"AN INTEGRATED PERSPECTIVE ON DESIGNING MANAGEMENT SUPPORT SYSTEMS"

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An Integrated Perspective on Designing Management Support Systems

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Abstract

This research presents a new integrated framework for the design of management support systems (MSSs). Three different views of decision making (outcome, process, and learning) are combined with three different role (automate, informate, and stimulate) and system (restrictiveness, guidance, and customizability) perspectives. The role perspective focuses on the intended impact of the MSS on the decision maker(s) and the system perspective emphasizes the impact of the MSS system design on the decision support possibilities. The dominant matches in the proposed integrated framework (outcome, automate, and restrictiveness), (process, informate, and guidance), and (learning, stimulate, and customizability) define the typical decision making situations and have implications for the design of appropriate MSSs. The implementation of these conceptual ideas are illustrated in Brandframe, a MSS for supporting a brand manger in the domain of fast moving consumer goods.

Keywords: Management support systems; decision support systems; knowledge-based systems; frameworks for design of decision support systems; marketing applications of decision support systems and knowledge-based systems.

1 Introduction

This Section emphasizes the importance of decision making in organizations, defines the type of decision support systems considered in this research, and describes the focus and structure of the paper.
1.1 Decision Making and Organizations

Decision making is a pervasive and integral part of human activities and has emerged as a major multi-disciplinary area of study -see [22,23,24,29,44,49] for reviews. Decisions are very important for organizations also. In the information processing view of organizations [18,19,43,58], decisions and the capabilities for effective decision making play a central role in the design of organizations. For example, it has been observed that mechanistic structures (such as formal hierarchies) are useful when the information and the decision making systems within the organization are pre-planned and rigid with little uncertainty. In contrast, organic organizational structures (such as networks) are preferred when the decision making environment in the organization is flexible and ad-hoc, with greater scope for discretion and judgement.

Galbraith [17,18] and other researchers have studied the relation between organization design and organizational decision needs and capabilities in some detail. An important result of their research is that newer forms of organizations result from new capacities for information processing and decision making within organizations. Progress in information technology over the past decades is giving us glimpses of organizational changes resulting from enhanced information processing capacities. Examples of such changes are the emerging electronic markets [40] in industries such as airlines, banking, and insurance. Morgan [47] has expressed this inter-relationship between organizational design and information processing capabilities as "... organization in such circumstances increasingly rests in the information system".

1.2 Decision Support Systems

Since the invention of the first business computers in the early 1950s, computers have been used extensively for information processing and decision making in organizations. Most early applications of computers in organizations considered well defined, operational tasks (such as management accounting) and the resulting computer systems focussed primarily on transaction processing and information presentation. In 1971, Gorry and Scott-Morton [20] coined the term "decision support systems", and clearly argued for the importance of designing computer systems to support the decision processes of managers. Such computer applications were seen to be different (from earlier applications) in
focusing on tasks which were variable, less routine, poorly structured, and more strategic in orientation.

The field of decision support systems (DSSs) has expanded over the past two decades and descriptions of developments in this area can be found in references [1,25,26,62,68]. Surprisingly, there is disagreement even today about the definition of the term “decision support system”. While researchers have proposed many restrictive definitions of a decision support system, we favor a more general definition, such as the one proposed by Silver [57]: “A decision support system is a computer-based information system that affects or is intended to affect how people make decisions”. Such a definition includes all computer-based systems (such as database retrieval systems, linear programming packages, and expert systems) which impact (or intend to impact) human decision making.

In the literature of DSSs, many alternative terms such as executive information systems [54], expert support systems [30,63], and management support systems [56] can be found. Researchers have often justified the need for these terms by emphasizing the special decision needs satisfied by these systems. Though the principles grounding our research (Sections 2 and 3) are applicable to all computer-based systems which impact human decision making (i.e., DSSs according to Silver’s above definition), our focus in this paper is on DSSs which support managerial decision processes. Thus we use the term “MSS” (Management Support Systems) in the rest of this paper to refer specifically to DSSs which are designed for supporting managerial decision processes.

1.3 Focus and Structure of Paper

The design and development of MSSs has been (and is still) strongly influenced by quantitative modelling approaches from management science and operations research. The typical architecture of many MSSs [61] consists of a "data" component (some form of a database), a "model" component (usually one or more quantitative models), and a "dialog" component (to interface with users). Interaction with such a system is usually done by the specification of the input problem, the selection of the appropriate model(s) to be used, and the generation of the solution(s) of the model(s). Such model oriented MSSs have proven to be useful for relatively well structured and rigid tasks in organizations.
However, they have not had the desired impact on supporting the decision processes of managers.

Back in 1970, Little [39] observed that the "big problem with management science models is that managers never use them". As a solution to this problem, Little suggested the incorporation of a manager's subjective judgements into the model-bases of MSSs. The importance of explicitly incorporating the tacit knowledge of managers in decision processes is supported by experimental evidence. Moriarty and Adams [48] showed that for the prediction of sales for two durable products, a management judgement forecast outperformed a sophisticated Box-Jenkins model. Blattberg and Hoch [7] found that in a business forecasting situation, a combination of model and manager always outperformed either of these inputs in isolation. Other experiments [11,35] confirm that managers easily accept and use research results confirming prior beliefs and do not easily substitute their own mental models with the results of objective analyses. These results motivated the coupling of MSSs with expert systems, and led to researchers [30,63] proposing several architectures integrating MSSs and expert systems. Conventional expert systems are mostly ill-suited for supporting managers as they usually aim to "replace" experts (managers) rather than support them. However designing knowledge-based MSSs is useful because it allows for the integration of the mental models of managers and the provision of richer support for decisions in MSSs (as described later in Section 5).

This research takes the position that it is necessary to rethink the relationship between managers and MSSs and the conceptual design and use of computing systems for managerial decision support in organizations. The role of MSSs should not be limited to the storage and presentation of information and the (quantitative or heuristic) model-based solution of problems. MSSs can play an important role within organizations by providing a flexible, informative, and stimulating decision environment for managers. The focus should be less on automating problem solution and more on facilitating and stimulating a manager's decision making capabilities [3,4]. The emphasis should be on providing a rich decision environment for the manager to experiment, learn, and reflect till a certain stage of cognitive equilibrium [3,8,69] is reached. There should be an increased emphasis on supporting the process of decision making and less direction towards a pre-determined decision outcome. Providing greater information to the manager about the decision process can provide useful active stimuli to trigger
the manager into experimenting with new and innovative decision procedures. This facilitates learning and can lead to more effective decision making.

The integration of different knowledge-based concepts from artificial intelligence can help MSSs in providing a rich, flexible, and stimulating decision environment as described above. However, there is a distinct lack of substantial conceptual bases for the design of knowledge-based MSSs in the literature. This research attempts to fill this gap by presenting an integrated framework to guide the design of MSSs for supporting managerial decision processes effectively and intelligently. Three different views of decision making are identified and elaborated upon in Section 2: outcome (emphasis on the final decision), process (focus on the process of decision making and not solely on the final outcome), and learning (emphasis on improving the decision and decision procedures). Two different perspectives - the role and system perspectives - are described in Section 3. The role perspective focuses on the intended impact of the MSS on the decision maker(s) and consists of three important dimensions - automate, informate, and stimulate. It extends and augments the automate/informate duality of technology identified by Zuboff [70]. The system perspective considers the impact of the MSS system on decision support possibilities and includes three aspects identified by Silver [57] - restrictiveness, guidance, and system customizability. The integrated framework (described in Section 3.3) combines these two (role and system) perspectives and relates them to the three different views of decision making.

The integrated framework presented in this research is useful because it has important implications for the design of MSSs. These implications are illustrated through the design of a marketing MSS called Brandframe. Brandframe has been designed to support the decision processes of marketing managers in the domain of fast moving consumer goods. The particular characteristics of the decision situation facing a brand manager (as described in Section 4) can be interpreted in terms of our integrated framework and it leads to specific design choices in Brandframe (as described in Section 5). The last Section of the paper (Section 6) highlights the contribution of our research, provides comparisons with prior research and outlines directions for future research.
2 Views of Decision Making

While there are different approaches to studying human decision making [22], two useful views [29] are: (a) outcome oriented, and (b) process oriented. More recently, another approach more focused on learning has been receiving interest in the literature [3, 69]. These three views and the degrees to which they are supported by conventional MSSs are described in the following sub-Sections.

2.1 The Outcome View

The outcome oriented view of decision making is primarily concerned with the final decision (Figure 1-a). The relevant question in this view is: what is the decision? The emphasis is on ensuring that the desired or "correct" output is produced for an appropriate set of inputs. The procedure used to transform the inputs into the outputs is (by and large) of not much concern. A MSS used in such a view would typically encode one or more decision models and focus on providing friendly interfaces for inputting data and interacting with the manager. Most MSSs with a strong dependence on operations research models subscribe largely to such a view of decision making. For example, an optimization package would tend to focus on producing the "optimal" solution for a certain set of inputs. Though not equally apparent, conventional expert systems also embody such an outcome view of decision making. Expert systems typically encode the (heuristic) decision models of a human expert which are then used by a naive (or less trained) person to replicate the decisions of the expert.

2.2 The Process View

In the process 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? The process model of decision making cited most often in the literature is Simon's [59] four phase model of decision making: intelligence (finding occasions for making a decision), design (determining possible courses of action), choice (choosing among the determined set of courses of action), and review (evaluating past choices). In the process view of decision making, MSSs can be seen [57] as interventions in the
decision process which impact the decision procedures of decision makers in both beneficial and dysfunctional [6,34] ways. Due to the emphasis on the process view in this research, it is useful to describe it in more detail and observe how conventional MSSs have fared in supporting its different aspects.

The intelligence phase has been divided into two phases [46]: identification (the recognition of the need for decisions) and diagnosis (the clarification and definition of the decision situation). The sub-phase of identification can be triggered by [46] "opportunities", "crises", or "problems". MSSs can be useful for determining opportunities for decisions. For example, a conventional model-based MSS, such as BRANDAID [37], can trigger an alert if the current market share of a product is below a fixed threshold relative to the targeted market share. A manager would typically use both evaluative and predictive [23] judgements to determine whether attention needs to be paid to the triggered alert. Knowledge-based technology [14] can be used to represent such judgements in MSSs. However complications can arise because these subjective evaluations are conditioned on the varying perceptions of the external world by different managers.

The design phase is characterized [46] by the development of custom solutions, or more commonly a search for prior (or ready-made) solutions and their adaptation to the current decision. This phase is also influenced by judgmental inputs from the manager and the goals and constraints imposed by the organization. Conventional MSSs tend to be model based. The results obtained from these models have to be often "modified" or "massaged" to reflect the soft, qualitative domain constraints evaluated subjectively by managers. Most MSSs do not provide facilities for keeping track of old solutions, identifying their applicability for the current decision task, and adapting them appropriately.

The choice phase aims at the selection of a solution to the decision problem. Approaches to choosing among solution alternatives can be classified as [55] holistic, or heuristic, or wholistic. Holistic methods evaluate each alternative independently and select the alternative rated highest. In heuristic methods the preferred choice is obtained by a sequential process of comparison of alternatives with one-another or with an acceptable standard. In wholistic methods, choice is determined based on reasoning by analogy [12].
Most holistic methods (such as multi-attribute utility theory [28]) and many heuristic methods (such as elimination by aspects [64]) can be well supported in MSSs. Wholistic choice methods such as reasoning by analogy are supported poorly by conventional MSSs. Managers also often like to compare, contrast, and integrate the results of two (or more) solution techniques before making a final choice. Support for such integrative exercises is poor in MSSs as significant expertise and knowledge is required to make meaningful integrations.

The final phase of review consists of retrospective analyses, evaluation of decision implementation, and report generation. Retrospective analyses yield valuable knowledge about the decision process. This process knowledge can improve future decision procedures. An evaluation of the response to the decision provides feedback about its effectiveness. Summaries and reports are useful for organizational records. All these activities cumulatively lead to new insights for managers and aid their learning. MSSs are usually good at generating reports, and some provide mechanisms for evaluating responses to the executed decisions (provided quantifiable checks are adopted). However, most MSSs do not provide features for retrospective analyses. This limits the learning possible for the decision maker.

While Simon's decision model has strongly influenced the design and development of MSSs, many researchers have pointed to the need to consider aspects of the decision process not represented explicitly in Simon's model. We consider one important limitation below.

Gorry and Scott-Morton [21] have pointed to the fact that managerial problem solving really consists of a series of inter-dependent, temporally separated decisions, and there is the important phenomenon of learning as a manager solves a problem over time (as depicted in Figure 2 and elaborated upon further in Section 2.3). These inter-dependencies across decision cycles and the potential learning across temporally separated decisions are not captured in Simon's model. However such inter-dependencies can play an important role in supporting managerial decision processes as they are related to the ability of the manager and the MSS to utilize experiential knowledge. Conventional MSSs provide poor support for such integration across decision cycles.

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Figure 2 about here
2.3 The Learning View

Currently, there is considerable interest in a new "learning" oriented view of decision making. The relevant question in this view 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. Morgan [47] has mentioned that while most organizations have become quite proficient at single loop learning (i.e., the ability to detect and correct errors in relation to a given set of operating norms), many organizations are yet to develop skills for double loop learning (i.e., the ability to question the operating norms used for single loop learning). Morgan [47] has identified conditions which encourage double loop learning in organizations: enhanced reflective learning in decision makers, the exploration of different solution paths, and avoiding imposing fixed structures, goals, and objectives on the decision process.

Most MSSs have largely focussed on and facilitated single loop learning. For example, organizations typically have information systems which generate exception reports to highlight important problem conditions. In contrast, MSSs do not provide adequate support for double loop learning. This is because they usually do not aim to stimulate reflective learning in decision makers, and impose fairly rigid solution structures on the decision makers (an artifact of the quantitative decision models contained within them).

Zeleny [69] has argued that no aspect of a decision process should fixed a priori and that decisions emerge as "harmonious" patterns balancing the different decisional components (such as criteria, alternatives, and constraints). In such a view, also espoused by other researchers such as Margolis [45], there is a limited role played by rules, algorithms, and computational logic. More importance is accorded to the ability to recognize "patterns" - harmonious and stable configurations of different problem components - till a stable pattern or "cognitive equilibrium" is reached.

Such a view has important implications for the design of MSSs. 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 [69]. These ideas are related to the need for utilizing experiential knowledge (see
Section 2.2) and learning across different decision cycles (as depicted in Figure 2). The decision paradigm supported by most conventional MSSs is model oriented and does not include the learning of pattern recognition abilities as described above.

However, researchers have proposed various learning oriented variants of MSSs in recent years. Manheim [41,42] has introduced the notion of “active MSS” to define MSSs which aim to actively shape the decision processes of decision makers. Other researchers [3,50,51] have proposed MSS architectures using the concept of virtual agents which seek to challenge and stimulate the thought processes of decision makers.

2.4 Decision Perspectives and Organizational Characteristics

The decision making view to be stressed in a MSS depends upon several factors such as the degree of structuredness [20] of the decision problem, the degree of uncertainty in the decision environment, the skill level of the end-users, and the degree of flexibility and innovation allowed within the organization.

The outcome view of decision making is favored by 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). Conventional expert systems are a good example of outcome oriented computer-based systems resulting from such pressures. Conventional expert systems are useful for well-structured problems in stable decision environments, are used by naive users and are useful when the organization wants consistency and uniformity in decision making. The process view of 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. Though learning is possible in all decision situations, the learning view of decision making has the most value for unstructured problems in dynamic decision environments. For a learning-oriented view of decision making, it is also necessary to have skilled end-users and an organizational decision environment which encourages flexibility and innovation.
3 Perspectives on Management Support Systems

This Section describes and analyzes two different perspectives on MSSs: the role perspective and the system perspective. The former view is concerned with the impact of the MSS on the decision maker(s) and the latter focuses on the impact of the MSS system design on the decision support possibilities.

3.1 The Role Perspective

Many researchers have identified the importance of choosing a definition of an information system which accounts for the environment in which the technology is used. For example, Alter [2] has defined an information system as a combination of work practices (methods used by people and technology to perform work), information, people, and information technologies organized to accomplish goals in an organization. In this context, the role perspective of MSSs asks the question: what is the impact of the MSS on the decision maker(s)? We can identify three important impacts: the capabilities of MSSs to automate, informate and stimulate. Each of these impacts is described in more detail below.

3.1.1 Automate

The strength of conventional computing applications has been automation, and their abilities to "replace manpower" (by automation) are well documented [60]. From a decision making perspective, there are three major benefits of automation: prescription, proscription, and integration. The model(s) encoded in a MSS can explicitly prescribe a "preferred" or "normative" decision procedure. Benefits from such a prescription are the achievement of consistency and uniformity of decision procedures. A MSS can also proscribe a decision task by allowing the decision maker to choose between a (restricted) set of alternative solution procedures. Besides helping to achieve a certain degree of uniformity in the decision task, proscription can prevent decision makers from pursuing clearly inferior decision procedures, while giving them limited choice and flexibility. The integrative benefits can be witnessed across the temporal (integrating the temporal interactions in the decision processes) and inter-model (integrating the use and results of different models) dimensions. Benefits from integration include higher levels of accuracy, synthesis, analysis, and validity in the decision procedures.
3.1.2 Informate

The term "informate" was first used by Zuboff [70] to denote the capability of intelligent technology to capture and provide information about organizations. For example, Zuboff [70] described how corporate databases and information systems create and capture data which cause them to cumulatively assume the status of an "organization surrogate". While Zuboff has focussed 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 process view of decision making, information about the different phases of decision making (such as "what opportunities or problems triggered the decision process?" and "how different solution alternatives were generated and explored") is important to be able to understand why and how a particular decision was taken by the manager. Note that this information would not be important in the outcome view of decision making where the focus would be only on the initial problem and the final decision. Information about decision processes can serve as valuable guides for decision making and aid adaptive decision making and learning. The innovative adaptation of prior decision processes to current decision situations can increase the speed and quality of decision making. A study of similarities and differences across different decision processes can provide important insights to the manager and serve to enhance future decision procedures.

Figure 3 provides a graphical representation of the manner in which the different components (such as alternatives, criteria and constraints) of a certain problem situation can potentially evolve during the decision process to yield the final outcome. The user might begin with a particular specification of the initial problem (in terms of a set of alternatives, and certain criteria and constraints) and then progressively change the different components of the problem (such as add new criteria, change alternatives, and modify constraints) till an eventual solution (represented by a "desired" configuration of the problem components) is reached. Conventional MSSs would typically either focus only on the "outcome" (the final configuration of problem components) or facilitate the decision process by providing specific transformation operators (such as the ability to edit alternatives, and change criteria). In contrast, a MSS designed for informing the
decision maker would not only facilitate the problem component transformations, but also capture valuable information about the decision process such as the knowledge components used by the decision maker, and the manner in which the decision maker utilized the knowledge components to arrive at the decision. This knowledge about how the decision space was navigated (along with reasons, if any for the particular path followed) can informate managers and provide them with insights into their own decision procedures (or those of others). Information about the progressive evolution of the solution together with comments and notes about critical steps in the process can significantly aid learning in naive and less experienced decision makers. Conventional MSSs have yet to exploit this ability to informate decision makers.

Figure 3 about here

3.1.3 Stimulate

The third important impact of MSSs on the organizational environment is their ability to stimulate decision makers into new and innovative decision procedures. The importance of double loop learning and conditions facilitating it were described in Section 2.3. MSSs can serve a valuable role in stimulating decision makers in double loop learning by aiding the questioning of existing norms and decision procedures. Proper stimulation can aid learning in 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.

Let us illustrate this with an example. Imagine that a MSS stores all important states, events and actions in decision processes as it evolves over time (as shown in Figure 3). A collection of such 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 existing decision processes. These insights can lead to innovations in decision processes. This "vertical" stimulation from an "horizontal" informing base (a collection of details of prior decision processes) is depicted graphically in Figure 4. Conventional MSSs do not provide support for such stimulation based on the cumulative knowledge of several different decision processes.

Figure 4 about here
3.1.4 Position of Conventional MSSs

Each of the three dimensions of the role perspective of MSSs can be applied to the three different perspectives (outcome, process, and learning - see Section 2) on decision making. Automation can be guided towards producing a particular outcome (producing a fixed output for a certain set of inputs), or a decision process (fixed decision procedures), or learning (automatic triggering of learning oriented situations - such as exception conditions). Informatization can be about outcomes (tracking outputs for input conditions), processes (recording critical phases in decision processes), and learning (noting how a certain decision process improved over time). Similarly stimulation can be directed at outcomes (e.g., "is this the right output for the inputs?"), decision processes (e.g., "is this the best process to take the decision?"), and learning (e.g., "is this the best way to improve the decision process?").

While all of the above different emphases are possible, each view of decision making has a dominant match with a particular dimension of the role perspective of MSSs. Automation is best at producing a fixed outcome for a certain decision situation. Informatization can provide the most useful information about the decision process and stimulation is best suited for enhancing learning in decision makers and the decision environment. These dominant matches are depicted in Figure 5.

Figure 5 about here

Figure 6 depicts a plot of the position of conventional MSSs along the three dimensions of automation, informatization, and stimulation. Most MSSs are very strong on the automation dimension and tend to focus on automating (via model solution) all or parts of decision procedures. MSSs currently existing in organizations have little or negligible stimulative and informative components. The position of commercial expert systems would also be similar to that shown in Figure 6 as they typically "capture" expert knowledge for solving a particular task and aid other decision makers in replicating the task performance of experts. They present solutions to problems with limited explanations (of the generated solutions), but do not aim to stimulate users into experimenting with the decision procedures.

Figure 6 about here
3.2 The System Perspective

The system perspective emphasizes the links between MSS design and the decision capabilities provided by the MSS. The relevant question in this context is: what is the impact of the MSS system design on the decision support possibilities? For this perspective, we consider Silver's framework [57] identifying the following three important dimensions of the design of MSSs: system restrictiveness, decisional guidance, and customizability.

System restrictiveness has been defined [57] 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”. System restrictiveness cannot be measured in absolute terms, and is affected by subjective contextual and perceptual conditions of the decision process. Conventional MSSs and expert systems tend to be quite restrictive.

Decisional 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 [57] “subject to what users can do, how the system affects what they do”. Highly restrictive systems limit the degree of decisional guidance possible and vice versa. According to Silver [57] the differing decisional guidance capabilities of MSSs have not been researched adequately in the literature.

The last dimension of customizability refers to the degree to which decision makers are able to 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.

While Silver has focused on the process view of decision making in his analysis, the three dimensions of the system perspective mentioned above can be analyzed along all three views (outcome, process, and learning - see Section 2) of decision making. Restrictiveness can restrict the set of outcomes (for particular inputs), or decision processes (for a certain decision problem) or possible learning mechanisms. Guidance can be given with respect to either outcomes, decision processes, or learning mechanisms. Similarly, a MSS can be
customized to allow new and different outcomes, processes, or learning procedures.

Analogous to the role perspective, we can analyze the dominant matches between the three views of decision making and the three dimensions of the system perspective. Highly restrictive MSSs are best suited to the outcome view of decision making as they tend to limit choice. Systems with a high degree of guidance have a good match with the process view as they provide guidance to the decision maker about "how to" navigate through the decision space. Customizable MSSs are well adapted to the learning view of decision making as they allow managers to change important characteristics of the system depending upon what they have "learnt" from different decision situations. These dominant matches are depicted graphically in Figure 7.

Figure 7 about here

Figure 8 depicts the position of conventional MSSs along the three dimensions of restrictiveness, decisional guidance, and customizability. Most conventional MSSs can be characterized by high restrictiveness, low decisional guidance, and low customizability. The emphasis on prescriptive automation within these systems tends to restrict decision makers, give little discretionary power to them, and lower the degree to which they can customize the systems.

Figure 8 about here

3.3 An Integrated View

Figure 9 presents an integrated view of decision making and MSSs using the concepts described in Sections 3.1 and 3.2. The two axes of Figure 9 correspond to the role and system perspectives of MSSs explained in Sections 2.1 and 2.2. The three perspectives of decision making covered in Section 2 can be mapped on to the dominant matches (see Figures 5 and 7) along these perspectives as shown in Figure 9. This integrated view has some important implications for the appropriateness of various MSS designs for different views of decision making.

Figure 9 about here
The outcome view of decision making tends to favor automation and system restrictiveness. 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. Conventional expert systems are good examples of MSSs supporting an outcome oriented view of decision making. Expert systems aim to enable the widespread replication of a certain expert solution by non-experts. This is made possible by capturing expert knowledge for the task and encoding it in a highly restrictive and automated manner. It is common to see expert systems literally guiding decision makers through a series of questions towards a desired (set of) outcome(s). Most other model oriented MSSs also can be classified in this category. While automation and restrictiveness can be beneficial (such as in promoting consistency and quality of decision making), they can have negative consequences in hampering innovation and limiting creativity through exploratory learning. Silver [57] had provided more details about factors favoring and disfavoring system restrictiveness.

The process view of decision making favors informatization and decisional guidance. If the process by which decisions are made is of concern to the organization, then it is important to design MSSs which are able to provide high degrees of decisional guidance to managers and informate them about decision processes. Few MSSs truly support this view of decision making. While many MSSs have been proposed in the literature [31, 36] to help decision makers choose between operators or solution techniques, they do not really capture knowledge of decision processes and use it for informing the decision makers. An exception is a MSS for case-based decision making recently developed by Angehrn and Dutta [4]. While expert systems do provide limited explanations for the outcome reached, they are highly restrictive and provide little scope for decisional guidance (more details on this issue are provided in Section 5.2.2).

The learning view of decision making calls for greater emphases on stimulation and customizability in MSSs. If the organization wants to learn and innovate continuously in its decisions, it is important to design MSSs which stimulate decision makers into new exploratory modes of 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 [27], it is only recently that MSS architectures are emphasizing learning.
Approaches to learning in MSSs include proposals for virtual agents [3, 41, 42, 50, 51] which observe, challenge and stimulate the decision maker, and case-based stimulation [4]. System customizability for supporting learning has to go beyond superficial capabilities for altering user interfaces to true customizability in the structuring and execution of the underlying decision processes. Though the system proposed by Angehrn and Dutta [4] incorporates an ability to learn from and adapt to the problem solving procedures of decision makers, more research needs to be conducted on this issue.

Most of the attention in the literature on MSS design has focussed on methodologies for the implementation of MSS within organizations [6]. In this research, we are concerned with the design of a MSS and not with its implementation within organizations. Thus our integrated framework does not include many important implementation aspects such as involvement of end-users and top management commitment.

4 Brandframe: A MSS for a Brand Manager

The experimental domain of fast moving consumer goods has been chosen in this paper to illustrate the ideas described in the preceding two Sections. A MSS called Brandframe has been implemented to support the decision processes of a brand manager. This Section introduces the decision environment of a brand manager, provides some background information about prior marketing MSSs, and motivates the overall architecture of Brandframe.

4.1 The Decision Environment of a Brand Manager

In the domain of fast moving consumer goods, brand management is a dominant form for organizing the marketing function. The brand manager has a stereotypical role that can be (to a large extent) generalized to other companies.

A brand manager is responsible for his brand in a fairly complex environment. The results for his brand (sales, market share, profits) are dependent on a large number of factors and events in the market: consumer preferences, brand perceptions, own marketing strategies (advertising, packages, sales promotions, and actions), strategies of competitor brands, actions of retailers, and social and political events in the environment. The market is usually not a homogeneous entity, but consists of different sub-markets and market segments.
A brand manager performs several activities: (a) monitoring his brand in the market (e.g., through continuous information streams from syndicated services such as consumer and retailers' panels); (b) diagnosing specific events (e.g., finding the cause for a sudden drop in market share; and (c) devising and implementing marketing programs to improve the position of his brand (e.g., advertising campaigns and sales promotion actions). Usually a brand manager works within the framework of an annual marketing plan, which contains sales targets and marketing budgets per period.

The decision environment of a brand manager is characterized by uncertainty, incomplete knowledge and rapid changes. The tasks of a brand manager [33] include (a) developing a long range and competitive strategy for the product; (b) preparing an annual marketing plan and sales forecast; (c) working with advertising and merchandizing agencies to develop programs and campaigns; (d) stimulating support of the product among the sales force and distributors; (e) gathering continuous intelligence on the product's performance, customer and dealer attitudes, and new problems and opportunities; (f) designing specific marketing programs (such as sales promotions); (g) implementing specific marketing programs; and (h) reviewing the impacts of the implemented programs. Figure 10 gives a graphical representation of the primary activities of a brand manager. There are obvious similarities between Figure 10 and the process view of decision making described in Section 2.2.

4.2 Computer-Based Support for Marketing Decisions

Mathematical models in marketing first became popular during the early 1960s when some of the early books on this topic - such as [16] - started appearing. Marketing information systems arose during the late 1960s [9] with an emphasis on the collection and organization of the large amounts of marketing data that was starting to be collected. The era of marketing MSSs started during the late 1970s with Little [38] defining them as "a coordinated collection of data, models, analytic tools, and computing power by which an organization gathers information from the environment and turns it into a basis for action". Note the strong "model-based problem solving" approach inherent in such a definition of marketing MSSs.
The first "marketing expert systems" (MES) started appearing in the literature during the late 1980s in the form of the PEP [5], NEGOTEX [52] and other systems. Wierenga [66] has reviewed prior research in MESs in detail. Some important observations made by Wierenga are:

- MESs are in their infancy. Only 27 different MESs could be located in the literature. While it is certain that some MESs are never reported in the literature, the number of reported systems is still fairly small.
- Actual on-going use of MESs in companies is very limited. Of the 27 systems considered, 15 were prototypes, and only four systems had applications designed around them.
- Most MESs are rule-based. The architecture of more than 70% of the studied systems was dominated by rules.

The usual approach within marketing to supporting a brand manager's decisions is the utilization of quantitative models, such as the Multiplicative Competitive Interaction (MCI) model [10] and BRANDAID [37]. While useful in many ways, these models are limited in their handling of qualitative factors/relationships, the treatment of incomplete, uncertain, and heuristic knowledge, and are unable to tap the tacit knowledge of managers. Marketing MSSs, either model based or expert systems, have tended to be highly restrictive systems with a predominant emphasis on automation. In such a form, they are limited in their capacities to informate and stimulate marketing managers. Given the complexity and uncertainty of the decision environment facing brand managers, it is important to rethink the relationship between marketing MSSs and marketing managers, and redesign marketing MSSs to provide a flexible, learning oriented decision environment for marketing managers. Brandframe is a marketing MSS which aims to achieve some of these goals.

4.3 The Architecture of Brandframe

Brandframe is a MSS designed to support the decision processes of a brand manager in the domain of fast moving consumer goods. Brandframe provides support for many tasks of a brand manager related to the day to day problems in managing a brand. It does not aim to assist the brand manager in developing a long-range competitive strategy for the brand or in preparing annual marketing plans and sales forecasts.
Brandframe adopts an architecture that is less restrictive, more customizable and in which meaningful guidance can be provided to the manager end-user. The goal of Brandframe is to support the brand manager in taking decisions and not to prescribe a fixed solution. To make the decision process meaningful to the manager and to account for the differences in their mental models, Brandframe provides facilities for customizing important aspects of the system. Instead of prescribing a normative solution procedure, Brandframe gives flexibility to the user in choosing different decision tasks in an arbitrary sequence with appropriate guidance about how and when to choose them. The overall aim is to provide a flexible, learning oriented decision environment which incorporates significant knowledge about the domain and about the manager's particular world model.

The overall architecture of Brandframe is as depicted in Figure 11 (some screen dumps from Brandframe are provided in Section 5). Conceptually, Brandframe can be thought of as being composed of the following eight inter-connected modules. All modules are inter-connected (depicted by the thick links in Figure 11) and are mutually accessible.

**History & Prior Cases:** This module is concerned with the acquisition and storage of decision processes and problem solving procedures followed by managers in different situations. Whenever a manager uses Brandframe to solve a particular problem, this module provides the capability to dynamically store descriptions of important phases and decision points encountered by the manager during the decision or problem solution process. This module is similar to case libraries in case-based reasoning systems [32,53], but is different in that the “cases” stored are detailed descriptions of decision processes (as in [4]) and not simply descriptions of problem-solution pairs. Referring to the description of decision processes in Section 2.2, this module provides support for the review of prior decision processes.

**Process Analyzer:** This module is responsible for the analysis of decision processes and for the activation of specific process related help procedures. The process analyzer module decides upon important states, events and actions in decision processes which need to be stored in the history & prior cases module. It also provides guidance to the user in the analyses of prior decision processes.
Thus the process analyzer module contains domain knowledge and user models to perform meaningful analyses of decision processes of brand managers. This module is similar to critics in critiquing systems [15]. In conjunction with the history and prior cases module, this module provides support for retrospective analyses (see Section 2.2) of decision processes.

**World Modelling:** As described in Section 4.1, the external environment for a brand manager consists of a constellation of brands and retailers with complex, inter-dependent links. These objects and their mutual relationships are captured in the world modelling module. This module also provides facilities for the manager to change and customize aspects of the external world (such as designate the set of competing brands).

**Targets and Constraints Setting:** Every brand manager "manages" a brand within a set of constraints to achieve certain targets. Targets can be of the form of "desired market shares" and constraints can be like "maximum advertising expenditure". These targets and constraints have an important impact on decision processes and their outcomes. These aspects are managed by the targets and constraints setting module.

**Monitoring and Tracking:** Relevant information (such as sales, market shares, and competitive actions) are periodically inputted into Brandframe from different sources (such as scanning panels, trade press, and business contracts). This module is responsible for monitoring the information arriving from the external world, tracking important features (depending upon the targets and constraints faced by the brand manager) and signalling exception conditions calling for immediate attention. Using the terminology of Mintzberg et. al. [46] - see Section 2.2 - this module is responsible for the identification sub-phase within the intelligence phase of decision making.

**Diagnosis:** The responsibilities of this module correspond to the diagnosis sub-phase [46] within the intelligence phase [59] of decision making. This module helps the brand manager to 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).
Program Designer: The program designer module generates and designs alternative marketing actions which can influence developments in a favorable direction (such as restore lost market share or neutralize a competitor's actions) and helps in the choice and design of the marketing program (such as sales promotions, advertising campaigns, and price reductions) which is most appropriate given the diagnosis and the current targets and constraints. The activities supported by this module correspond to the design and choice phases of Simon's [59] model of decision processes.

Report Generator: This module provides important capabilities for the interface between the manager end-user and Brandframe. It enables the brand manager to retrieve and look at different historical and current information about the decision environment and processes. The emphasis within this module is to provide a friendly, graphical interface for the retrieval and analysis of information.

A prototype of Brandframe was developed over a period of 18 months (starting in early 1991) using KAPPA - a PC-based expert system shell tool (marketed by Intellicorp Inc.) integrating rules and object oriented programming. This prototype version of Brandframe was demonstrated to various brand managers in Holland. Their response to the system was very enthusiastic, and many were interested in implementing Brandframe within their own companies. Brandframe is currently being implemented in Van den Bergh Foods (the Unilever subsidiary in the Netherlands) for brand managers in the domain of fast moving consumer goods. The screen dumps of Brandframe given later in this paper are from the prototype version of Brandframe. Due to the sensitivity of market related information, we are unable to include screen-dumps from the version of Brandframe being implemented in Van den Bergh Foods. However, the prototype version of Brandframe is sufficient for demonstrating the main ideas of this research.

5. Decision Support in Brandframe

This Section describes how the decision support capabilities of Brandframe can be analyzed using the concepts described in Sections 2 and 3.
5.1 The Decision Making Perspective

As mentioned in Section 2.4, the decision making view to be stressed in a MSS depends upon several factors such as the degree of structuredness of the decision problem, the degree of uncertainty in the decision environment, the skill level of the end-users, and the degree of flexibility and innovation allowed within the organization.

For a brand-manager (see Section 4.1), the decision task is relatively unstructured and there is considerable uncertainty in the external decision environment. Brand managers are skilled staff who operate with considerable independence and autonomy (which encourages flexibility and innovation). Thus the process and learning views are the most useful decision perspectives to be stressed in MSSs (such as Brandframe) designed to support their decision processes. The following two sub-Sections describe how the different aspects of the role and system perspectives (see Sections 3.1 and 3.2) of MSSs are oriented towards supporting the process and learning views of decision making within Brandframe.

5.2 The Role Perspective

Section 3.1 mentioned three distinct aspects of the role perspective: automate, informate, and stimulate. Each of these aspects can influence the design of a MSS depending upon the view of decision making emphasized in the MSS. This is illustrated below with the example of Brandframe.

5.2.1 Automate

Automation is best suited to the outcome view of decision making in which the emphasis is on obtaining model-based solutions to specific input problems/situations. As explained in Section 4.2, models for supporting certain aspects of a brand manager's tasks do exist but they have important limitations. Brandframe incorporates such models - such as Little's decision calculus model [39] for the determination of advertising expenditures - but integrates their results with the heuristic knowledge of the brand manager using knowledge-based approaches [14]. 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.
The task of a brand manager can be viewed as consisting of a sequence of decision phases as shown in Figure 10. 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 12). This prompt is non-binding as the user can always choose to explore some other alternatives in the diagnosis module rather than move on to the design of a marketing program or choose to design a marketing program other than that suggested by Brandframe. Brandframe prescribes certain aspects of the decision situation by allowing the consideration of a fixed set of alternatives. For example, Brandframe only allows for the consideration of 5 different marketing programs (such as sales promotions, advertising, retailing, and price) as shown in Figure 12. Brandframe also automates the integration of certain process aspects along the temporal and inter-model dimensions. For example, in the bulletin message window of Figure 13, Brandframe can be seen performing some temporal comparisons on the values of certain important process variables.

An analogous impact of automation can be also observed for the learning view of decision making within Brandframe. Brandframe prescribes and prescribes conditions under which certain stimulative messages are generated. The aim of these messages is to enhance learning (see Section 2.3) by stimulating reflective learning in the manager and encouraging the exploration of other paths by the questioning of assumptions grounding the decision process. For example, consider the message in the bulletin window in Figure 13. Parts of the message in the window reads "... this price movement is significant and causes competitive disadvantage. You should consider action to compensate.". This message was generated by Brandframe after performing an internal analysis of the current decision situation, the actions of the brand manager (using the system) thus far and expectations of future consequences. Messages like these are continually generated by Brandframe depending upon the development of the decision process. They cumulatively aim to enhance double-loop learning within the brand manager.
5.2.2 Informate

As mentioned in Section 3.1, there is a dominant match of the informate dimension of the role perspective of MSSs with the process view of decision making. Given the emphasis on the process view of decision making within Brandframe, Brandframe provides extensive facilities to continually informate the brand manager about decision processes. This information is displayed in bulletin windows as shown in Figures 12, 13, and 14. 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 (such as comparisons with other competing brands as shown in Figure 14).

At any point in the decision process, the brand manager can scroll through the bulletin window and review important aspects of the decision process navigated thus far. Brandframe informates the manager about important details of the decision process and the manner in which the decision space has been explored (as depicted conceptually in Figure 3). Besides providing a permanent record of the decision process, this informing 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 focussed 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 informing capabilities of Brandframe captures such information and uses it to informate managers. The simple fact of being able to observe the process of navigating the decision space can help (upon review) to highlight strengths and weaknesses of decision processes and lead to improved decision making.

The power of the informing mechanism within Brandframe is enhanced by the case library (contained within the history and prior cases module) which stores descriptions of entire decision processes. Thus a brand manager can not only
review the current decision process, but can also review prior decision processes. This is very useful for aiding inexperienced brand managers who can "learn" by being informated about the decision processes followed by more experienced brand managers.

Note that the informating capabilities of Brandframe are different from the "explanations" generated in typical expert systems. Conventional expert systems usually "lead" users through a series of questions, and then present an "explanation" describing why each question was generated and how the entire sequence of questions and answers lead to the final decision. Brandframe does not "lead" the brand manager. The brand manager is free to explore any of the eight different modules of Brandframe (Figure 11) in any order as desired and take any appropriate actions. What Brandframe does do is record the particular sequence of actions performed and questions raised by the brand manager (with results of internal analyses, if any, performed by Brandframe) together with the final decision. It does not attempt to "explain" the final decision. Explanations, if any, are contained in special comments entered by the user (such as reasons why a particular choice was not considered) or in the results of analyses of the situation presented by Brandframe periodically to the user (see Figures 13 and 14).

5.2.3 Stimulate

Brandframe provides both passive and active stimulation to brand managers. Passive stimulation results from the informating capabilities of Brandframe described in the preceding sub-Section. The ability to observe the process of navigating a decision space (Figure 3) and to compare and contrast several different (prior) decision processes (Figure 4) can stimulate reflective learning in brand managers. The learning mechanism is passive because no "stimulative messages" are given by Brandframe to the manager and the brand manager plays the deciding role in choosing to review current or prior decision process information.

More active learning results from the system taking a pro-active role in stimulating learning in the brand manager. An example of this is the prompting of special stimulative messages under certain conditions as shown in Figures 13 & 14 (and as discussed in Section 5.2.1). Another important example of active stimulation is in the interaction of the history & prior cases and process analyzer modules.
Figure 4 depicted how vertical stimulation can result from an informing base of descriptions of prior cases. The process analyzer module can under certain conditions (such as no action from the manager-user for more than a specified amount of time) 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 & prior cases module takes the initiative to retrieve one or more similar cases (prior decision processes) and helps the manager in navigating through the prior cases. More details on the guidance provided by Brandframe via prior cases are presented in Section 5.3.2.

Most of the stimulative messages in Brandframe are oriented towards the structuring of decision processes. An example can be seen in Figure 12 where Brandframe visually represents the degrees to which different marketing programs are desirable. It suggests a certain program (outcome) and provides a brief justification for its choice. The brand manager can use this justification to think about the appropriateness of the suggested marketing program and decide to accept the choice or explore the justification for the selection (or the rejection) of another marketing program. Brandframe also contains facilities to perform "what-if" analyses (similar to those present in many other knowledge-based systems and MSSs) which allow the user to experiment with multiple worlds and question assumptions.

In addition to the above, Brandframe aims to stimulate brand managers by providing easy access to information about different marketing models and strategies. For example in Figure 15, Brandframe provides explanations of different devices for the sales promotion marketing program. The brand manager can thus not only be informed about the current decision process, but can also have access to general marketing information available in books and company documents. Though not included in the prototype version, multi-media can be used to present richer forms of information such as the TV advertising clips used for that brand. Our initial interviews with brand managers have indicated that they would highly value such a richer presentation of brand and market related information. Thus we aim to include multi-media information presentation mechanisms in the version of Brandframe being implemented in the Dutch company. This stimulation via access to information is usually passive in nature (obtained at the request of the user), but it can be also presented actively (such as in Figure 15 where the explanation of the suggested sales promotion device appears automatically).
5.3 The System Perspective

The influence of the three dimensions of the system perspective - restrictiveness, guidance, and customizability (see Section 3.2) - on the design of Brandframe are described in the following sub-Sections.

5.3.1 Restrictiveness

MSSs designed with an outcome oriented view of decision making tend to favor a high degree of restrictiveness as described in Section 3.3. Given the dominance of the process and learning views in Brandframe, it is not a restrictive MSS with regard to outcomes. However, a certain degree of restrictiveness with respect to process and learning results from automation choices within the system. Restrictions can be seen to be either weak or strong. Weak restrictions are non-binding and can be over-turned by the manager. Strong restrictions are binding and cannot be altered by the brand manager.

Suggestions about the next phase of decision making (see Section 5.2.1) are an example of weak restrictions contained within Brandframe. As illustrated in Figure 12, Brandframe can suggest a particular marketing strategy and offer to activate the module to design the suggested strategy. However, this suggestion is non-binding and the brand manager can always choose another marketing strategy. Note that should this happen, the process analyzer would record this fact (together with any justification input by the manager for ignoring the suggested choice) and use it to informate (see Section 5.2.2) users in the future.

Restrictions about the allowable marketing programs (five as shown in Figure 12) or the allowable specific marketing devices and the goals achieved by them (as shown in Figure 16) are binding in that Brandframe cannot consider other marketing programs or marketing devices. Such choices about the appropriate set of marketing programs and devices and their related goals are made by the system designer (in consultation with the brand managers using the system) and tend to restrict the brand manager in a binding manner.
The choice of particular conditions under which to trigger specific stimulative messages (as described in Section 5.2.1) tends to have restrictive effects on the learning induced in the brand managers. However, the exact nature and degree of such restrictiveness is difficult to ascertain because of the imprecise nature in which learning occurs in brand managers either directly or indirectly due to Brandframe.

5.3.2 Guidance

Given the dominant match between the guidance dimension of the system perspective and the process view of decision making (see Section 3.2), Brandframe contains a strong emphasis on guidance. Some examples of guidance by Brandframe have been described in the earlier sub-Sections. For instance, the suggestion of specific marketing programs to choose (Figure 12) and the generation of particular stimulative messages (Figures 13 & 14) tend to guide decision processes and learning in brand managers.

An important and novel guiding feature that can be provided in Brandframe is in navigating and analyzing decision process. While details on these capabilities (provided by the process analyzer and history & prior cases modules) are given in reference [13], a simple clarifying example is useful. Decision processes in Brandframe are stored using three types of objects: states/outcomes, events (caused by the external environment), and actions (performed by the brand manager). Assume that at some stage of the current decision process, the brand manager asks Brandframe (either on his 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 & prior cases module. After comparing (structurally and semantically as described in [13]) 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 17 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 (with the “Suggest” button in Figure 17). 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. Assume that the state “market share slightly down” is currently being looked at and that it is related to other objects as shown in Figure 18. Then Brandframe would suggest (along with justifications) the states “Rainy weather”, “More rain and storms” and “Market share down more”, and event “Market reports in” to the brand manager. The manager can continue the process as desired by either looking at another object and invoking the help of Brandframe for new suggestions or asking for an alternative case to be retrieved. The technical details of this implementation are reported in reference [13].

Note that the guidance procedure described above is different from “case-based reasoning” as described in the literature [53]. There is no attempt to “adapt” a prior solution to the current situation as Brandframe does not subscribe to an outcome view of decision making. Rather, the aim is to stimulate the manager in thinking about the decision process and enhancing learning which leads to improved decision procedures. The emphasis is on supporting the decision process and not on replicating the final outcome. Thus most of the features in this module are oriented towards analyzing and suggesting information/guidance to the manager about the decision process represented in the case relative to the current decision situation (faced by the manager). Though the use of case-based reasoning for supporting human decision making was first raised by Kolodner [32], she has neither described concrete implementations of such ideas (as done in Brandframe) nor provided any conceptual links to human decision making and the design of MSSs (as done in Section 3).

5.3.3 Customizability

Given the emphases on processes and learning in Brandframe, it is important to provide means to customize different aspects of the system. Besides the usual customization facilities offered in MSSs of entering specific constraints and targets (see Section 4.3), Brandframe allows managers to customize aspects of world models and decision processes.
The external world for a brand manager was described in Section 4.1 as a complex, inter-linked set of brands (and retailers). The perception of this external world is dependent upon the mental models of brand managers. For example, two brand managers may perceive different sets of competing brands 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 ability to the brand manager to customize the world model in the MSS to suit his 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. Performing most these manipulations is simple from an implementation point of view as it involves the modification of the object hierarchy representing products, brands and markets. However, this object hierarchy is transparent to the user who only perceives the categories consistent with his mental model as depicted in Figure 19.

Sections 4.3, 5.2.2 and 5.3.2 described how the process analyzer and history & prior cases modules interact to store and analyze prior decision processes. Each time a manager uses Brandframe, his specific decision process is captured and stored within the history & prior cases module. The process analyzer module uses these prior cases to guide current decision processes as described in Section 5.3.2. The point to note is that progressively the decision support capabilities offered by Brandframe changes and becomes more and more customized to the manager’s specific decision style and knowledge as captured in the history module. This is an important kind of customization support offered by Brandframe.

The cumulative impact of the customization abilities described above is that Brandframe adapts its reasoning and decision support capabilities to better match the style and knowledge of the brand manager. As a brand manager learns, the incremental knowledge (as reflected in the decision process) is stored within the history module and influences the decision support offered by Brandframe later.
6 Conclusion

This Section summarizes the main contributions of our research and compares them with prior research and ends the paper with some concluding comments.

6.1 Contributions of Paper & Comparisons with Prior Research

The literature of MSSs contains many studies of the impact of MSSs on organizational decision making and decision processes - for example see references [1,2,25,57]. However [57] most of these prior studies have focussed on the implementation process and tried to relate system success (such as increased use by users) with organizational features affecting the implementation process. Relatively few researchers have focussed on factors affecting DSS design features.

This research has presented a new integrated perspective on designing systems to support managerial decision processes. As described in Sections 2 and 3, this view integrates three different views (outcome, process, and learning) of decision making, and three dimensions each of the role (automate, informate, and stimulate) and system (restrictiveness, guidance, and customizability) perspectives. The framework does not prescribe a unique view of decision making or a single "correct" set of design criteria for MSSs. Typically most MSSs would be positioned along the different dimensions of the role and the system perspectives to different degrees. This was illustrated in Sections 4 and 5 with the example of Brandframe, a MSS for supporting a brand manager.

The benefit of the integrated perspective as described in Section 3.3 is that it provides a comprehensive framework to guide the design of MSSs (not the implementation of MSSs - a process which needs consideration of factors not covered in this paper). Specifically, there are three important questions to be answered for determining the appropriate set of design features for a MSS:

• Which view of decision making is to be represented in the MSS?
• What is the intended impact of the MSS on the decision maker(s)?
• What is the intended impact of the MSS system design on the available decision support capabilities?
The answer to each question influences the choice of appropriate features in the MSS. For example, if the outcome view of decision making is important and desired, then emphasis has to be paid to automating the decision and restricting the allowed variations in the decision process. On the other hand, if the process and learning views of decision making are important (as in Brandframe), then other aspects of the role and system perspectives have to be highlighted (as described in Section 5).

Our integrated framework extends and augments prior research, most notably that of Zuboff [70] and Silver [57]. Zuboff [70] was the first to make the distinction between the automating and informating impacts of computer-based systems in organizations. While Zuboff only considered traditional transaction processing and management information systems in her research, we have extended her ideas in two directions in this research. First, we have added the third dimension of stimulate to the two impacts identified by Zuboff: automate and informate. The ability of computer-based systems to stimulate managers and workers is an important feature which is becoming more common with the maturation of artificial intelligence technologies. Second, we have extended her ideas about informatization from databases (and related management information systems) to the informatization of managers about decision processes. The resulting informating base of decision processes can be a valuable source of stimulation as illustrated in Figure 4 and as described in Sections 5.2.3 and 5.3.3.

Silver [57] has identified important features affecting the design of MSSs in the process view of decision making - the three dimensions of the system perspective mentioned in Section 5.3. The integrated perspective presented in this paper incorporates Silver's model, but augments it with the three dimensions of the role perspective and relates it to the different views of decision making. Silver identifies two generic forms of guidance: suggestive and informative, but does not use or extend Zuboff's [70] concept of informatization to MSSs. While the potential benefit of providing decision traces to users is mentioned, he does not provide descriptions of specific means (or systems) implementing it. His suggestive guidance is related to the stimulate component of the role perspective in our research, but is mainly focussed on suggestions regarding structuring the decision process in terms of operators, inputs and models to be used.
Some of the ideas implemented in Brandframe can be found in prior research. For example, researchers have defined the notion of active DSS [41,50,51], symbiotic DSS [42] and human-machine cognitive systems [67]. The notion of virtual agents has been introduced by researchers [3,50] to model the stimulative impact of MSSs on managers. Angehrn and Dutta [4] have implemented a case-based reasoning agent which performs many of the case-based stimulative actions contained in Brandframe. However, most of these prior implementations have been fairly adhoc and lacking in consistent conceptual bases. It is hoped that the integrated framework presented in this paper fills this gap and provides a conceptual framework to ground the design of intelligent MSSs.

While comparisons of some technological innovations in Brandframe (such as the storage of entire decision processes as cases and their use for informing and stimulating decisions) with prior research have been provided at appropriate places (Sections 5.2.2 and 5.3.2) in the paper, we have not focussed on the technical aspects of the implementation in this paper. Such details are provided in other papers [13,65].

6.2 Concluding Comments

The aim of this paper has been to outline the philosophy guiding our research on the design of MSSs. We understand that the ideas expressed above are limited to the choice of design features in MSSs and do not capture the complexities of the process of actually implementing MSSs in organizations - such as tensions between end users and corporate MIS groups and difficulties in perceiving true end user demands.

We have also deliberately kept the integrated perspective described earlier (Section 3.3) compact and clean. We could have allowed for more variations along each dimension, but we feel that it would both decrease the ease of applicability of the framework and reduce its comprehension by managers and system designers.

As the next phase of our research, we intend to conduct empirical experiments to validate our ideas. This will be done after Brandframe is implemented in Van den Bergh Foods as we want to use real brand managers and real problems for our empirical research. We are specially interested in observing the impact of the capability to capture entire decision processes and use it to guide and stimulate
managers as described earlier. Also, we would like to enhance the capabilities of Brandframe to learn patterns and associations from information about prior market situations, actions, and resulting outcomes (stored in the history & prior cases module). This would allow the development of certain capabilities within Brandframe to gradually change its knowledge autonomously. However, these ideas are complex and need more careful research.

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Interactions across decision cycles

Figure 1: The outcome oriented view of decision making

Figure 2: Interactions across different decision cycles

Figure 3: The process of decision making
Figure 4: Stimulation from knowledge about prior decision processes

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Figure 6: Position of conventional MSSs in the role perspective

Figure 7: Dominant matches for the system perspective of MSSs
Figure 8: Position of conventional MSSs in the system perspective

Figure 9: An integrated perspective for the design of MSSs
Design of marketing program

- Monitoring market conditions to find problems and opportunities
- History
- External world data (e.g., panels)
- Organizational targets and constraints

Choice of marketing program

Implementation of marketing program

Review

Figure 10: Typical activities of a brand manager

External World

- History & Prior cases
- World modelling
- Monitoring & tracking
- Program designer
- Process analyzer
- Targets and constraints setting
- Diagnosis
- Report generator

Figure 11: The conceptual architecture of Brandframe
Analysis for Heineken: period 4

RECOMMENDATION for strategy: Advertising: 35

BECAUSE:
Your awareness is down
Your preference score is down
Your advertising share is down
Amstel has a higher preference score
Amstel has aggressive sales promotion
Amstel has aggressive advertising
Amstel recently lowered its price

OTHER STRATEGIES:
Sales promotion: 17
Price: 13
Product: 11

Figure 12: Suggestion for marketing strategies by Brandframe
Analysis for Heineken: period 4

The average market price has changed from 81 in period 3 to 79 in period 4, while your own price changed from 82 in period 3 to 83 in period 4. This price movement is significant and causes competitive disadvantage. You should consider action to compensate.

Your advertising expenses were 1218 in period 3 and 1323 in period 4. This can cause some competitive disadvantage, while your advertising share compared to your competitors is down. Pay attention to your advertising share.

Pay special attention to the following brand(s):
- Grolsch: higher preference score.
- Amstel: higher preference score.

Choose the name of the threatening brand
- Oranjeboom
- Grolsch
- Amstel
- Duvel
- Trappisten
- Amstel_Gold
- Heineken_Bok
- Stender
- Bavaria

Figure 13: A partial transcript of the decision process in Brandframe - I
Analysis for Heineken: period 4

Sales promotion: 3.00
Advertising: 7.00
Retailing: 0.00
Price: 0.00
Product: 0.00

Total contribution of the attribute Prestige is -2.08. Your last reported perceived score on Prestige (-1.6) is worse compared to the current average in Pilsener (average: -0.3). Prestige is considered to be an attribute of moderate importance (weight: 1.3). Though being of moderate importance, watch this attribute and try to improve position by reducing the attached importance or by scoring better on Prestige.

Total contribution of the attribute Hangover_Pr is -1.05. Your last reported perceived score on Hangover_Pr (1.5) is worse compared to the current average in Pilsener (average: 1.35). Hangover_Pr is not considered to be an important attribute.

After reading the comments on the perceptual attributes, you can press 'continue...' for further analyses.

Figure 14: A partial transcript of the decision process in Brandframe - II
Program designer: sales promotion

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recommendation for Sales promotion:</strong> Sampling: 6.44</td>
<td></td>
</tr>
<tr>
<td><strong>Other devices:</strong> Contest: 6.34</td>
<td></td>
</tr>
<tr>
<td>Self liquidating premium: 5.18</td>
<td></td>
</tr>
<tr>
<td>Premium: 5.14</td>
<td></td>
</tr>
<tr>
<td>Coupon: 4.62</td>
<td></td>
</tr>
<tr>
<td>Stamps: 3.08</td>
<td></td>
</tr>
<tr>
<td>Cash refund: 2.66</td>
<td></td>
</tr>
<tr>
<td>Price discount: 2.24</td>
<td></td>
</tr>
<tr>
<td>Product plus: 1.44</td>
<td></td>
</tr>
</tbody>
</table>

**Note:**
The recommended sales promotion device might not be appropriate for the kind of product you are selling, or may otherwise not be applicable because of time or budgetary reasons; in this case choose the first device in this ranking that suits you and read the explanation.

**Explanation of another?**
- Contest
- **Sampling**
- Self liquidating premium
- Stamps
- Cash refund
- Price discount
- Product plus
- Premium
- Coupon

Sampling means offering the product free or almost free (in a small quantity). The costs of sampling are very high because the product is for "free", it commonly has an expensive package, and has high distribution costs. Sample actions usually have a long implementation time. Advantages: a fast introduction of the product and brand loyalty is stimulated.

---

**Figure 15:** Recommendations and explanations in Brandframe
Program designer: sales promotion

<table>
<thead>
<tr>
<th>Contest</th>
<th>Self-tog. premium</th>
<th>Cash refund</th>
<th>Product plus</th>
<th>Coupon</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6.34</td>
<td>5.18</td>
<td>2.66</td>
<td>1.44</td>
<td>4.62</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sampling</th>
<th>Stamps</th>
<th>Price discount</th>
<th>Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6.44</td>
<td>3.08</td>
<td>2.24</td>
<td>5.14</td>
</tr>
</tbody>
</table>

Please give weights [0 ... 5] to the following sales promotion goals. Give weights to the extent that you want to reach these goals.

<table>
<thead>
<tr>
<th>Generation of awareness</th>
<th>Attraction of new customers</th>
<th>Increase use</th>
<th>Increase loyalty</th>
<th>Support advertising</th>
<th>Improve image</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3.30</td>
<td>2.50</td>
<td>2.90</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 16: A screen-dump from the program designer module
**Figure 17**: Suggestive stimulation from prior cases

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-01-1992</td>
<td>Market share down</td>
</tr>
<tr>
<td>15-01-1992</td>
<td>Market reports in</td>
</tr>
<tr>
<td>20-01-1992</td>
<td>Market share down</td>
</tr>
<tr>
<td>31-01-1992</td>
<td>Market share down more</td>
</tr>
<tr>
<td>02-02-1992</td>
<td>Market reports in</td>
</tr>
<tr>
<td>25-02-1992</td>
<td>Market share down</td>
</tr>
</tbody>
</table>

*Events*:
- More rain & storms
- Rainy weather
- Market information from retailers
- Market share down more
- Market reports in
- Market share down
- Market reports in

*Goals*:
- Goals
- Goals
- Goals
- Goals
- Goals
- Goals
- Goals
- Goals
Figure 18: An example of case-based stimulation in Brandframe
**Current structure of the Beer market**

<table>
<thead>
<tr>
<th>SUBPRODUCT CLASSES</th>
<th>BRANDS</th>
<th>MARKET SEGMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilsener</td>
<td>* Pilsener_Brands: *</td>
<td></td>
</tr>
<tr>
<td>Specials_Belgian</td>
<td>Amstel</td>
<td>* Geogr_Regions: *</td>
</tr>
<tr>
<td>Specials_Non_Belgian</td>
<td>Heineken</td>
<td>Noord_Hol</td>
</tr>
<tr>
<td>Non_Alc_Beer</td>
<td>Grolsch</td>
<td>Zuid_Hol</td>
</tr>
<tr>
<td></td>
<td>Oranjeboom</td>
<td>Noord_Ned</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mid_Oost_Ned</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mid_West_Ned</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Noord_Braband</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Limburg</td>
</tr>
<tr>
<td></td>
<td>* Specials_Belgian_Brands: *</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trappisten</td>
<td>* Occupation: *</td>
</tr>
<tr>
<td></td>
<td>Duvel</td>
<td>White_Collar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blue_Collar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students</td>
</tr>
<tr>
<td></td>
<td>* Specials_Non_Belgian_Brands: *</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Heineken_Bok</td>
<td>* Sex: *</td>
</tr>
<tr>
<td></td>
<td>Amstel_Gold</td>
<td>Males</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Non_Alc_Beer_Brands: *</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Buckler</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 19:** The market structure as seen by the brand manager
List of Figure Captions

Figure 1: The outcome oriented view of decision making
Figure 2: Interactions across different decision cycles
Figure 3: The process of decision making
Figure 4: Stimulation from knowledge about prior decision processes
Figure 5: Dominant matches for the role perspective of MSSs
Figure 6: Position of conventional MSSs in the role perspective
Figure 7: Dominant matches for the system perspective of MSSs
Figure 8: Position of conventional MSSs in the system perspective
Figure 9: An integrated perspective for the design of MSSs
Figure 10: Typical activities of a brand manager
Figure 11: The conceptual architecture of Brandframe
Figure 12: Suggestion for marketing strategies by Brandframe
Figure 13: A partial transcript of the decision process in Brandframe - I
Figure 14: A partial transcript of the decision process in Brandframe - II
Figure 15: Recommendations and explanations in Brandframe
Figure 16: A screen-dump from the program designer module
Figure 17: Suggestive stimulation from prior cases
Figure 18: An example of case-based stimulation in Brandframe
Figure 19: The market structure as seen by the brand manager