Subscription to Medium (Function of Consumer Cell)

Exposure to Media Type

a) Advertising Expenditure Saturation Expenditure Level

b) Circulation (Coverage) of Media Used Total Population Exposed to Media Type

Exposure to Advertisement

Size of Advertisement Use of Color in Advertisement Appeals Used in Advertisement

Advertisement Noted

Content of Advertisement Existing Consumer Attitude Prominence of Brand Name in Advertisement Existing Consumer Awareness

Awareness Gain Response

Existing Consumer Attitude Content of Advertisement Prominence of Brand Name

Memory Update

FIGURE 3
ADVERTISING EXPOSURE AND RESPONSE PROCESSES
FIGURE 4

DECISION AND RESPONSE FUNCTION SPECIFICATION FOR THREE MARKET SECTORS
FIGURE 5
THE ATTITUDE SCALE
Effect of Attitude on Perceived Need

Figure 6

Effect of Consumer Use Opportunity on Perceived Need

Figure 7
FIGURE 8
EFFECT OF TIME SINCE PURCHASE ON PERCEIVED NEED

FIGURE 9
SAMPLE INCOME STRATIFICATION