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INFORMATION TECHNOLOGY FOR SENIOR LEVEL MANAGEMENT SUPPORT.

Christer Carlsson

Dept of Business Administration, Åbo Academy
20500 Åbo, Finland

Abstract

Information technology will here be used to denote the confluence of advances in **decison support systems, expert systems** and **telecommunications.** Decision support systems are described as "the professional use of computer systems by the computer non-professional", and emphasize independent use of computer-based tools for senior level management planning and decision making. Expert systems are similarly charcterized as "... computer programs which can reach a level of problem-solving expertise comparable to that of a human expert in some specific domain". Advances in telecommunications support the use of computer and local area networks, electronic mail and video conferences.

Senior level management is based on one key concept: **decisiveness,** i.e. the ability to obtain and analyse pertinent facts, to understand their implications and to act. The ability to find a synthesis of essential elements, and then to act upon this insight is often described as a necessary element of successful management.

Senior level decision making is individual, despite groups of advisors and committees to prepare the basis for the decison. Senior level decisions have to be communicated to people, to groups and to organizations in order to motivate, manage and control. Information technology is useful for all these tasks.

In this paper we will explore in detail the use of information technology for senior level management support. We will outline benefits - and possible drawbacks and limitations - with the help of some experience from a study of 11 major Finnish companies.

Keywords: information technology, senior level decision making, management

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1. INTRODUCTION.

The typical Boss is a decision machine; as he alone is responsible for everything, and he alone has available all the facts which are necessary for constructing an overall picture of his field of responsibility, he alone must make all the important decisions. It is not easy to move from being a Boss to becoming a Leader, to share responsibility, to communicate, to build and manage an innovative organization and to acquire strategic ability, i.e. the ability to identify essential, causal relationships behind the facts.

(Jan Carlzon, translated notes from a talk)

Theoretical studies of management are normally concerned with various forms for "rational intervention in human affairs", with a paraphrase of Peter Checkland's (1985) corresponding definition of operational research. "Rational" seems appropriate for two reasons: (i) as researchers we are trained to pursue some logically reasonable structure in descriptions, explanations and predictions; (ii) for practical interventions in human affairs a rational basis has always been easier to explain if something goes wrong. Let us study the concept of "rational intervention" for the cases Boss/Leader.

With some simplification it seems appropriate to identify the Boss as the ideal decision maker for theoretical purposes: he neatly collects all necessary facts and makes his decisions alone, thus eliminating all complicating problems with missing data and all disturbance from cooperation with other people. He closely adheres to the ideal goal seeking behaviour of traditional operational research or systems analysis (or "hard" systems thinking, cf Checkland). This goal seeking behaviour aims at optimizing the structure and behaviour of systems and maintaining them in that state, which seems an appropriate objective for a Boss. The standard methodology can be condensed into three steps: (i) define the system of concern; (ii) define the system's objectives, and (iii) engineer the system to meet those objectives, whereby there is no real difference between human and machine elements of the system.

The goal seeking behaviour is derived from an internal logic of the context, which is defined and exploited, and motivates the label "rational" for the behaviour. This is in analogy with the main principle of natural science methodology: there is a logic (or law) behind all observed events, and we need only knowledge, ingeniuity and luck to discover it. With all necessary facts available, a knowledgeable decision maker or researcher should find the internal logic, and establish the goal seeking behaviour which ensures an optimal systems design (any human activity could be regarded as a goal-seeking system, and "systems design" refers to an organized series of human activities, cf Checkland). This is then the best he can hope to carry out in the studied context, which makes it the rational intervention to choose.

Nevertheless, the goal seeking behaviour has met with considerable criticism for several reasons.

Goal-seeking behaviour is value-free, in the sense that the system's objectives are not questioned, but are taken as given ends a priori known to be desirable. The resulting optimal systems design is static and the organization would be hard put to adapt to fast and unremarkable changes (drastic changes force adaptation). Goal-seeking behaviour should not be desirable even for the Boss unless he operates in a very stable, highly profitable and uncontested context (cf Alko).

The internal logic is necessarily abstract and simplified, as it is the derived essence of the context. The problem seems to be that the logic is an oversimplification, that key elements of the context are lost, and that an intervention should be based on multiple factors, many of which do not have any immediately identifiable logical basis.

Checkland paraphrases Keynes in stating that the material to which management science is applied "is, in too many aspects, not homogeneous through time", which essentially means that an internal logic may rather quickly become irrelevant.

The goal-seeking behaviour of the Boss is probably not even very economical, as he is able to make optimal decisions only on the issues presented to him, or those his time allows him to deal with. His focus is narrowed by the abstractions and by the synthesis, which are necessary for him to at least partially grasp the issues presented to him, and there is some danger that his time will be used for pseudo-issues and he will be tackling pseudo-problems.

The Boss will be fully occupied with reacting to problems, albeit his reactions are optimal, and has no time for planning ahead. Strategic planning is regarded as one of the corner-stones of modern management, but it is questionable if the Boss' focus on problematic issues would be a fruitful basis for strategic planning, as he should question objectives, basic perceptions of the context and fundamental assumptions on the relationships forming his operational systems design, not take them as a given basis for goal-seeking behaviour.

Checkland summarizes the tradition of goal seeking behaviour ("hard systems thinking") in the following way (cf (1985)/p 765): "it seeks to make possible the efficient achievement of goals or objectives, taking goal-seeking to be an adequate model of human behaviour; it assumes that the world contains systems which can be 'engineered', hence that models of those systems can be made; it talks the language of 'problems'and 'solutions', which eliminate problems." He then points out that there is another tradition, "soft systems thinking", which does not regard goal seeking as an adequate model for intervention in human affairs, but still manages to build and apply a complete conceptual system. "...the 'soft' tradition regards systems models as models relevant to arguing about the world, not models of the world; this leads to 'learning' replacing 'optimizing' or 'satificing'; this tradition talks the language of 'issues' and 'accomodations' rather than solutions." This "soft" approach seems to answer much of the criticism levelled at the tradition of goal seeking behaviour.

However, much of the ideas quoted here as "soft systems thinking" originated in Geoffrey Vickers' quest to understand the social process which characterizes human affairs. He finally formulated the fundamental mechanism as an "appreciative system", which Checkland describes in the following way (cf (1985) p 762): "... an appreciative system is a cultural mechanism which maintains desired relationships and eludes undesired ones. The process is cyclic and operates like this: our previous experiences have created for us certain standards or norms, usually tacit (and also, at a more general level, values, more general concepts of what is humanly good or bad); the standards, norms and values lead to readiness to notice only certain features of our situations; they determine what 'facts' are relevant; the facts noticed are evaluated against the norms, a process which <u>both</u> leads to our taking regulatory action and modifies the norms or standards, so that future experiences will be evaluated differently. Thus Vickers (1970) argues that our human experience develops within us: '... readiness to notice particular aspects of our situation, to discriminate them in particular ways and to measure them against particular standards of comparison, which have been built up in similar ways'. These readinesses are organized cicularly into an appreciative system, which creates for all of us, individually and socially, our appreciated world. We fail to see this clearly, in Vickers'view, because of the concentration in our science-based culture on linear causal chains and on the notion of goal seeking."

Checkland states that his "soft systems thinking" is a methodology which "maps onto the idea of appreciative systems". We will not deal with that assertion here, but we will find out in what way, and to what extent information technology (IT) may contribute to the formation of appreciative systems in senior level management.

We have implicitly stated that there is a necessary transformation taking place from Boss-type managers to Leader-type managers, and we have explicitly stated that the methodology producing goal-seeking behaviour is becoming obsolete (partly because of the need for Leader-type managers). Then our second objective will be to find out how modern information technology could support the development and use of an alternative methodology.

We are interested in Leader-type managers, and we want to find out if information technology could support Leaders, i.e. if we with IT could support (i) the sharing of responsibility, (ii) communication, (iii) the building and management of an innovative organization, and (iv) strategic ability, i.e. the ability to identify essential, causal relationships behind the facts. This is, no doubt, rather demanding, and we cannot hope to find any definite answers, but we hope to reach at least some suggestions on the basis of a study we have carried out in 11 major Finnish companies.

2. THE CONTEXT FOR MODERN MANAGEMENT: Some elements of a complex, interactive system.

Decision making is not a rational process, it is an interaction of uncertain factors which defy rational description and treatment. The uncertainty originates in political, technological, administrative and financial problem complexes, which are randomly sampled for factors as a basis for decision making. The random sampling is explained with the decision maker's lack of knowledge/information/data or time - or interest. The random sampling results in a so-called ill-structured problem. The distinction between ill- and well-structured problems is rather blurry, but ill-structured problems are characterized by (i) there is no clear definition of the problem, (ii) the elements considered problematic are probably mere symptoms, but are multiple and interrelated, and (iii) the information about these symptoms is imprecise and unreliable. If the context allows us to be precise on the elements i-iii, and also to find an internal logic, we have a well-structured problem. In order to make the context even more blurry, semi-structured problems fall between the two categories, with elements of both the ill- and well-structured problems.

The ill- and semi-structured problems are encountered in most management activities on all levels of organization. IT is expected to provide new methods and tools for dealing with ill- and semi-structured problems: to produce good knowledge and data bases, to give knowledge support and to develop new, computer-based methods for tackling large, computationally difficult complexes of interrelated and imprecisely formulated problems.

Management forms a context of semi-structured problems, in such a way that the problems have both ill- and well-defined elements simultaneously. This means that management is a complex and demanding system of activities, which in practise has the following consequences: (i) decision making should be fast and efficient, because many problems and tasks will appear simultaneously; (ii) it will not be possible to concentrate on finding optimal solutions to single problems, as (iii) problems and tasks should be dealt with as a complex of continuously interacting elements.

The growing necessity of **strategic planning** is providing another complicating element. IT, and especially the tools and methods of decision support systems, have made strategic planning technically easier and more efficient, but its substance and the knowledge base needed have become more complex with the growing complexity of the management context. In order to build a strategic plan some fundamental elements are needed: (i) a critical mass of knowledge covering the areas of business activity, markets, growth potentials and new business opportunities; (ii) methods for integrating diverse elements of knowledge into a cohesive, productive knowledge base; (iii) efficient analytical tools for uncovering interdependencies, causal relationships and consequences in the mass of knowledge; (iv) knowledge and intuition to choose among strategic alternatives; (v) the control of sufficient resources to carry out a chosen strategic plan, and (vi) a vision of what should be achieved within the strategic planning horizon. These elements show that strategic planning requires advanced and extensive knowledge, and advanced computer support.

A strategic vision (cf (vi), above) should be both creative and practical, which sounds rather contradictory. Creativity is defined in many ways; the common wisdom version could be "the ability to make or otherwise bring into existence something new, whether a new solution to a problem, a new method or device, or a new artistic object or form". Creativity brings new insight, but the insight must be formulated in order to be brought into existence. Insight is formulated with the help of intellectual tools, among which the most prominent are methods for concept analysis and formation. This is again a field in which IT, and especially the methods developed for expert systems, should provide support. Computer-supported systems should be, or become, intellectual tools also for management purposes.

A strategic vision should be practical enough, (i) to be told as a modus operandi to the organization; (ii) to form a basis for strategic planning, and (iii) to be translated to guidelines for practical management. It seems that IT is expected to provide the conceptual bridge between the creative and the practical.

Modern information technology offers various forms of computer-supported systems:

* **decision support systems**, which help decision makers formulate and test decision alternatives, and which improve the effectiveness of decison making;

* **expert systems**, which can help minimize the probability for bad decisions;

* **automatic, on-line database systems**, which make routine decisions independently without human intervention;

* **traditional database- and knowledge base systems**, which carry out the traditional task of storing, manipulating and presenting data (and knowledge in the last few years), but are more advanced, easier to use, and more efficient than correspon-ding systems of the previous generation.

We will study these systems in some more detail, and find out their effects on modern management, but first we need some technical framework for the systems.

3. COMPUTER SUPPORT FOR SENIOR-LEVEL MANAGEMENT.

Measured in the time used by the participants, and the cost of that time, board meetings and meetings of the senior managers of a company are expensive. Measured in terms of the consequences of decisions taken at these meetings, they may be very expensive. If it with computer support is possible to make these meetings more efficient, and to make sure that the participants have up-to-date, valid and relevant basic information, then the investment costs for that computer support are marginal in relation to the alternative costs for poor decison making.

We found it rather surprising in our study of some major Finnish companies that a significant part of the discussion at senior-level management meetings had to do with the validity and the relevance of basic information, and that uncertainties in key factors often had a decisive influence on the decisions taken.

Then it is easy to list the following basic requirements on a computer-supported information system for senior-level manage-ment:

* basic information should be up-to-date and relevant for the issues to be decided;

* basic information should be validated and correct, detailed enough to permit discussion in depth, and multidimensional, to permit summaries and alternative lines of reasoning;

* basic information should be presented in an understandable form;

* deviations and problematic states should be singled out, interpreted and explained;

* basic information support should be provided for managers with different background, different conceptual framework, different analytical style and different ways of argumentation, to provide for effective and fruitful discussion.

The technical basis for a computer-supported information system for top-level management is constructed from the following elements of modern information technology:

* Work Station-type microcomputers, built around the 386 microprocessor and with a capacity of 3-4 MIPS, to be used as workstations for the managers;

* Local Area Networks for building an integrated system of workstations, in which a common data- and/or knowledge base and jointly used software is stored on a central (micro-)computer, a so-called File Server, and used by n workstations; the File Server is a powerful microcomputer with large hard-disk capacity, typically 100-200 Mb, and possibly with several operating systems (MS-DOS, Unix, OS/2);

* user-supported channels to mainframe computers, which allow access to mainframe facilities for novice users with no previous knowledge of operating mainframe systems;

* user-support systems, which allow an irregular user to find relevant data from a database system, to modify and combine data elements, to collect them in understandable and effective reports, and to present them in professional graphics;

* modeling systems, also known as desicion support systems generators, which develop models both in mainframe- and in microcomputer environments, and which transport data and models between the two environments; a decision support system helps its user to analyse data, to construct and test alternative plans, to compare decison alternatives and to report insight gained in these activities in an understandable form to fellow systems users, e.g. through a LAN;

* database- and/or knowledge base systems, which also operate both in mainframe- and microcomputer environments, and transport data and reports between the two environments; the 4+-generation system supports its user and helps him to modify, combine and present data and/or knowledge in understandable reports; a modern system is built with user-supported, datapack,

videotex and computer network channels to external databanks, database systems and computer networks;

* graphics systems, which are integrated with the user-support systems, the modeling systems, the database/knowledge base systems and operate in a LAN.

All these elements are available as commercial products, but the complete, integrated system is not very much in evidence, at least not in operative use as a top-level management support system. The concept of an integrated system is quite well accepted in several of the companies we have studied, but actual applications will take some time to appear as an integrated system will have to be adapted to existing, somewhat outdated third generation systems.

Graphics systems have become very popular in the last 2-3 years, for several reasons. They represent tangible advantages of computer support: every user realizes what efforts he saves with a colour graphics system when he produces graphical summaries of some complex analytical results, hundreds of data elements, time series, production statistics, etc. Graphics is an essential element for computer support in group activities, i.e. strategic planning sessions, negotiations, budget meetings, presentation of investement plans, etc. Numerical information requires detailed analysis and discussion before all participants have understood and accepted its substance, and it is still not clear if all participants have the same overall picture. Graphics gives an overall picture, which all participants immediately can refer to, and which allows innovative and creative discussion.

For graphics systems to offer support in group activities they should have the following characteristics:

* there should be no technical software restrictions on which kind of data the system could handle or present;

* the system should be easy to use for even novice users, and should have facilities for a combination of computer graphics, video and slide presentations;

* the graphics should both allow in-depth descriptions of details (also known as the "dataland effect") and sufficiently general overviews (the "helicopter effect") of data;

* the system should be standardized enough to be operational on all computer hardware used for group activities.

Many of the commercially available graphics systems have these characteristics, which has contributed to the rapid growth of computer support in graphics.

Another sector of IT which is becoming more and more important is teleconferencing, which for some reason is seldomly mentioned among the computer-aided support systems for senior-level management. The growing use of teleconferencing is a consequence of the internationalisation of business and the need for very rapid senior-level decision making (as many of the events requiring decisions are computer-activated or -supported ...). A survey made in the U.S. in 1986 showed that the time needed to organize a meeting of senior level managers was (Butler Cox Foundation):

Table 1. Time expired before senior-level managers could meet.

less than 1 day	4 %
1-7 days	25 %
8-30 days	42 %
1-3 months	18 %
more than 3 months	11 %

In the studied Finnish companies the same type of crowded schedules and hectic activity were very normal. Teleconferencing could be of help for managers with a need to discuss critical issues, but with no time for travelling to meetings:

* a teleconference can replace a meeting which otherwise would not have been held;

* a teleconference can be used as a preparatory or follow-up meeting to some important conference;

* scarce human resources and highly qualified expertise can be shared by many profit centers at different locations;

* key persons need not travel continuously;

* when organizing a company geographical restrictions are not an issue, which allows a functionally optimal organization.

If we include teleconferencing in the integrated system discussed above, we will probably get a new generation of communication facilities for management, which will have at least some influence on business in the 1990'es.

4. DECISION SUPPORT SYSTEMS.

Decision support systems (or DSS) are products of the 1980'es, and have gained importance with the increased use of interactive computer systems. Decision support systems are innovations in the use of IT for management support, but we will discuss some details of modern data management- and data manipulating systems before going into details with the DSS, as the data handling systems support the use of a DSS.

4.1 Data management systems.

Among the data management systems Reuter's Monitor system is widely spread and used, and offers up-to-date information on key business characteristics on an international scale. This kind of information is becoming vital as a control function for the context in which business is done, as an identifier of so-called weak signals, and as an outline of business opportunities.

Modern data management systems also include (i) videotex-based price and store look-up systems, which serve sales representatives in the field; (ii) content-addressable text-retrieval systems, for instance to sample and summarize market research interview results; (iii) commercial databanks and value-added network services, with up-to-date, critical information on (for instance) market segments; (iv) market intelligence systems with in-depth research data on some national market, a class of products, competition, etc.; (v) production management and control systems, with monitoring functions for key efficiency and productivity factors. These systems are, of course, very advanced versions of traditional filing systems, and offer much improved monitoring possibilities of the company's own operations as well as of its environment; it only remains for management to learn how to make the most efficient use of these possibilities.

Comercially available systems are built according to some standard, which not always adapt very well to the requirements of the users. Here we would like to propose that the data management systems are built into and adapted to the integrated system described above, in section 3. This can be accomplished with some interface software, which then preferably integrates the data management system to a database or to the user-support system.

There is a new, interesting solution to the standardisation and integration problem - the use of expert systems as interfaces. Then all the knowledge needed to utilize data from a data management system is built into the expert system, and a user is guided along according to his needs. He does not even have to know anything about the organization or the technical characteristics of the system, and the interface takes care of all the operations needed for connecting the user's workstation to the system.

4.2 Data manipulation systems.

Computer-supported systems which manipulate numerical data are well-known since at least 20 years: they are computer-based operational research models, and have been with us since it first became possible and relevant to program the Simplex-algorithm for a computer. Gradually we got classes of standard problems which could be solved with the same algorithm, and which made it commercially viable to develop computer programs for solving these problems. In this fashion we got software for dealing with production planning, queueing, transportation, networks, scheduling, storage, media selection etc. - all essential operational problems. This was rather successful for a while, until it became apparent that the standard problems were too standardized and too abstract to actually be very relevant for real life applications (as we noted in section 1).

Operational research applications have gradually disappeared during the last decade, and have mostly been replaced with interactive computer-supported systems, which in a number of cases have been built as decision support systems. The reasons are manifold: (i) management problems are too complex with too much imprecision to be adequately covered with mathematical models; (ii) optimization methods have become too advanced to be even roughly understandable to anybody but a small group of experts; (iii) the users of optimization methods are scarce, as various kinds of software packages (as spreadsheets, statistical routines, time series analysis, etc.) which only require an intuitive understanding, have become popular and gained acceptance among the personnel supporting managers. The world is, nevertheless, not all black for operational research applications. Rather surprisingly some optimization methods are making a comeback as integrated routines in decision support systems. Advanced users of interactive systems have tired on the slow, suboptimal(!) heuristic methods used in the user-friendly DSS-software, and have found them exceedingly tedious for routine applications. They have then re-invented the algorithms as quick, safe procedures to find the best possible solutions, and without the DSS-people really knowing it, the OR-methods are back.

4.3 Decision support systems: innovations in management support.

Decision support systems represent both a methodology and a technology, in the sense that they are methodological innovations in the field of management, which have become possible with a new kind of software - the so-called DSS-generators. The motto of the DSS-movement has been formulated as "the professional use of computer systems by the computer non-professional".

DSS-applications are normally based on numerical data, but offer methods and support for tackling problems which cannot be solved as standard operational research problems. The DSS-movement offers a methodological approach which, in some sense, is more traditional OR than many modern OR-methods, as Arthur M. Geoffrion stated in his closing address to the EURO V - conference (1982).

The principle "professional use ... by the computer non-professional" becomes possible for a novice or occasional user of computer-supported systems only if he is supported by the system itself. The user-support replaces and adds to the knowledge and experience of the novice user, such that he is able to reach the level of "professional use".

The level of "professional use" is rather demanding with modern information technology:

i. the ability to capture and describe all pertinent aspects of a problem or planning task with a model;

ii. the capability to carry out a detailed analysis with the help of relevant data;

iii. the knowledge and technical ability to validate results and methods;

iv. the capability to derive relevant and operational conclusions from the analysis, and the technical provess to present them in an understandable and "selling" form, using graphics and modeling software;

v. the technical ability to communicate results in LANs, computer networks and telecommunications systems;

Most of these capabilities required years of training before we got the DSS-generators. The tools and techniques built into a DSS-generator for "professional use"-possibilities include several software innovations:

* the planning- or modeling languages, which represent the 4th+ - generation of software allow a non-professional to build non-procedural models in an "almost" natural language; the modeling languages support capabilities (i) and (ii);

* software-links to operating database systems implemented on either mainframes, minicomputers or in LANs of microcomputers, which give access to internal and external data for modeling and planning purposes; these software-links support capability (ii);

* the modeling languages are implemented on both mainframes and microcomputers (the latest versions support LANs), which allows a model to be run interactively on the micro or, for large models, either interactively or in batch mode on the mainframe; an efficient way to develop and use planning models is to build the model interactively on a micro and then run it on the mainframe; the use of the mainframe supports (ii) and (iii);

* the DSS-generator normally has a built-in report generator and support for an advanced graphics system, which will allow a novice user to produce professional reports; this supports (iv) and (v);

* modern DSS-generators support various LAN-standards and are linkable to standard computer networks; this supports capabilities (iv) and (v).

To summarize, a decision support system combines a large variety of tools and techniques which support even a novice user in multiple ways with only a few weeks of training. The end-user support is given as self-explaining advice on the workstation.

Decision support systems are built both for routine- and ad hoc use. Standard applications for budgeting and financial planning represent the routine use, and the DSS-application is built to serve multiple users. The ad hoc applications, if we want to categorize, are tailor-made DSS-models built by/for one user to solve some complex problem, normally with numerical information.

DSS tools and methods support so-called "what if"-modeling, i.e. offer possibilities for a fast, efficient modeling and comparison of alternatives. Another feature supported is "goal seeking", which allows a user to define his goals, and then have one of the DSS-tools search for alternatives (described as variables in the DSS-model) which could produce a goal-attainment. DSS tools offer possibilities for a user to explore and test complex inter-dependences among the factors constituting a problem, in order to learn and understand the effects of the interactions and his possibilities for actions.

Decision support systems support decision making, and they may even have a decisive influence on the quality of decisions made by producing insights which would have been impossible without the computer support. In a survey of Finnish DSS-users we found routine applications more frequent than ad hoc models, and that the middle management level had the most devoted DSS-users. Most of the DSS-applications had been built by the end-users, in many cases with the help of professional consultants or graduate students working on master's theses. A majority of the applications were built quickly and without too much expense: a typical use of resources was 2-5 man-months to produce a working prototype.

Decision support systems have fairly quickly been accepted and adopted for practical purposes, as they produce a high service return on investment.

Developments in decision support systems follow three main directions:

* DSS for multiple users are developed for coordination and the construction of planning frameworks in which existing datebase systems are used; the objective is to develop a hierarchical, multilevel and standardized planning system, which runs in a mainframe environment;

* group DSS, which are developed for operative, tactical and strategic planning, and allow a group of planners to use a common set of planning models, and a common database for creative and innovative planning; the group DSS is often built in a LAN;

* personal DSS, which are personal planning and problem solving tools for ad hoc planning and for tackling complex problems; the personal DSS is normally built on a workstation.

Only the multiple-user DSS in a mainframe environment is an investment today, as the technology needed both for the group and the personal DSS is rather cheap.

The survey of Finnish DSS-users indicated that the systems produce some tangible benefits: (i) strategic planning with a DSS becomes more creative, more systematic and produces more alternatives; (ii) problems are solved better and faster, which makes operations more productive; (iii) data, information and knowledge will be more evenly distributed in the organization, as the models applied in a DSS are interactive; (iv) a DSS represents a first formulation of a corporate IT culture, and there are some indications of competitive advantage from the use of DSS.

5. EXPERT SYSTEMS.

Expert systems are "problem-solving computer programs, which can reach a level of performance comparable to that of a human expert in some specific domain" with a definition introduced by Dana S. Nau (1983). Expert systems differ conceptually from traditional computer applications, because the inference structure (which represents program logic) is separated from the knowledge base (i.e. the elements to be operated on). In traditional computer applications data is normally implemented as parameters or starting values of variables, and are thus integrated with the program. Expert systems operate with elements and sets of knowledge, which distinguish them from decision support systems in which the database subsystem is built on numerical data. Systems with a knowledge base need something more than the algorithms, the heuristic rules or the binary logic of decision support systems; the inference structures of expert systems are derived from multi-valued or fuzzy logic to allow for both precise, systematic deduction and common sense or approximate reasoning.

An expert system is normally described as a system of interacting subsystems (cf fig. 2, Trends in Information Technology (1988)):

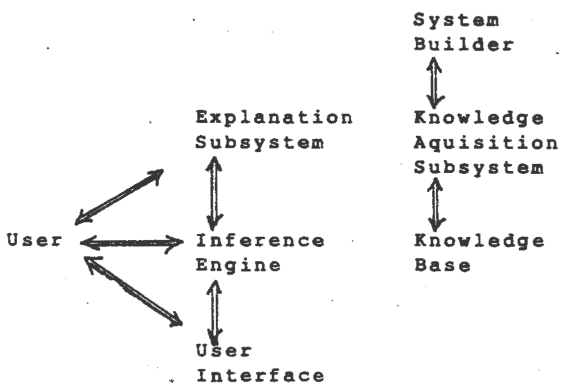


Fig. 2 Architecture of a simple expert system.

The <u>inference engine</u> automatically executes a line of reasoning when provided with the rules and parameters involved in a task, event or problem. The <u>knowledge base</u> contains the rules and parameters related to a task, event or problem. The <u>knowledge acquisition system</u> assists the system builder in recording rules and parameters in the knowledge base. The explanation system traces the system's progress through the reasoning process and provides, on request, a record of the logic supporting a decison. The system builder facilitates the building of an expert system with system development software, the so-called expert system shell, which provides tools for constructing the above-mentioned subsystems and supports knowledge engineers. The user interface manages consultations between users and the expert system when carrying out assigned tasks.

We will not go into details with the inference structures,. or even with the various parts of an expert system, but we will outline the kind of knowledge we should be able to represent and use in an expert system for management support. The knowledge needed and used for strategic planning is an appropriate example: "... the purpose of strategy is concentration of strength against weakness ... strategy is non-obvious management of a system over time ... good strategy must be based primarily on logic, not primarily on experience derived from intuition ..." (cf Henderson (1981)). Obviously, these phrases are too general and too imprecise to allow any kind of inference structure, but let us sample a few more observations (adapted from Henderson (1981)):

* to be successful a company should be stronger than its competitors on success factors which define its competitive niche or market segments;

* the boundaries of market segments are determined by success factors in which competing companies are equally strong;

* for each market segment there is one competitor who defines the segment, the dominating competitor;

* the more variable the environment, the more combinations of success factors may become critical;

* the greater the variety of resources needed, the more combinations of success factors may become critical;

* if one success factor is critically important, only one competitor will survive in the segment;

* pure chance gives the advantage to the competitor who first enters or starts to develop a market segment;

* if two competitors are equally strong, they cannot coexist; one is going to displace the other;

* if there are few competitors and the market is thin, then the generalist has the advantage;

* strong and growing markets eliminate the generalists, since specialized competitors will cut off and keep the generalists out of profitable market segments;

* in a cyclic environment the decisive success factor is the ability to both grow fast in favourable conditions and sustain long periods of adversity;

* as successful operations require multiple resources, there are multiple competitors who could affect operations adversely;

* there should be an individual strategy for each competitor, but adaptation to one competitor will reduce the possibilities to build individual strategies for other competitors;

These observations, which represent common wisdom and generally accepted experience in strategic planning, could be given adequate representation in an inference structure of a management-supporting expert system. They also show the kind of qualitative and informal knowledge needed to construct an expert system as a support for strategic planning - the knowledge should, of course, be much more detailed, with alternative consequences of the inference rules.

With tools for this kind of knowledge representation expert systems offer management support in areas which so far have been inaccessible to systematic analysis: experience and expertise. Then there are some benefits which can be attained through the use of expert systems as management support systems:

* the "cloning" of expertise, which can be distributed and used throughout the organization;

* experts may be replaced with less expert but cheaper people for fairly routine, less demanding tasks, if the necessary expertise is provided with an expert system;

* an expert system may even serve as an expert support system, as its knowledge base may be used as a back-up for the tiring and faulty memory functions of an expert;

* unique but seldomly needed expertise can be stored and used when needed;

* when organizations grow large they tend to become bureaucratic, i.e. a complex system of principles is created in order to simplify and coordinate the handling of various matters ; an expert system can be used to keep track of and explain the procedures and rules needed for handling a large organization;

These benefits are real and important, perhaps most of all because they have been unattainable with traditional analytic techniques. There are also indications of increased productivity as a result of an effective use of expert systems (American Express, Digital).

Expert systems are expected to offer essential competitive advantages in the 1990'es for those companies which make serious commitments to the development and use of expert systems in their planning, problem solving, decision making and operational activities.

6. CONCLUSIONS.

As the first of our three objectives we wanted to find out in what way, and to what extent information technology may contribute to the formation of appreciative systems in senior level management.

Vickers described his appreciative system as "a quest to understand the social process which characterizes human affairs", and Checkland describes its fundamental processes as "a cultural mechanism which maintains desired relationships and eludes undesired ones". In order to be more precise, let us list the various processes of this mechanism and show how information technology may support those processes (cf fig. 3):

appreciative system	supported by
previous experience	expert system, database
standards, norms	expert system
notice of only certain features of situation	graphics, data management, teleconferencing
evaluation of facts against norms	decision support system expert system
regulatory action	

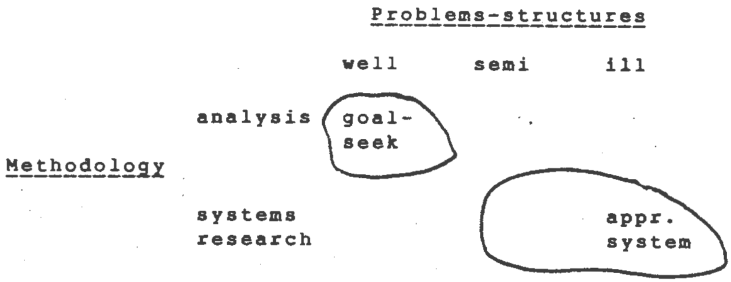
Fig. 3 Appreciative systems and information technology.

As we have shown in our discussion of the various elements of information technology, they offer support for handling qualitative elements of knowledge, which Vickers found missing in the goal-seeking model of social processes. IT-applications can, consequently, be said to contribute to the formation of appreciative systems, but they will probably move the concept much further than Vickers had intended.

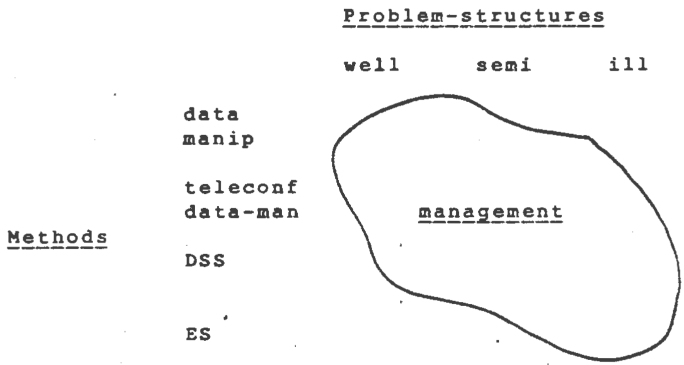
The setting for an appreciative system in Vickers' formulation is a group of senior managers, well-educated, experienced and highly motivated sharing their views on some issue, and then by discussion and mutual education reaching a conclusion, which settles the issue. When we introduce information technology, we also introduce another conceptual framework which presents the issues in another way, and tools and techniques for handling knowledge in ways which previously have not been possible. As a conceptual framework and the formation, transformation and validation of knowledge form the basis for intellectual processes, we may conclude that an IT-supported appreciative system will be different from the one formulated and discussed by Vickers. The ideology of the IT-AS will probably not change.

Let us then turn to the **third** of our three objectives: we wanted to find out if information technology could support Leaders, i.e. if it is possible to support (i) the sharing of responsibility, (ii) communication, (iii) the building and management of an innovative organization, and (iv) strategic ability. On an ideological level we already found that an IT-supported appreciative system supports Leaders, most of all perhaps the sharing of responsibility and the building and management of an innovative organization. The communication is supported by graphics, teleconferencing, LANs and group DSSs, and the strategic ability by expert systems, which help a user to identify essential, causal relationships behind the facts, and decision support systems, which help a user to outline and test the consequences of various alternatives. Our conclusion would thus be, that we at least have the knowledge and the capability, as well as the methods and tools available for supporting Leaders; it only remains for the Leaders themselves to discover this fact.

The **second** of our three objectives was to find out how modern information technology could support the development and use of an alternative methodology (alternative to the traditional methodology producing goal-seeking behaviour). Our original methodological discussion can be described with the following structure:



The introduction of information technology adds new possibilities to this structure:



The field of management research cuts across this structure in rather an interesting way, when compared to the objectives of the various IT-applications. In line with our previous discussion it seems obvious that the introduction of new research instruments before long will raise a new methodology (cf Carlsson (1988)). Intellectual processes need new concepts, and more developed conceptual frameworks in order to thrive and grow, and methodologies should be adapted to the changing needs of intellectual processes (not the other way round). This is the reason why we may conclude that information technology, most probably will support the development and use of a new methodology for management research. Or with a paraphrase of Aldous Huxley: "If you are a senior manager, in all world there is only one small part you for sure can develop, and that is management (i.e. yourself)."

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