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AND
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IN
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EDITED BY
HENK G. SOL - CEES A. TH. TAKKENBERG - PIETER F. DE VRIES ROBBÉ

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HENK G. SOL
Department of Mathematics, Technical University, Delft, The Netherlands

CEES A.TH. TAKKENBERG
BSO/Partners, Utrecht, The Netherlands

PIETER F. DE VRIES ROBBÉ
Academic Hospital, Groningen, The Netherlands

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PREFACE

In 1985 it was 20 years since Nobel Laureate Herbert A. Simon published: 'THE SHAPE OF AUTOMATION: For Men and Management'.

This short but important and still topical book dwells on three subjects:
- The Long-Range Economic Effects of Automation;
- Will the Corporation be Managed by Machines?
- The New Science of Management Decision.

In contrast with George Orwell, who was a critic of contemporary political systems rather than a prophet, Simon portrays a far more rosy picture of our 'brave new world'. Simon's work breathes optimism.
First, computer technology; looking back it is doubtful whether even the professor expected the hardware development we have wittnessed.
Secondly, our ability to 'tame the beast'; there is now not much reason for complacency and satisfaction. Offices and factories can by no means be called automated, at most semi-automated.
Thirdly the organizational and social implications of these rapid technological developments; referring to what he then called: 'The Computer and the new decision making techniques ...'
Concerning this last point, there is little need to emphasize that had been less practical application in organizations than the often impressive theoretical developments would lead one to believe.
In Europe this situation is even more accute than in the USA and Japan. The ESPRIT programme of the ECC and many similar national programs intend to bridge the gap.

NSOR's November 1985 Mini Euro Conference has been devoted to those promises contained in Simon's seminal work that just now, some ten to fifteen years late, are beginning to appear above the practical horizon.

The Second Mini Euro Conference looked at Expert Systems, Artificial Intelligence, and Decision Support Systems from a 'traditional' Operations Research/Management Science point of view: 'as methodologies, techniques and tools to improve Management Decision making!

This conference was a platform for the exchange of information among theoreticians and practitioners who share a common interest in this subjects.

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INTRODUCTION

by Dr. Henk G. Sol, Professor of Information Systems, Delft University of Technology, Dr. Cees A.Th. Takkenberg, Partner, BSO/Partners, Utrecht, Dr. Pieter de Vries Robbé , University of Groningen

Support for managerial decision making in organizations is attracting a lot of interest. Numerous researchers and practitioners have no hesitations in putting the label Desision Support Systems (DSS) on their work. With the same ease Expert Systems (ES) and Artificial Intelligence (AI) are put forward as tracks to improve organizational efficiency and effectiveness. Various contributing disciplines are jumping on the label DSS to sell their products for academia and practice. Clearly the basis for defining DSS has been migrating from an explicit statement of what a DSS does to some ideas how the DSS objective can be accomplished. This migration during the years can be shown in the following descriptions for DSS:

1. In the early 1970's DSS was described as 'a computer based system to aid in decision making'. The starting point was found in the application of interactive technology to managerial tasks in order to use computers for better decision-making. There was a strong cognitive focus in this DSS **concept**, viz. that of a single decision-maker.
2. In the mid to late 1970's the DSS **movement** emphasized 'interactive computer-based systems which help decision-makers utilize data bases and models to solve ill-structured problems'. The emphasis lies not so much on the **decision** process, but rather on the **support** for personal computing with fast development tools and packages, e.g. for financial planning.
3. In the later 1970's to early 1980's the DSS **bandwagon** provides **systems** 'using suitable and available technology to improve effectiveness of managerial and professional activities'. User-friendly software is produced almost unexceptionally under the label DSS. Disciplines like operations research and cognitive psychology are jumping on the bandwagon. Concepts like information center and prototyping are put forward in the same flavour as DSS.
4. By now we face a new technical base for DSS: the convergence on **intelligent workstations.** Telecommunications put forward the issues of organisational versus personal computing and distributed DSS. We see new

H. G. Sol et al. (eds.), Expert Systems and Artificial Intelligence in Decision Support Systems, 1–7.

technologies emerging as expert systems and document–based systems. This is expressed by Elam et al. (1985) in the need for a new vision on DSS. They propose to confine the notion DSS to 'the exploitation of intellectual and computer–related technologies to improve creativity in decisions that really matter'.

A useful framework for research on DSS is introduced in Sprague (1980). He discusses the perspective of the end–user, the builder and the toolsmith from which a DSS can be viewed. In accordance with this distinction the concept of a DSS–generator is put forward to bridge the gap between general tools and specific DSS. Sprague distinguishes as the main components of a DSS a data base, a model base, and an intermediate software system which interfaces the DSS with the user.

Within the data base for decision support one can distinguish between external data from public data sources, administrative data produced by the transaction processing system, and internal data created by personal computing.

The models in the model base as envisaged by Sprague are mostly of the equation type: A great number of so called corporate models or financial models consists of definition equations and behavioural equations. Econometric models also consists of equation models. Another category is formed by optimization models based on (non)linear, dynamic or stochastic programming.

A first generation of so–called DSS generators focuses on equation models with data base and interactive facilities like data–, model– and text manipulation, cf. Klein and Manteau (1983) and Berquist and McLean (1983). By now, the integrated facilities are not only offered on mainframes, but also on micro–computers together with facilities for 'down–loading from and uploading to central computer systems through data communication'.

A conceptual framework is put forward by Bonczek et al. (1981). They replace the components mentioned, by the concepts of a language system, a knowledge system and a problem processing system. A language system is the sum of all linguistic facilities made available to the decision maker by a DSS. A knowledge system is a DSS's body of knowledge about a problem domain. The problem processing system is the mediating mechanism between expressions of knowledge in the knowledge system and expressions of problems in the language system.

The framework put forward by Bonczek et al. makes it easy to relate the

work in the field of artificial intelligence to DSS. We define an 'expert system as a computer system containing organised knowledge, both factual and heuristic, that contains some specific area of human expertise, and that is able to produce inferences for the user', see Chang, Melamud and Seabrook (1983).

When one looks upon an inference system as a special kind of problem processing system and upon the knowledge base as the knowledge system, then expert systems fit neatly into the framework. Along this line a school of researchers focuses on the representation of knowledge for decision support, cf. Fox (1984), Bonczek et al. (1983). The relevance of epistemology to improve decision-making processes is addressed by e.g. Lee (1983). However, as Stamper (1984) remarks: 'Our growing technical capacity to produce, store and distribute information is no guarantee of the information's organisational and social usefulness. The trend towards intelligent, knowledge-based systems cannot solve the problem: instead it could well make the problem worse by disguising poor information under a cloak of logical self-consistency'.

Although DSS may provide a link on the path from traditional information processing towards knowledge engineering, we may recall that expert systems are always based on historical expertise. The search for expertise should not detract attention from grasping creativity-processes in new, unexperienced problem situations.

Although the interest for DSS should be welcomed, a clearer delineation of the concept of DSS is needed in order to make it a potentially rich research track. Rich, in the sense that it can foster the effectiveness and efficiency of organisational decision-making. Keen has questioned the role of modelling and quantitative models in stimulating creative thinking. If the OR discipline is taking up the DSS line, it should pick up this challenge and focus on creative dicision-making and learning on the merge of MIS and OR/Management Science.

One line is to focus on heuristics from an AI perspective. Another melting point could be model management and model representation. A third line is to take up the process of problem solving in a knowledge-based framework. Therefore, Sol (1985) extended the frameworks presented by Sprague and Bonczek into a new one, see Figure 1.

Sol proposes to direct DSS–research to the concept of DSS–generators or, more generally, DSS design environments. One of the main reasons for this choice is the lack of generalizability in dealing with specific decision support systems. Another reason is that one has to address all stages in the process of problem solving, not only at the conceptual level.

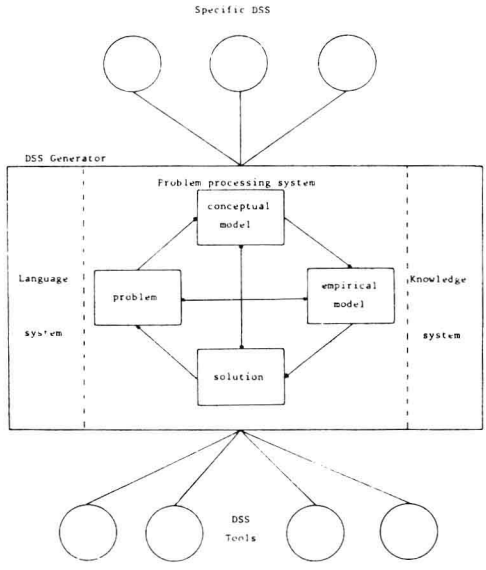

Figure 1. Extended framework of the one presented by Sprague and Bonczek

The trends mentioned above are clearly reflected in this proceedings of the Second Mini Euro Conference, held in Lunteren, The Netherlands, 17–20 November 1985.

The developments on the edge of DSS and Operations Research are depicted by D.B. Hertz by addressing the virtues of Models: Operations, Expert and Intelligent Manifestation. He sees a hybrid merge of rule–based, knowledge–based, algorithm–based and heuristic–based systems to provide advice, diagnosis and analysis for decision–makers.

Philosophical and methodological issues around the conference theme are addressed broadly by A. Bosman when he asks whether DSS is a vision or a discipline. He argues that DSS can only become a discipline when we focus on the process of decision–making as a separate field of study.
H.J. Lüthi and R. Pfeifer discuss the question: 'DSS and ES: A Complemen–

tary Relationship? They provide a conceptual framework to compare the two in the context of management problems. They conclude that DSS and ES should be considered as complementary concepts.
H.A. Kurstedt illustrates that expert systems with their replicative orientation are of a lower order than responsive, intelligent management tools.

Another important theme is modeling and model management.
R.M. Lee presents 'A logic Programming Approach to Building Planning and Simulation Models'. He shows that this approach is able to represent to dynamic programming, decision trees, Pert-networks and discrete event simulation.
A knowledge based formulation of linear planning models is presented by M. Binbasiogen and M. Jarke. They express that under current AI-technology, model formulation cannot be made fully general and user-friendly at the same time. A problem-solving approach seems fruitfull.
H. Koppelaar illustrates how shortcomings of quantitative models can be overcome by linguistic explanatory analysis of decision support situations.
The issue of specific modelling support environments is taken up by U. Maschtera. Useful support environments may contain natural language interfaces, abstraction aids, coupling operators, modelling expertise, and validation aids.

The conference theme clearly heads to various design issues: The efficiency of parallel knowledge processing is addressed by H.J. van de Herik et al. through the example of 'Heuristics in the Abbot Mark Problem'.
R.M. O'Keefe et al. present 'Microcomputer Based Expert Systems Shells: the spreadsheets of Artificial Intelligence'. They argue that declarative programming and knowledge based methods have applications far beyond expert systems, as illustrated by spreadsheets.
Extensions to the Expert System Shell 'Delfi-2' are presented by H. de Swaan-Arons et al. They show that shells should enable various formalisms for knowledge representation.
G.L. Doukidis and R.J. Paul put forward ASPES as a skeletal Pascal Expert System. It consists of a general purpose inference engine to which the user adds his domain specific knowledge base.

Important applications are emerging:
J.C.R. Pomerol et al. describe 'An Intelligent Support System for Strategic Decisions'. The main feature of this system is a scenario developer which is connected to various expert systems.

P. Gallo et al. elaborate a knowledge–based approach to business planning. They highlight critical conditions for the correct and effective design of support systems.

J. Kazimierczak addresses 'Knowledge Acquisition from User Programs by Computers'

J.J.J. van Beek presents a prototyping approch to the 'Analysis of Establishment Potential'. The system developed combines knowledge on establishment assessment with heuristics to look for new establishments.

Finally Ch.H. Kriebel evaluates the evidence created by these contributions. He discusses the shaping of management decision science with intelligent technology. He illustrates that the shape of management decision science has emerged through the discipline of mathematics and the medium of information technology towards closer linkages between the fields of operations research and psychology/computer science–based problem solving paradigms in artificial intelligence.

The contributions clearly show that the potential for impact and payoff is great.

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MODELS: OPERATIONAL, EXPERT, AND INTELLIGENT

David Bendel Hertz
Distinguished Professor, University of Miami
Director, Intelligent Computer Systems
Research Institute
P.O. Box 248235, Coral Gables, FL 33124, USA

ABSTRACT. Operations research (OR) has developed both formal and heuristic solutions to a broad spectrum of real-world issues. Artificial intelligence (AI) through its expert systems (ES) approaches has recently begun to attack similar problems. I believe that AI/ES and OR applications have similar objectives to permit the executive or decision maker to improve his understanding of, and take desirable actions in a particular operational domain. Both must build computable models which have an equivalent model structure. The surface differences are programming devices that may be stripped away. In the not too distant future, all significant programs intended to provide advice, diagnosis and analysis to aid decision-makers will be hybrid. That is, AI rule-based, knowledge-based and OR algorithm-based, heuristic-based expert systems will be joined to accomplish the desired end-result as efficiently as possible. This will be achieved through the construction of programming languages calling on the combined knowledge of AI, OR, and the computer science communities.

1. INTRODUCTION

As many of my colleagues and long-time friends in this audience know, my connections with operations research go back to the early days of OR, to the Operations Research Society of America, of which I was a founding member, and to the first IFORS conference at Oxford.

Almost twenty years ago I wrote:

> Computer technology permits the creation of an information network which, like the human central nervous system, is not merely a network of communicating cells but essentially a unifying mechanism for the organization of experience. This means increasing coordination of operations, revising the historical tendency toward progressive fragmentation and subdivision that

H. G. Sol et al. (eds.), Expert Systems and Artificial Intelligence in Decision Support Systems, 9–22.