Designing Managemen Systems Using an

Augmenting the process and learning aspects of making decisions.

The appropriate design of computer-based systems for supporting managers, referred to here as management support systems (MSSs), is of central importance in both fundamental research and real-world application. By using a unique integrative approach, we developed and deployed a system for supporting managers of consumer products at a large manufacturer and were able to evaluate the system in actual use. Our integrative perspective for designing MSSs relates the object and mode of decision support required from a MSS to dominant system-design characteristics. The *object* of decision support is concerned with the question: What to support? Three different objects of decision support are emphasized in our research:

- Outcome (emphasis on the final decision)
- Process (focus on the process of decision making)

Managem Support S

t Support

Integrative Perspective

• Learning (emphasis on improving the decision and decision process)

The *mode* of decision support relates to the question: how to support? Three different modes of decision support are considered in our integrative perspective:

• Automate (automation of the decision)

• Informate (emphasis on creating and providing information about the decision and the decision process)

• Stimulate (active stimulation for innovative decision making)

The design characteristics of MSSs can be described in terms of Silver's ideas [9] of restrictiveness, guidance, and customizability of MSSs (see the sidebar "Defining a DSS" for a brief qualification of our use of the term).

Dominant matches between the objects and modes of decision support are mapped onto Silver's characterization of MSS design characteristics in

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our integrative perspective. The implications of the integrative perspective presented in this research are illustrated through the design of a marketing MSS called Brandframe.

Object of Decision Support

Different objects—outcome, process, and learning—of decision support are described here. They reflect three answers to the question: What to support?

The *outcome* support view of decision making is primarily concerned with the final decision. The relevant question in this context is: What is the decision? The emphasis is on ensuring that the best, or "correct," output is produced for an appropriate set of inputs.

Defining a DSS

Though the field of Decision Support Systems [4] is more than two decades old, there is disagreement even today about the definition of the term "decision support system." While researchers have proposed many restrictive definitions of a DSS, we favor a more general definition, such as the one proposed by Silver [9]: "A decision support system is a computer-based information system that affects or is intended to affect how people make decisions." Though the principles grounding our research are applicable to all DSSs, our focus in this article is on DSSs that support managerial decision processes. Thus we use the term "MSS" (Management Support Systems) in the remainder of this article to refer specifically to DSSs designed for supporting managerial decision processes.

The procedure used to transform the inputs into the outputs is not of primary concern.

The outcome support approach of decision making is favored when there is a high degree of structure in the decision problem, low uncertainty in the decision environment, end users with low skills levels (potentially causing undesirable outcomes), and a rigid organizational decision environment (in which the focus is on getting specific outcomes).

In a *process*-oriented view of decision making, the emphasis is on the process by which decisions are made, and not solely on the final outcome. The relevant question in this context is: How is the decision reached? MSSs are seen as interventions in the decision process that interact with and impact the decision procedures of decision makers [9].

A process focus in decision making is useful for both structured and unstructured problems when there is uncertainty in the decision environment, the end users are skilled, and the organizational decision environment is flexible. With increased information about the decision process, skilled end users can flexibly and meaningfully change critical parts of decision processes to respond to changes in the external decision environment.

When the object of decision support is *learning*, the relevant question is: How to improve the decision and the decision process? The ability to question decision procedures and adopt new innovative decision procedures is seen as a critical component of organizational learning. Further, Zeleny [11] has argued that no aspect of a decision process should be fixed a priori because decisions emerge as "harmonious" patterns balancing the different decisional components (such as criteria, alternatives, and constraints). There is less of a need to model human thinking by logical rules and algorithms and more of an emphasis on providing a flexible decision environment with the ability to capture "habits of mind" (patterns) conditioned on specific contextual knowledge [11].

A focus on learning in decision making has the most value for unstructured problems in dynamic decision environments. It is also necessary to have skilled end users and an organizational decision environment that is flexible and encourages innovation.

Modes of Decision Support

The mode of decision support is concerned with the question: How to support? Three different modes of decision support are described here: automate, informate, and stimulate.

Automation of decision making has been the traditional strength of DSSs and other computer-based applications. MSSs with an emphasis on automation have certain decision procedures and mechanisms "hard-coded" into the system. For example, an optimization package can automate the allocation of resources for a particular business problem. From a decision-making perspective, there are three major impacts of automation: prescription (of normative solutions), proscription (of allowed alternatives), and integration (of different models).

The term "informate," which does not appear in either *Webster's* or the *Oxford English Dictionary*, was first used by Zuboff [12] to denote the capability of intelligent technology to capture and provide information about organizations. While Zuboff has focused primarily on the "informatization" capabilities of data-oriented information systems (such as databases), the same concept can be extended to MSSs and the decision processes of decision makers.

In the informate mode of decision support, a MSS captures information about the different aspects of the decision situation, such as "what opportunities or

problems triggered the decision process?" and "how different solution alternatives were generated and explored," and uses this information to support and aid decision making by the manager. For example, knowledge about how the decision space was navigated, along with reasons, if any, for the particular path followed can inform managers and provide them with insights into their own decision procedures or those of others.

The primary focus within the stimulate mode of decision support is on stimulating learning by aiding the questioning of existing norms and decision procedures. Proper stimulation can aid learning for decision makers and help them to notice special features in the decision environment, explore different solution designs, test alternative hypotheses, and reflect on the obtained results. For example, a collection of descriptions of decision processes can serve as a valuable base of knowledge to stimulate reflective learning in decision makers by recognizing the strengths and limitations of prior decision processes. These insights can lead to innovations in decision processes.

System Design Dimensions

The system design of a MSS should be related to the object and mode of decision support required from the MSS. The relevant question in this context is: What is the impact of the MSS design on the decision support requirements? We will use Silver's framework [9], which identifies the following three types of MSS system design characteristics: restrictiveness, guidance, and customizability.

MSS restrictiveness has been defined [9] as "the degree to which, and the manner in which, a MSS limits its user's decision-making processes to a subset of all possible processes." MSS restrictiveness cannot be measured in absolute terms and is affected by subjective contextual and perceptual conditions of the decision process.

MSS guidance refers to the ability of MSSs to guide and influence the discretionary powers of decision makers during the decision process. While system restrictiveness delimits what decision makers can do with MSSs, system guidance describes "...subject to what users can do, how the system affects what they do" [9]. Highly restrictive systems limit the degree of decisional guidance possible and vice versa.

MSS customizability refers to the degree to which decision makers can adapt and specialize MSSs to fit the special characteristics of their respective decision situations. The customizability of a MSS is generally related inversely to its restrictiveness. Highly customizable systems can adapt better to the changing needs of decision makers.

An Integrative Perspective for MSS Design

Figure 1 presents our integrative perspective for the design of MSSs. The perspective maps the system design dimensions of [9] onto the dominant matches between the objects and modes of decision support as explained here.

Highly restrictive MSSs are best suited to the outcome object and automate mode of decision support as they tend to limit choice. If the primary organizational consideration is that a particular outcome is reached, then highly automated and restrictive MSSs are appropriate. These characteristics make it possible for the MSS to prescribe or proscribe preferred or normative decision procedures. Many current MSSs can be classified into this category.

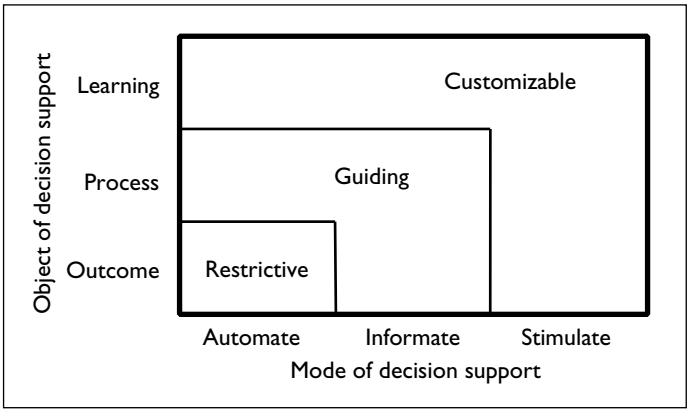


Figure 1. An integrative perspective for the design of MSSs

Guidance-oriented MSSs are well adapted to the process object and informate mode of decision support. If the process through which decisions are made is of concern to the organization, then it is important to design MSSs that can provide high degrees of decisional guidance to managers and inform them about how to navigate through the decision space. Few MSSs truly fit into this category. While many MSSs have been proposed to help decision makers choose between operators or solution techniques, they do not really capture knowledge of decision processes and use it for informating decision makers (see [1] for an exception).

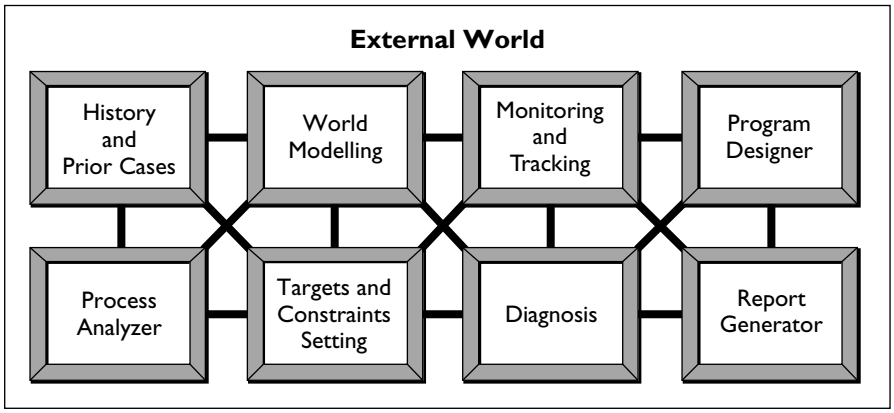
The learning view of decision making calls for greater emphases on stimulation and customizability in MSSs. It is important to design MSSs that stimulate decision makers into new exploratory modes of

History and Prior Cases: This module is concerned with the acquisition and storage of decision processes and problem-solving procedures used by managers in various situations.

Word Modeling: This module is responsible for modeling different objects and their mutual relationships in the external environment for the brand manager.

Monitoring and Tracking: This module is responsible for monitoring information arriving from the external environment, tracking important features, and signaling exception conditions calling for immediate attention.

Program Designer: This module generates and designs alternative marketing actions that can influence developments in a favorable direction and helps in the choice and design of the marketing program, such as sales promotions and advertising campaigns.



Process Analyzer: This module is responsible for the analysis of decision processes and for the activation of specific process-related help procedures.

Report Generator: This module provides important capabilities for the exchange of information between the manager end user and Brandframe.

Targets and Constraints Setting: This module manages aspects related to targets and constraints guiding a brand manager's behavior.

Diagnosis: This module helps the brand manager interpret and relate changes in critical variables (such as sales and market shares) to events in the external world (such as actions of competing brands) and internal actions and constraints (such as prior marketing actions taken for the brand).

Figure 2. The conceptual architecture of Brandframe: Brandframe can be thought of as being comprised of the interconnected modules depicted here.

problem solution and allow them to continuously adapt the MSSs to the changing decision needs of the environment. While the ability of MSSs to promote learning was recognized early [5], it is only recently that MSS architectures have started to emphasize learning. Approaches to learning in MSSs include proposals for virtual agents [8] that observe, challenge and stimulate the decision maker, and case-based stimulation [1].

Table 1. Approaches to evaluating alternative actions

Manner of evaluation	Average
Experiment: e.g., test in market by market research	3.6
Use models: mathematical models or simulation models	*2.0*
Experience, insight, and intuition	*6.0*
Other approaches such as consult with colleagues	5.3

Note: 1 = never; 7 = always

Experimental Domain for Research

In the domain of fast-moving consumer goods, brand management is a dominant form for organizing the marketing function. Brand managers are responsible for their brands in fairly complex environments. The results for a manager's brand (sales, market share, profits) are dependent on a large number of factors and events in the market: consumer preferences, brand perceptions, marketing strategies (advertising, packages, sales promotions, and actions), strategies of competing brands, actions of retailers, and social and political events in the environment.

To gain insight into the job of brand managers, a detailed questionnaire was given to 34 brand managers [3]. As part of this survey, the managers were asked to indicate their approaches to evaluating alternative marketing actions. Their responses are partially given in Table 1—it can be noted that the importance of different model and model-based approaches is significantly lower than experience, intuition, and insight for a brand manager. Combining these observations with the fact that brand managers are skilled staff operating with considerable independence and autonomy, it can be inferred that MSSs for brand managers need to provide a flexible, learning-oriented decision environment. This implies a greater emphasis on the informate/process and stimulate/learning matches along the different objects and modes of decision support from our integrative perspective.

Decision Support in Brandframe

A MSS called Brandframe was implemented to support these emphases (the overall architecture of Brandframe is depicted and briefly summarized in Figure 2).

Outcome/Automate/Restrictiveness

Brandframe incorporates several common marketing models—such as Little's decision calculus model [7] for the determination of advertising expenditures. However, the automation emphasis within Brandframe is not on generating model-based solutions, but rather on attempting to augment the process and learning aspects of decision making.

Brandframe prescribes (in a non-binding fashion) a certain sequencing of the decision phases. For example, after the diagnosis of a certain situation, Brandframe automatically prompts the user to activate the module for the next decision phase—the design of an appropriate marketing program (see Figure 3a).

Brandframe proscribes certain aspects of the decision situation by allowing consideration of a fixed set of alternatives. For example, Brandframe allows only for consideration of five different marketing programs (such as sales promotions, advertising, retailing, and price), as shown in Figure 3(a).

Brandframe also automates the integration of certain process aspects, along the temporal and intermodel dimensions. For example, in the bulletin message window of Figure 3(b), Brandframe can be seen performing some temporal comparisons on the values of certain important process variables.

An analogous impact of automation can also be observed for the learning view of decision making within Brandframe. Brandframe prescribes and proscribes conditions under which certain stimulative messages (see Figure 3(b) for an example) are generated. The aim of these messages is to enhance learning by stimulating reflective learning in the manager and encouraging the exploration of other paths by the questioning of assumptions grounding the decision process.

Process/Informate/Guidance

Brandframe includes facilities to continually informate the brand manager about the current decision processes. This information is displayed in bulletin windows as shown in Figures 3(a)–(c). The kind of information captured by Brandframe includes actions performed by the manager, answers given to specific questions, the activation sequence of the decision modules, and the results of internal analyses performed by Brandframe under various conditions

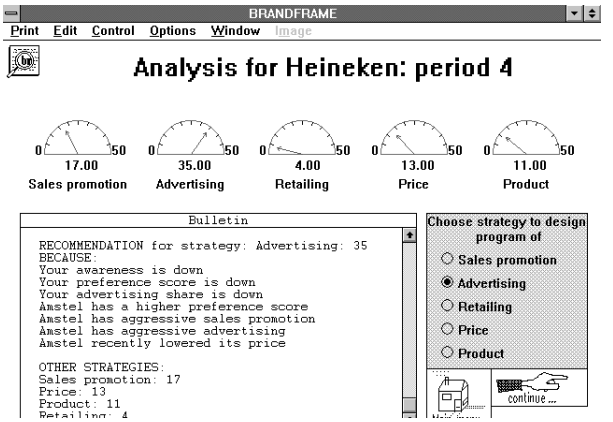


Figure 3(a). Suggestion for marketing strategies by Brandframe

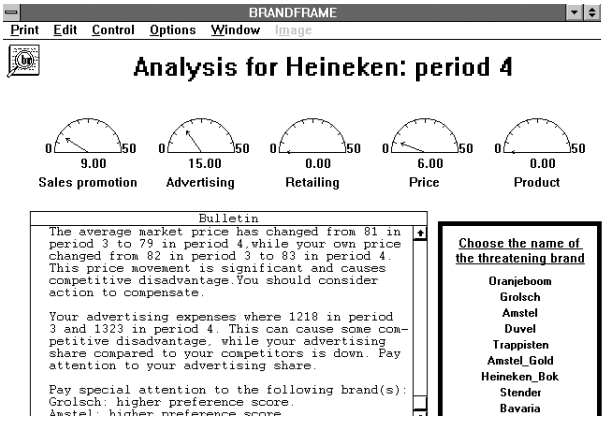


Figure 3(b). A partial transcript of the decision process in Brandframe–I

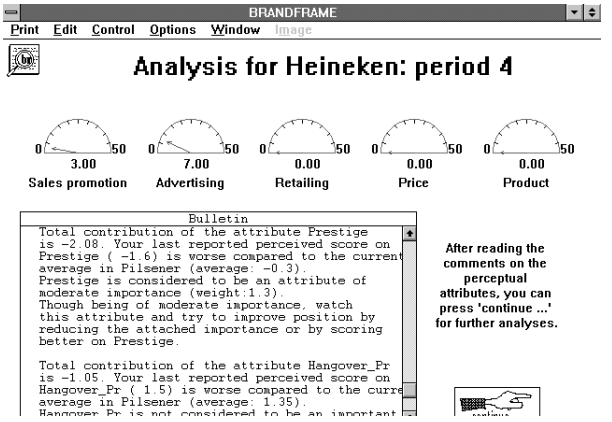


Figure 3(c). A partial transcript of the decision process in Brandframe–II

(such as comparisons with other competing brands, as shown in Figure 3(c)).

At any point in the decision process, the brands manager can scroll through the bulletin window and

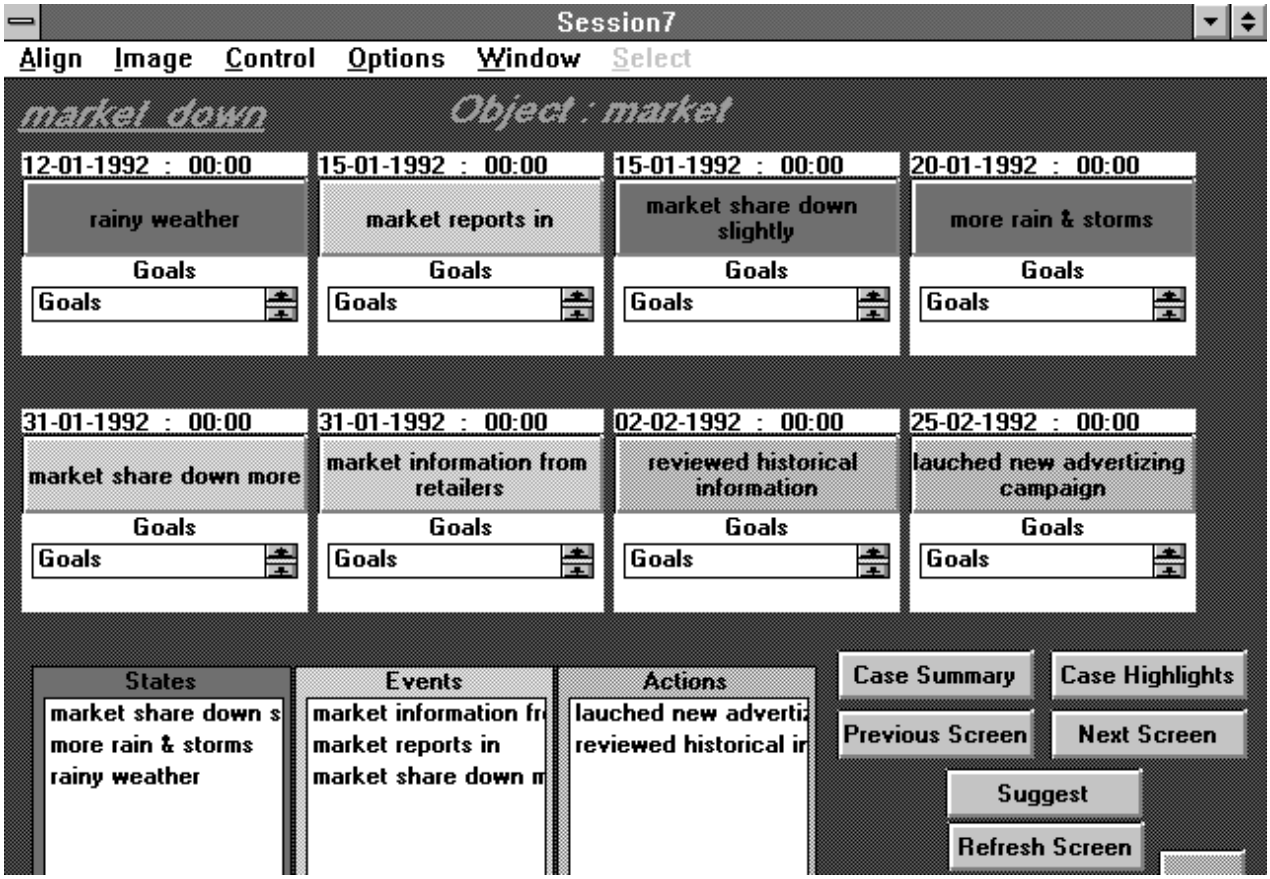


Figure 4. Suggestive stimulation from prior cases

review important aspects of the decision process navigated thus far. Besides providing a permanent record of the decision process, this capability serves to enhance learning via passive stimulation. With a conventional outcome-oriented MSS, detailed knowledge about "how a decision was reached" is usually lost, with attention typically being focused on the initial problem and the final decision ("What decision was reached?"). However, important knowledge about the decision is contained in the detailed process of decision making: "Why did the brand manager consider that option?, Why did the brand manager not choose the other option?, On which aspect of the problem did he spend the most time?, What particular sequence of decision phases was followed?", and so on.

The power of the informating mechanism within Brandframe is enhanced by the case library (contained within the history and prior cases module), which stores descriptions of prior decision processes. Thus a brand manager can review the current decision process as well as prior decision processes.

Assume that at some stage of the current decision process, the brand manager asks Brandframe (either on his or her own initiative or in reaction to Brandframe's active prompt) to find a similar prior decision situation. The process analyzer module searches through the prior cases in the history and prior cases module. After comparing the current state in the current decision situation to prior cases, the process analyzer retrieves the most similar prior case—the case titled "market down" from January 1992. This prior case consists of different states, events, and actions (Figure 4 shows how this can be done).

The manager can look at any state, event, or action in the retrieved case and read information and comments specific to that object. The manager can also ask Brandframe to suggest other objects to look at by using a "Suggest" button, as shown in Figure 4. Brandframe then analyzes the retrieved case "market down" and (among other aspects) looks at relationships between the object currently under consideration and other objects and suggests related objects to the manager.

Learning/Stimulate/Customizability

Brandframe provides both passive and active stimulation to brand managers. Passive stimulation results from the informating capabilities of Brandframe described earlier. The ability to observe the navigating of a decision space and to compare and contrast

several prior decision processes can stimulate reflective learning in brand managers.

More active learning results from the system taking a proactive role in stimulating learning by the brand manager. An example of this is the prompting of special stimulative messages under certain conditions, as shown in Figures 3(b) and 3(c). Another important example of active stimulation is in the interaction of the history and prior cases and process analyzer modules. The process analyzer module can under certain conditions trigger a prompt asking whether help is desired from prior cases. If the brand manager answers positively, then the process analyzer module in conjunction with the history and prior cases module takes the initiative to retrieve one or more similar cases and helps the manager in navigating through the prior cases.

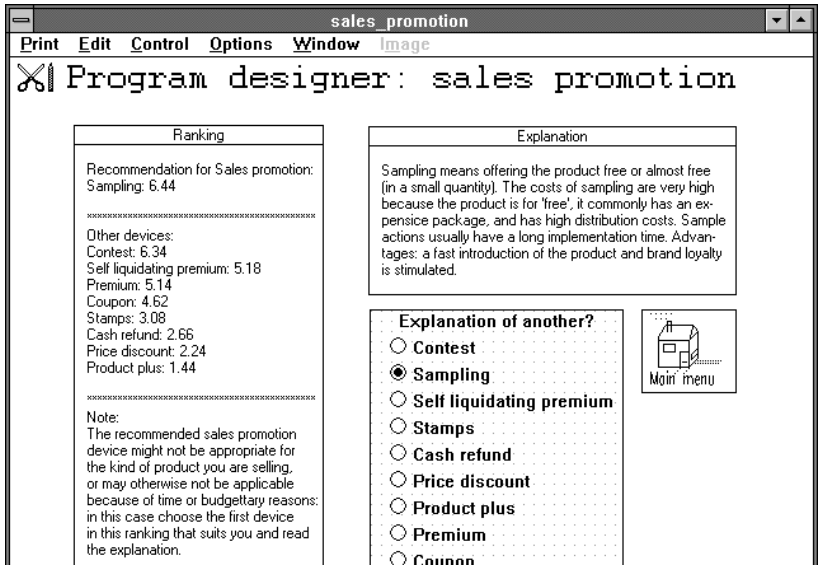


Figure 5. Recommendations and explanations in Brandframe

Brandframe contains facilities to perform what-if analyses that allow the user to experiment with multiple scenarios and question assumptions. Brandframe also aims to stimulate brand managers by providing easy access to information about different marketing models and strategies. For example, in Figure 5, Brandframe provides explanations of different devices for the sales promotion marketing program.

Besides the usual customization facilities offered in MSSs of entering specific constraints and targets, Brandframe allows managers to customize aspects of the world model and decision processes. The perception of the external world is dependent upon the mental models of brand managers. For example, two brand managers may perceive different sets of competing brand models for the same brand. As there is no "correct" choice of the structure of the domain model (such as the right set of competing brands) and due to dynamic changes in the world (such as the creation of new brands) it is important to give the brand manager the ability to customize the world model in the MSS to suit his or her mental model. Thus Brandframe provides facilities to allow brand managers to edit (create/delete/modify) product categories, brands, market segments, and other important market-related features.

Additionally, each time a particular manager uses Brandframe, the manager's specific decision process is captured and stored in the history and prior cases module. The process analyzer module uses these prior cases to guide current decision processes described earlier. The decision-support capabilities offered by Brandframe progressively change and become customized to the manager's specific decision style.

Empirical Evaluation of Brandframe

As part of this research, a prototype of Brandframe was developed over an 18-month period using KAPPA, a PC-based expert system shell tool marketed by Intellicorp, Inc. Brandframe was subsequently implemented for selected brand managers over a period of seven months in Holland Fast Moving (HFM).[1] A detailed questionnaire [3] was administered to the two brand managers (for two different product groups) who were using Brandframe during the testing period.[2] Table 2 lists the responses of these two brand managers to selected statements regarding their overall evaluation of Brandframe. The last column of Table 2 lists the average of their responses for similar statements[3] for the existing alternate marketing MSSs[4] within the company.

While the results of Table 2 must be interpreted cautiously due to the small size of the sample, they provide some initial insights about the role and utility of Brandframe.

[1]HFM, which is a wholly owned subsidiary of a major international company, is a leading company in the production and marketing of products in the category of fast-moving consumer goods in Holland.

[2]Note that as the knowledge base of Brandframe has to be customized for each brand, Brandframe was implemented for two product groups only during the evaluation period. Hence the detailed questionnaire could be administered only to the brand managers responsible for these two product groups.

[3]The term "BF" was replaced by the name of the alternate system.

[4]The alternate MSSs within HFM are similar to automated systems currently used by brand managers in leading international companies marketing fast-moving consumer goods.

- Brandframe gets better ratings for flexibility, ease of use, and usefulness as compared to the existing alternate computer systems;
- The mode of decision support in Brandframe is not perceived as automation but more to support the process of decision making; and
- There is a discrepancy between the two brand managers in their perception of the stimulate/learning role of Brandframe. From follow-up interviews with the brand managers, it was determined that the difference in ratings was due less to specific system features and more to a priori biases in the brand managers' minds about the role of MSSs, such as Brandframe, in brand management. This highlights the implementation challenges in understanding specific user attitudes while implementing MSSs.

Comparisons with Earlier Research

Several MSS frameworks proposed in the literature can be classified along four broad categories, depending on their relative emphases:

- Technology focus: Some frameworks, such as [2], emphasize the technological tools and platforms underlying the design of MSSs;
- Development focus: Frameworks in this category [10] focus on activities related to the development of MSSs, such as systems analysis, implementation, training, and evaluation;
- Decision support focus: The essential concern in such frameworks [4, 6] lies on such decision-support issues as the relation of MSSs to decision making needs and the impact of MSSs on decision processes;
- General: Such frameworks [9] attempt to include all of these aspects of technology, development, and decision support in one all-encompassing model.

Proponents of general frameworks argue [9] that the complexity of the DSS field—reflected in the numerous interacting technological and behavioral issues—requires an overarching model. However, such frameworks run the risk of either becoming overly complex and detailed or staying at a shallow level of abstraction. Rather than trying to develop a general framework in this research, we have emphasized a framework with a specific decision support focus. A decision support focus is, in our view, the most critical aspect for the design of MSSs. This research avoids a technology focus for two reasons: first, the technological components of MSSs are changing rapidly, and second, it is our belief that the principles of MSS design from a decision support perspective are largely independent of the underlying technological bases. The same technological components can be used to produce two very different MSSs (from a decision support perspective) and vice versa. A development focus is essential for ensuring the success of MSSs in organizations, but these aspects are beyond the scope of this research.

Existing frameworks with a decision support focus have tended to have a dominant task or problem emphasis, such as the task structure of Gorry and Scott-Morton [4] and the decision structure of Lerch and Mantei [6]. The perspective presented in this research integrates three different objects (outcome, process, and learning) of decision support with three modes (automate, informate, and stimulate) of decision support to yield significant MSS design characteristics (restrictiveness, guidance, and customizability). Such an approach is not centered on the task or problem to be tackled by the MSS. This research takes the position that given a particular task/problem, the factors affecting MSS design are more related to the object and mode of decision support than to the task/problem itself. This is because the same task/problem can be tackled by different foci on the objects and modes of decision support. Depending upon the required relative emphases of the objects and modes of decision support, different requirements are imposed on MSS design. For example, a marketing MSS may be designed in an outcome/automate approach for novice users. An alternate MSS for the same marketing problem may be designed in the process/informate approach for more experienced users.

Our integrative framework extends and augments earlier research, such as that by Zuboff [12] and Silver [9]. We have added a third dimension of "stimulate" to the two impacts identified by Zuboff: automate and informate. Our integrative perspective incorporates Silver's model of system design characteristics, but places it in the context of the object and mode of decision support. In our view, this provides for additional conceptual clarity and utility.

Conclusions

Lerch and Mantei [6] have proposed two criteria for evaluating MSS frameworks: (a) how well the framework facilitates communication between researchers and practitioners; and (b) how well the framework provides aid and guidance for MSS design. We believe that our integrative perspective serves both dimensions well.

We have deliberately kept our integrative perspective compact and clear. We could have added addi-

tional dimensions and/or allowed for more variations along each dimension, but we feel it would decrease the ease of applicability of the framework and reduce its comprehension by managers and MSS designers.

Our integrative perspective requires that two simple but important questions be answered for determining the design of MSS:

- What is the object of decision support required from the MSS?
- What is the mode of decision support to be provided by the MSS?

The answer to each question influences the design of the MSS as was illustrated for the case of Brandframe described in this article. Note that our integrative perspective does not prescribe a unique object and mode of decision making. Most MSSs typically emphasize different aspects of the object and the mode dimensions to different degrees. It should also be observed that the task/problem to be tackled by the MSS is not of primary concern in answering these questions. C

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