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Published in:
Excerpta Informatica

Publication date:
1986

Citation for published version (APA):
Kleijnen, J. P. C. (1986). Decision support systems: Electronic brains without gut feelings. *Excerpta Informatica*, *2*(3), 1-2.

Decision Support Systems: Electronic Brains without Gut Feelings

Decision Support Systems (DSS) is a term that has been around for about a decade: the first book in the Addison-Wesley Series on Decision Support was Keen and Scott Morton (1978) which has become a classic. The concept itself has been applied since decision-makers started to use computers. Yet there is no widely accepted **definition** of the term DSS; see Davis and Olson (1985), Keen (1986), Sol (1985). I do not think that this lack of definition should worry us much; other young disciplines such as Operations Research are not clearly defined either (what are the differences among Operations Research, Management Science, Decision Analysis?). What is important, I believe, is to think about and to build computer-based Systems which Support high and low-level managers making Decisions. I shall try to sketch (not define) such systems and their relations with other systems.

Let us first consider an **example**. I pick the "GADS" example, because it is well accepted in the DSS literature (see Keen and Morton, 1978, p. 147) and I am familiar with it (as I spent a year at IBM in San Jose, California, when they were developing this system). The problem was how to partition San Jose into geographic subareas - called beats - to which police officers were to be assigned (a commercial analogue is: where to allocate taxi cubs, grocery shops, bank offices). The users formulated a possible solution, and the computer calculated the consequences, for example, the number of calls the police officers had to respond to. Next the users proposed a different solution, and the computer again calculated the consequences, and so on: what-if approach. The computer could indeed determine these consequences, since it had stored data on traffic accidents, crimes, and so on: when and where did what happen? The users did the creative work: which configuration should be evaluated; which criteria should be calculated (workload for officers, waiting times for citizens). The computer retrieved data (fast, accurate, and detailed) and performed arithmetic (total calls per day, variation over the year). For details on this example I refer to Keen and Morton (1978) and Kleijnen (1986).

After the above example it seems reasonable to circumscribe DSS as computer-based systems which support managerial decision-making, by combining data with models. **Models** give an abstraction of reality. In most DSS, models are relatively simple. Examples of simple models are mortgage calculations, using a programming tool such as Visicalc or Lotus 1, 2, 3; such spreadsheets are extremely popular, because they are conceptually simple, and they run to inexpensive micro-computers. More elaborate financial simulations run on bigger computers (for example, WIZARD). Examples of non-financial simulations are inventory models: when and how much to order? The literature, however, claims that inventory models represent well-structured problems, whereas DSS address ill-structured problems; inventory models are standard in Operations Research textbooks. I disagree with the DSS literature: I claim that in practice hardly any problem is well-structured; real problems involve multiple, conflicting criteria. For example, inventory models are part of software (such as IBM's COPICS) and their results are never implemented automatically; instead their outputs are order-advices to the manager who has to weigh inventory costs against service and goodwill. There there are purely technical problems (involving no people) for which a model derives "the" optimal solution which is implemented routinely; an example is an oil refinery optimized through linear programming software.

Models are essential subsystems of DSS. Models make DSS related to Operations Research, and they differentiate DSS from **Electronic Data Processing** (EDP). EDP records what actually happened (ex post registration of events, periodically summarized into status reports), whereas models describe laws (relationships) that supposedly govern future events. Consequently, models serve decision-making, whereas EDP primarily serves accounting and auditing. However, models (Operations Research, DSS) need data (EDP): data are necessary to derive laws, and once laws are formulated laws need some historical data as input in order to forecast the future (otherwise we get models with GIGO: garbage in, garbage out). One of the problems of Operations Research is the lack of data; DSS have emphasized the role of the data subsystems. That role is stimulated by developments in computer hardware and software, such as mass storage devices, Data Base Management Systems (DBMS), on-line data capture (Point of Sale Systems). **Challenges** do remain. By definition, data on the future are missing; we can only forecast the future. This prediction is more error-prone, the more turbulent the invironment is. Strategic problems require external data and only some data are supplied by public data bases. In general data bases contain well-structured data, and no free-format documents (on-line literature-retrieval systems may show the way to DSS). Networks of computers (micro's and mainframes) are about to become reality.

Note: Nowadays **Artificial Intelligence (AI) and Expert Systems (ES)** receive very much attention. However, I believe that they are not yet ready for application in DSS. Expert Systems may work well in "burocratic" organizations; such organizations apply formal rules without considering what is "reasonable"; examples are provided by fiscal "fictions".

And now I return to the title of this article ("..., electronic brains without gut feeling"). Models cannot replace humans, since models are based on assumptions that must be tested (outside the model) by humans; for example, the inventory model (implicitly) assumes that no advertising campaign will start. Most DSS models compute several outputs, and leave it to the users to weigh criteria and evaluate restrictions. And the alternatives to be evaluated, are formulated by humans, who use heuristics to find such alternatives. So in the **man-machine symbiosis**, the computer provides fast computation and large storage (for well-structured data); the human partner provides heuristic search procedures, associative memory, and learning capability. The computer stores numerous data (on past events or transactions); DSS transform these massive data into meaningful information, using models, in interaction with the user. DSS will be more and more accepted, as ous educational system and society at large become computerized.

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