On Decision Support Systems

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Abstract

The "primum movens" of this paper is to motivate the shift from Operational Research static paradigm for decision making to the decision support system dynamic paradigm, and to present the quintescencial of this new approach contrasting it with other powerful tools in the Information Systems arsenal.
Hints toward use of DSS to planning problems in a turbulent environment are briefly sketched for the sake of illustration.
Recent development in this field, including synergetic DSS and the enhancement of Simon's frame work by in corporating levels of decision maker's needs are also discussed. We end up with some concluding remarks along with lines for further fruitful developments in this emerging field.

Résumé

Le "Primum movens" de cet article est de justifier l'obslescence du paradigme statique de la Recherche opérationnelle pour la prise de décisions en faveur du paradigme des systems Interactifs d'aide a'la décision et de présenter la quintescence de la méthodologie des systémes Interactifs d'aide a'la Décisional en la comparant aux autres outils dans l'arsenal des moyens développés dans le domaine de systémes d'Information. En guise d'illustration, nous indiquous brievement comment ces idèes peuvent être exploitées a'bon escient, pour venir a'bout des problémes de plannification dans un environnement turbulent.
Quelques développement récents, en l'occurence les SIAD synergetiques et le renforcement de l'approche de Simon pour tenir compe de la hiérarchisation des besoins du décideur sont aussi présentés.

L'article se termine par une conclusion où quelque axes de réflexion pour des futurs travaux de recherche dans ce domaine sont indiqués.

1. Introduction

For centuries, voices have been raised advising us to take the time to reflect, to calculate, to anticipate before reaching a decision and acting on it (Piaget 1967). Gradually there arose the idea of referring to abstract constructs and hypothetical deductive reasoning to guide and justify human actions.

These hopes of reasoning out decisions took root with operations research(OR) (Miller and Starr 1969, Agrell 1983).

Nevertheless, the concepts, models and procedures used in operational research unlike their counteparts in the physical and natural science, can scarcely claim to describ realities which would be independent of the observer and which would exist independently of other human actors. In such a context where various participants in the process interact with the reality, tools which allow flexibility, adaptability, openness and willingness to take part in a learning process and to redefine problem boundaries, seem more appropriate than robust single analysis. Furthermore, in many concrete real life problems, accepting postulates on which OR techniques are rooted is tantamount to make science play a role of divinity out of objectivity.

In this paper, we take advantage of the above arguments to support the shift from OR static paradigm to the Decision Support System (DSS) dynamic paradigm.

We also present the quintessence of this new methodology and point out on recent developments in the field. The paper is organized as follows: In the next section, we briefly discuss limitation of OR for concrete real life problems and we motivate the Decision Aid Approach.

Section 3 is devoted to the DSS paradigm and to features which make it depart from other approach in the Information system arsenal.

In section 4, we discuss how these ideas may be applied to design a DSS for planning in a turbulent environment where information concerning the planning problem are partial or approximate. Recent developments in the design of more effective DSS are discussed in section 5.

We end up in section 6 with some concluding remarks together with lines for further developments in the field.

2 Limitations of Decision Theory; Decision -Aid theory

According to Morse and Kimball (1951), Operations Research is a scientific method of providing executive departments with a quantitative basis for decisions regarding operations under their control.

Although these methods have enjoyed acceptance within the scientific community, they may be challenged on several points regarding the questions under what conditions are we justified in recognising a value in concepts, models, procedures and results, and to what bases should we refer in judging the validity, viability of knowledge produced by OR.

Let me mention but a few points:

- The orthodox model of science and the naturalist attitude connected with it cannot be applied without difficult to OR as they imply freeing ourselves from what Nietzche has called the dogma of the immaculate perception.
- Faced with a problem involving decision-making, OR researchers think that a certain number of constraints which delimit a set of feasible solutions or even potential action exist objectively outside time and independently of actors involved in this decision.
- Methods developed on OR are rooted on the postulate of the optimum and of the reality of the first orders (Roy 1993).
If these assumptions and postulates may be accepted for well-structured problems they are of doubtful validity as far as, we leave the well-structured problems endpoint in the spectrum leading to unstructured problems. So applying blindly OR models on problems which are not well-structured lead to bad caricature of the reality, letting no chance to these models but churn out meaningless results.
Attempts to bridge this practicality gap is behind the shift to another kind of decision science, whose object is to formulate the problem throughout the decision process, Instead of claiming to approximate the best possible decision, this new approach develops a corpus of conditions and means on which one can base decisions in favour of what seems to be most suitable.

Such a science labeled decision-aid science seeks to develop a network of concepts, models, procedures and results able to form a structured and coherent body of knowledge which can act as keys so as to guide decision making.
Keeping in mind the above decision-aid principles and taking advantages of information technology, one may be able to ènlighten and scientifically accompany decision making processes. Thus conceived of , DSS escape those fundamental criticisms set forth above with reference to decision science.

3. Decision Support System Approach

3.1. The paradigm

The basic paradigm for DSS is that such a system consists of three major components:

- model base
- data base
- human interface

Each of which interacts with the other and with the decision maker.
Future decisions can be assessed with uncertainty.
This may require that DSS generate several alternatives or scenarios imposing a demand to evaluate the consequences of the alternatives, simulate future situations and provide answers to "What-if" questions.
Alternatively the decision maker may need a "goal-seeking" capability, in which the DSS searches for decision alternatives that can satisfy certain criteria.
Sensitivity analysis may be also needed to determine the impact in the parameters on the solutions.
It is also required to analyze the robustness of models and procedures.

3.2. Generic architecture

The specification which the DSS needs to satisfy lead to the technical/architecture and functional aspects of the system.

A we show in Figure 1, the DSS has an architecture comprising of data components and software components.

The data components include data, model and a solution data bases.

Also, there is component of dialog primitives that are used to compose interfaces.

The software components comprise a database management system (DBMS) capable of handling the data bases, a model base management system (MBMS) to handle the model base, a solution (scenario) management system and a controller (CTR) to control and to manage all DSS activities.

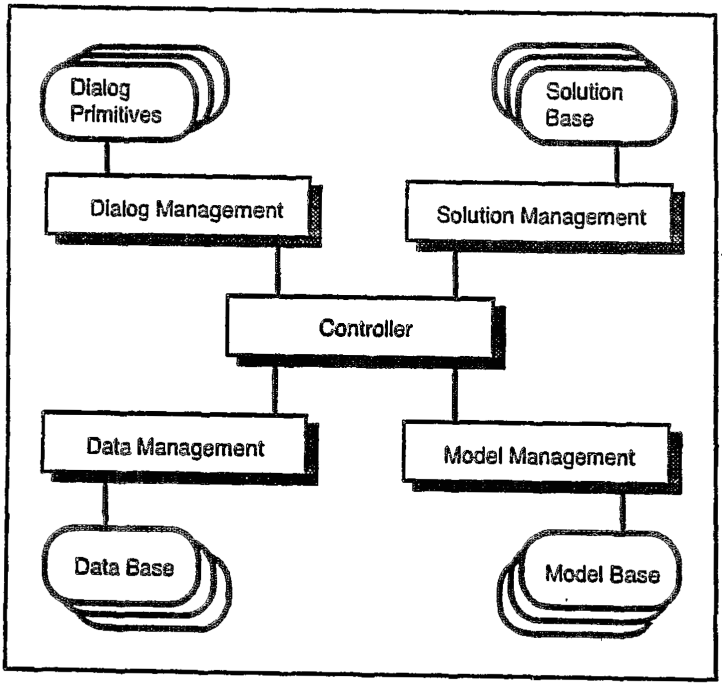

Fig 1: Generic DSS Architecture

3.3 Functions

Information system, particularly for business purposes, starts out as transaction processing system, handling the vast volumes of phone bills, charge accounts and insurance policies that firms have to deal with.

As this kind of data processing gained maturity, people aggregation of information could help managers make sense out of the mass of individual data items. The resulting systems were dubbed management information systems. It rapidly become clear that, merely aggregating information into reports was not useful

The next stage in evolution, thus was a realisation that aggregating information is not enough.

Managers require more sophisticated support for their decision making.

The focus shifted to how information systems could be used to support decision making, the subject matter of DSS.

This perspective implies that the following five functions should be distinguished:

(i) display data in various forms

(ii) solve problems

(iii) formulate representations

(iv) examines representations and solutions in a broader decision context.

(v) engage in a purposeful interpretation of the inputs and outputs in the system's own subjective perspective.

The function analysis of the DSS as an information provider allows to distinguish the following non-exclusive classes of the system (Kersten and Michaloski 1996): presentational systems, Analytical systems, Representational systems and Interpretational systems.

4. Outline of a DSS for planning in a turbulent environment.

A planning situation is characterized by a set of tasks each to be processed by a set of resources in a certain time interval.

A plan consists of a set of allocation triples (t, rs, I); t, rs, I standing for task, resource set and time interval respectively.

Among all feasible plans, the decider is supposed to find a good one.

Uncertainties are usually involved in a planning process. As a matter of fact, parameters like: time expected planning cost, quantity of a given resource, may be imprecise.

The general structure of a DSS which lends itself better in managing imprecision (Yager et al 1987) and which is able to integrate both algorithmic and social rationalities is shown in figure 2. An interested reader is refered to Luhandjula 1996 for more details on this system.

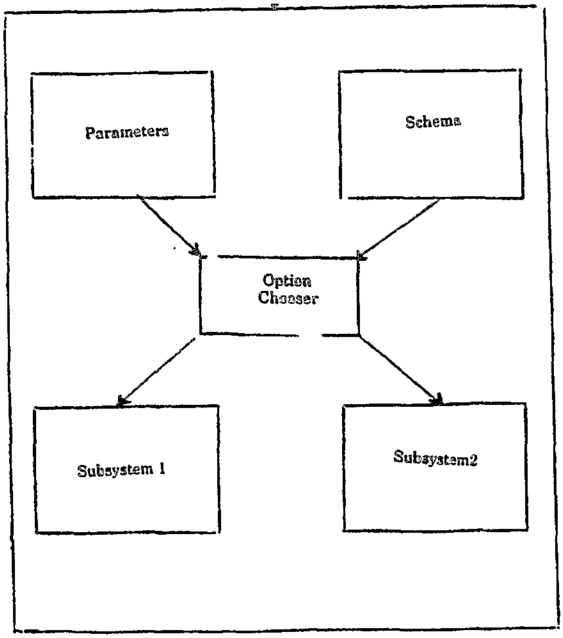

Fig 2: Structure of the planning DSS

The subsystem 1 contains several mathematical programming algorithms along with ad-hoc heuristics for dealing with situations where the multipility of objectives and the imprecision in data are in the state of affairs.
The subsystem 2 is a hierarchical partial order planner, capable of interacting with the decider and able to use these interaction within its plans.

A formal framework for determining pertaining software architecture is now in investigation. existing software engineering tools such as DSSA and various CASE packages should be analyzed from the perspective of this DSS development. existing software modules will be building blocks for the DSS implementation.

5. Further developments

5.1. Synergistic DSS

When efforts to build generalized problem-solving capability through DSS is put on hold these days, the focus of development switched to system based on specific domains of human and/or model expertise (Van Hee and Lenstra 1994). These systems rely on a specific collection of knowledge, models and rules (domain theory) describing critical facets of the problem under scrutiny.

Despite their apparent simplicity such systems pose many problems.
They assume that the domain theory is complete and correct.
However, for most real world tasks, completeness and correctness are extremely difficult if not impossible to achieve.
A given collection of knowledge, models and rules can be intractable to use.
To make this collection of data, models, rules and knowledge as complete and correct as possible, it may be necessary to write thousand of interacting, possibly recursive rules. Use of such rules may be intolerably slow. Furthermore, a domain theory may be difficult to modify.
A way to overcome the above mentioned drawbacks is to resort to consolidated hybrid architectures. From topological relationships among elements of the system, one may drive four types of hybrid architectures: Combination, Fusion, Integration and Association (see Figure 3).
A combination architecture for a thermal comfort problem is discussed elsewhere (Luhandjula 1996). The usual analytical approach is combined with the connectionist one.
Keeping the network architecture and the learning protocol as general as possible, one may take full benefits of the neural computing approach namely: parallel processing, learning, generalization from examples and error resistivity.

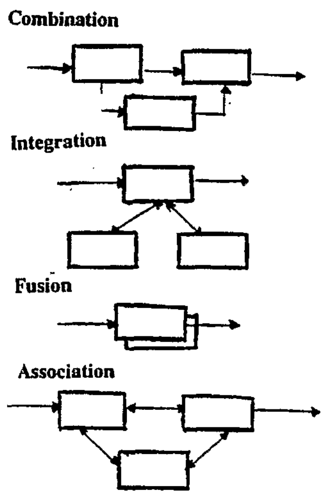

Fig 3: Topology of hybrid architectures for DSS.

5.2. Cognitive DSS

A look at the liberature on DSS essentially place reasoning about choice at one level (the material level).

However, the framing of choice and its impact on a decision process can be articulated by the decision maker at two distinct levels:

- the cognitive level (which also includes needs and values of the Decider) and
- the tool level

The multifacet character of the cognitive level is best manifested by what Maslow calls a "hierarchy of human needs" where a specific need provides rationales for some actions the decision maker undertakes to solve problems and make decisions.

Decision making is seen as a purposeful process which orients action towards addressing an unfilled need or towards attaining a higher degree of need fulfillment.

So a general theoretical approach to DSS requires that the cognitive predilections of the decision maker acting as the link between needs fulfillment and circumstantial interpretation provide both a template for support and a limitation for is utilisation.

In a way to mesh with the cognitive structures of the decision makers, DSS functions should match user needs with phases of decision making.

Such matching becomes possible through superimposition of De May's taxonomy (De May 1992), on the augmented Simon's phase model. Figure 4 below illustrates intrinsic character of the issue.

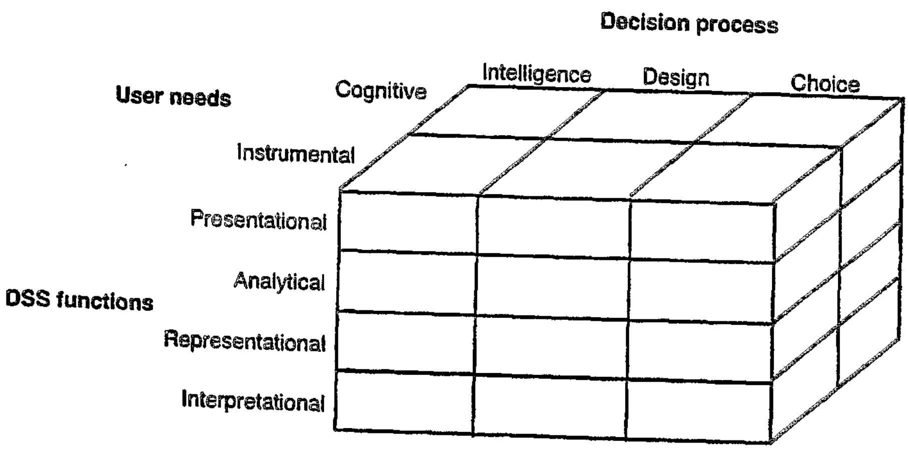

Fig. 4: Conitive DSS

6. Concluding remarks

DSS is evolving rapidly driven by expressed needs from managers and organizations for more support from information technology.
Full development of this field will require a creative coalescence of several disciplines in order to bring information technology to bear on the problem in an effective way.
A step towards such a coalescence has been outlined in this paper by a discussion on synergistic DSS.
Research opportunities and challenges are immense and the potential rewards are correspondingly great.
Without any claim to exhaustively, here are some point which need more attention.
The further enhancement of the efficiency of a DSS is connected with automation of creative processes. We have touched upon this point by a brief discussion on cognitive DSS (see 5.2) Such ideas as the principle of adaptive decision making (Gladun 1984 should be more deeply explored for more achievements along this line.
A particularly interesting and potentially important issue is how to gradually shift the dialogue initiative from users to system. This sort of movement is important in the next generation of DSS, where more intelligence is built into the system to relieve the amount of dialogue required of the user and to provide him with better summary information.
Most existing DSS are problem-centered. This makes them hard to accommodate an important portion of decision making process.
It would be desirable to take advantage of operations research, soft system methodologies, artificial intelligence and cognitive science in a way to push forward process-centered DSS methodologies.

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