DSS AS ENABLERS OF FLEXIBILITY

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ABSTRACT

Globalisation and competitive pressures are increasing volatility and uncertainty for business. Businesses face a variety of risks - legal, environmental, and competitive. Mechanisms for dealing with such risks are usually those concerned with strategy and planning. This paper briefly reviews the background to the increasing need to manage business risk. Information systems can be a means for risk management by enabling organisations to be flexible. While there is some discussion of IT as an enabler of flexibility, there is no investigation of the role of specific technologies such as decision support systems (DSS). Using a variety of examples this research argues that DSS may be an enabler of flexibility, and hence a tool for business risk management. The paper investigates the role of DSS in enabling time, range, intention and focus flexibility and in the metrics which contribute to these – efficiency, responsiveness, versatility and robustness. It demonstrates that DSS enable some of these, but are poor at supporting

others. The areas in which DSS are not supporting flexibility adequately present areas that developers need to address if DSS are going to continue to be a major corporate tool.

1. INTRODUCTION

While the topics of information systems (IS), information technology (IT) and risk management have jointly and separately attracted recent research, the focus is largely on the use of risk management in the process of IT development. There is, however, a reverse relationship in which information systems may be used as mechanisms for managing business risk.

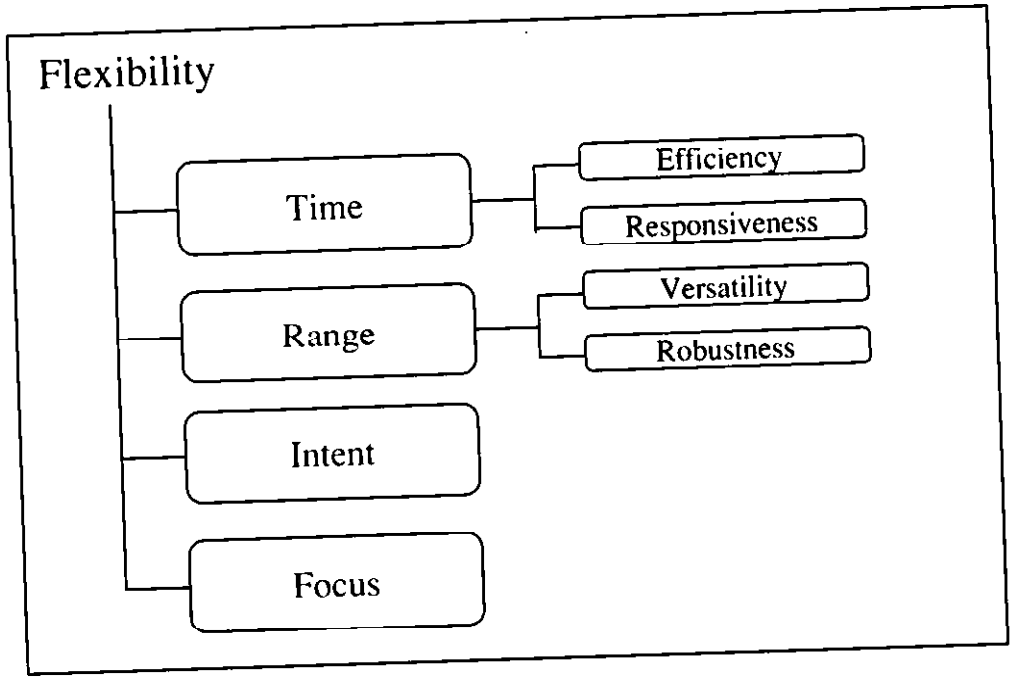

Figure 1 DSS and flexibility

IT is a competitive necessity for many organisations and a source of competitive advantage for others. IT applications, may be the cornerstone of an organisation's overall risk management approach since they can provide the flexibility to react quickly and successfully to a variety of possible changes in the economic, social, and political environment. As such, an IT system that increases an organisations flexibility will enable it to manage risk more effectively.

This paper discusses risk management and proposes that a specific application of IS, decision support systems (DSS), can be used as a risk management tool. The definition of flexibility utilised is that used by Golden and Powell (1997) in their investigation of inter-organisational systems. The purpose of the paper is to demonstrate that the definition of flexibility proposed can be used for other types of IS. Golden and Powell (1997) define flexibility as 'the capacity to adapt' and identify that it may be achieved across four

dimensions: 'time', 'range', 'intention' and 'focus'. The extent of time and range flexibility can be measured by efficiency, responsiveness, versatility and robustness. The intention and focus dimensions are operationalised within the context of the specific DSS. The role of DSS as enablers of flexibility is discussed for each of the dimensions. Analysis of the types of DSS, together with examples, illustrate discussion of the dimensions and metrics of flexibility. This gives insight into the ways in which DSS may be developed in order to become a more useful organisational tool. Figure 1 provides a map of the paper's structure.

2. FLEXIBILITY AND RISK MANAGEMENT

A core component for managing business risk is having the requisite flexibility to handle external and internal changes, i.e. changes in an organisation's or network's socio-cultural environment, its markets (suppliers, competitors, customers), or changes in products, processes, structures, or people (D'Aventi 1994). To be used as tools for enhancing business risk management, information systems, and specific technologies such as DSS, need to provide flexibility.

Lucas and Olson (1994) suggest that IT may contribute to organisational flexibility in three ways. First, by changing the nature of organisational boundaries and the time when work occurs. Venkatraman (1994), too, argues that IT is an enabler of flexible business networks. Boynton (1993) suggests that organisations that wish to compete effectively need to develop cross-organisational information processing capabilities that are flexible, reusable, modular, general purpose and open to links with other platforms both internally and externally. Many of these are characteristics potentially possessed by DSS. Second, Lucas and Olson argue IT contributes to organisational flexibility by altering the nature and pace of work and third, by helping firms respond to changing market conditions.

Some specific components of IT have been documented as sources of flexibility - personal computing (Shim and McGlade 1984), 4GLs and prototyping (Avison et al. 1988) and object-oriented technology (Prager, 1996). There is, as yet, no investigation of DSS roles. However, in terms of Lucas and Olson's suggestions, DSS are typically personal productivity tools. They seldom cross organisational boundaries though the sharing of DSS model-bases may have an element of this. Timing of work may alter with DSS scheduling systems. Similarly, the pace of work may be altered by DSS use, especially those for scheduling and planning. DSS have less impact on the nature of work, aside from supporting managerial decision making. The impact on the type of operations of most organisations is also less apparent.

Information technology may provide flexibility that provide the foundation for rapid response to changing market conditions. This may be as a result of the IT architectures (Allen and Boynton, 1991) or more responsive IS (Picot et al, 1993). Monteiro and Macdonald (1996) conclude that underlying IT architectures can be a tool that provides flexibility. They use the example of airline reservation systems. Underlying these systems are DSS models. For example, most reservation systems are driven by revenue management systems (RMS) that enable airlines to respond quickly to competitors' actions. RMS maximise revenues by segmenting the aircraft seats on offer and trying to sell them to different customer groups. Prices charged, which may change several times a day, depend on availability and past trends in bookings. Special events, the actions of competitors and connecting flights are all monitored and used as inputs to the DSS. These systems also demonstrate the link between DSS for planning and DSS for implementation.

Table 1: DSS contribution to flexibility

FLEXIBILITY FROM DSS						
Dimension	**Time**		**Range**	**Intention**		**Focus**
DSS Role	Improve/speed up decision making		Model foreseen Reveal Unforeseen	Planning		Co-ordination Collaboration
Metrics	Efficiency	Respons ive-ness	Versatility	Robust-ness	[Context Specific]	[Context Specific]
DSS Types	Improve Operations, Specific DSS, Financial Modelling	DSS Tools, DSS Generat ors	'What if' Modelling, Vision Support Systems, Scenarios, Creativity Support Systems, Heuristic DSS, Strategic DSS, Simulation, Forecasting, Conversational DSS	'Now that' Modelling Planning, Risk Analysis, Cognitive Mapping Insight Systems	Creativity Support Systems, Scenarios Exception/ reactive DSS, 'What if' 'Now that' Conversat-ional DSS	Environmental Scanning, Intelligent Databases Supply chain manage-ment Collabor-ative forecasting
Examples	FIPS, Audit Staff Scheduling	Revenue Manage ment Systems	IdeaFisher, Ideatree, IRS Quality Program	COPE	FPS HANS WHIMS	FIPS Container Shipping

Flexibility is the capacity to adapt, and DSS can play a crucial role in this capacity. Golden and Powell (1997), in their attempt to define flexibility comprehensively, identify that the ability to adapt may be apparent in four dimensions. First, in terms of the 'time' it takes an organisation to adapt (Eppink, 1978; Gustavsson, 1984; Upton, 1994). Here the predominant DSS role is to speed up operations and decision making. The second dimension is 'range': the number of options that an organisation has open to it for change that was foreseen and the options available to react to unforeseen change (Krijnen, 1979; Carlsson, 1989; Eardley et al., 1997). DSS models can reveal the unforeseen and help to model the foreseen. Third is the 'intention' dimension, the extent to which the flexibility is proactive or reactive (Evans, 1991; Avison et al., 1995; De Leeuw and Volberda, 1996). In this instance, DSS use is about planning. The final dimension is 'focus'; whether the flexibility is gained internally or by managing external relationships (Ansoff, 1965; Das and Elango, 1995). Here the DSS role is as a co-ordinating mechanism. The place of DSS in each of these dimensions is investigated.

Golden and Powell further identify four metrics of flexibility; 'efficiency', 'responsiveness', 'versatility' and 'robustness'. These relate to the first two dimensions of flexibility. Efficiency and responsiveness are measures of the time dimension, while versatility and robustness describe range. Efficiency measures the degree to which organisations meet challenges within time constraints. The traditional role for DSS is in enhancing efficiency through improved decision making and better operations. Responsiveness measures the time to adapt to new circumstances. DSS aid responsiveness by having a pre-developed set of models available as the environment changes, or, with DSS generators and tools, allowing the rapid development of specific DSS. Angehrn

(1993) distinguishes 'vehicle DSS', the kernel of which consists of a specific problem solving and problem structuring technique and 'toolbox DSS' that provide loosely coupled sets of tools. The former will, in most instances, enable far greater flexibility than the latter. Yet, vehicle DSS may be superior in enabling rapid response. Versatility is the capability to respond to situations that are foreseen, and robustness the ability to adapt and respond to changes unforeseen. 'What if' and 'now that' modelling enhance versatility. Again, the role of DSS in each of these metrics is considered.

Table 1 demonstrates the dimensions and metrics of flexibility together with the roles and types of DSS for each. Exemplar systems for each category are given.

3. TIME

The first dimension of flexibility, time, describes how long it takes an organisation to respond to environmental changes. Time is usually seen in the 'traditional' decision tricotomy of operational, tactical and strategic (Gustavsson 1984) or operational, competitive, and strategic (Eppink 1978). Operational problems are short-term, e.g. planning due to machine breakdowns or unexpected raw material shortage. Traditionally, there has been a major role for DSS models here. Tactical problems are medium-term e.g. changes in design or in the rate of production. Again this is a traditional DSS role. Strategic problems are long-term, e.g. major investments in machinery or business expansion. While there is a lesser DSS role here, primarily in modelling investment problems, there may be a developing one in wider strategic support.

For example, Loebbecke et al (1996) demonstrate a DSS for a store chain called FIPS (Fashion Information and Planning System) embedded in a merchandising system. It centralises purchasing power and streamlines the physical distribution of goods. It is dependent on tools to provide decision support and to increase the decision capacity of purchasing managers. Four operational modules and the integrated DSS 'FIPS' cover the process from ordering goods to delivery to stores. FIPS has two decision support modules: 'Fashion Information System' and 'Purchase Planning and Control'.

The *'Fashion Information System'* covers all information on sales, inventory, and sales price reductions in the stores, and ensures high data consistency, fast and flexible data availability, and easy and secure data input. *'Purchase Planning and Control'* is mainly used biennially to plan sales and demand on the basis of various categories of goods.

FIPS increases the range of products, and, thus, improves the competitive positioning. Lower sales price reductions, reduced inventory, and more complete ranges in the stores resulting in higher turnover are attributed to the system. FIPS has changed the processes underlying the purchasing and sales functions, strengthened the purchase versus the sales function and streamlined patterns of distribution.

This system clearly contributes to time flexibility as it enables a faster response to market changes. More specifically, it has a role in efficiency and responsiveness, the two measures of temporal flexibility.

3.1 Efficiency

Anderson (1993) defines manufacturing flexibility as the ability of the system to accommodate change with minimal degradation of performance. Upton (1994, 1995) describes efficiency as the ability to maintain uniformity of a performance measure, such as yield or quality, within a production range. Avison et al. (1995) propose that flexibility can

be measured by the extent to which it improves the quality of internal resources. The capability to react in an efficient manner is a key component of flexibility. Thus, one metric of flexibility is the ability to maintain efficiency while accommodating or adapting to change. DSS can reveal what is feasible within current organisational constraints and can allow the modelling of production constraints.

Butters and Eom (1992) review DSS in health care and find most are efficiency-oriented, concerned with allowing management to understand current cost behaviours, though in modelling such activity, these systems contribute to the responsiveness and versatility of the organisation too. In a typical example of DSS use, Balachandran and Zoltners (1981) demonstrate a DSS for audit staff scheduling. This integer programming model is efficiency-focused, as it balances team experience, availability, compatibility and preferences.

3.2 Responsiveness

The ability to respond to change within an appropriate time frame is an important metric of flexibility. Eppink (1978) proposes that organisations develop flexibility by increasing their capacity to respond to environmental changes. Speed of response is vital (Avison et al. 1995). Das and Elango (1995) define responsiveness as nimbleness and swiftness to explore external opportunities, while reducing the impact of threats. Volberda (1996) outlines one of the metrics of flexibility as the rapidity with which organisations can implement procedures to respond to changes. DSS have a clear impact on responsiveness. In the FIPS example, the DSS enables the department store to respond to market and fashion changes.

4. RANGE

The second dimension of flexibility is adaptability to foreseeable and unforeseeable changes. Eppink (1978) suggests that flexibility is a strategic response to the unforeseen. One way to achieve this is by planning for developments that are likely to occur, that is, for foreseeable events. A second way is by adapting to unpredictable or unforeseeable circumstances. Carlsson (1989) identifies two types of flexibility. The first relates to risk and involves planning for foreseeable events. The second is about uncertainty and making appropriate use of new, disclosed opportunities and responding rapidly to unforeseen changes.

Most current DSS are concerned with tactics and planning. They are successful in supporting decisions used for short-term, incremental, opportunistic moves based on current, rather than future, requirements. Thus , they are targeted to support change which is anticipated and thus can be modelled. However, there are moves to make DSS more useful for unforeseen changes. For example, Loebbecke et al (1998) offer DSS for vision, vision support systems (VSS), as a way that DSS tools and techniques may be applied to support business vision. This suggests that DSS can be employed to reveal the unforeseen. DSS can also be employed to enhance reaction time. This is especially the role of 'now that' modelling. The metrics for range are versatility and robustness.

4.1 Versatility

Versatility measures the extent to which the organisation has planned for, and can respond to, environmental change. Versatility measures the range of activities for which the organisation has contingency plans. These plans are formulated on the basis of changes that could be foreseen. Krijnen (1979), in the case of the foreseen, argues that a flexible organisation alters itself by taking into account developments which are likely to occur.

Versatility measures flexibility within a specific range of possible future options allowed for, or planned for, to accommodate foreseen future changes. That range is determined by the organisation's planning capabilities. Versatility measures the flexibility that an organisation possesses to react to changes in the environment that it could envisage. DSS have always had a role in planning. Usually this is via static planning models but it can encompass 'what if' models, forecasting and scenario development. There may be elements of versatility in VSS and creativity support, but this is typically used to support the intention dimension of flexibility.

While temporally-oriented DSS are usually the domain of lower and middle management, versatility-oriented DSS are typically used by senior management. However, DSS are seldom use by senior management since they are neither built appropriately for such users nor do they address strategic issues. While DSS have been built to support strategic decision making, they are largely unsuccessful. Strategy-oriented DSS need to reflect the relationship between the organisation and its environment (Liang and Tang 1991). As the environment changes, DSS based on short-term strategic objectives may inhibit rather than support evolving business strategy. Most current DSS tend to concentrate on quantitative, financial, short term, internal information while senior managers require qualitative, long term external data (Brezillon and Pomerol, 1996; Courbon, 1996). King suggests that the role of strategic DSS is to deliver competitive advantage. Hence, systems must directly address unstructuredness and so, support the intelligence and design phrases of the decision process. Chung et al. (1989) demonstrate the components of a strategic DSS. However, Bodi and Lee (1989) maintain that DSS can really only support structured and semi-structured situations for which a model can be developed. They argue that the failure of management information systems is because they do not help in solving novel, unstructured problems. Strategic DSS must enhance senior managers' mental models and improve the ability to access, combine, present and analyse models and to test the results. Reagan-Cirincione et al (1991) feel strategic decision making is a social and political, not solely an intellectual, task and that it is the process of building the model rather than its use that has greatest value. Strategic decisions are improved when the decision makers benefit from the process of model building (Bui and Loebbecke, 1996). DeSanctis et al. (1991), for example, describe a GDSS for the US Internal Revenue Service which has elements to gather ideas, evaluate the ideas and a set of models for problem analysis.

A prime example of systems designed to enhance versatility is vision support systems. These encompass scenario development systems, insight systems and exploratory systems. Enhancing decision makers' vision capabilities goes beyond being uncertain about the range of potential outcomes since one necessary element of a VSS is the development of those outcomes. Decisions based on creation and innovation are of critical importance. Such decisions superseded those based on analysing and reacting to rivals' strategies. It is 'creative visions, and derived [decisions and] strategies, that provide a longer term view of

what customers and end users really aspire, that hold the key to the industries of tomorrow' (El -Namaki 1992).

A second example is scenario development systems. Scenarios may be exploratory or anticipatory (Bunn and Salo 1993). An exploratory scenario starts at the present and unfolds the consequences of the present into the future. The resulting scenarios tend to be realistic but not insightful and, thus, may neglect occurrences that can arise in ways other than from a single identifiable cause. In terms of the discussion here, this is about the foreseen and is an aspect of versatility. On the other hand, anticipatory scenarios are built by searching for possible causes which could lead to a given future state. There is more emphasis on goals and explanations rather than consequences (Loebbecke and Bui, 1996). DSS based on these are about the unforeseen and, therefore, support robustness.

The third type of versatility-oriented DSS are creativity support systems (CSS) (Massetti 1996). Generative CSS encourage divergent ways of thinking, remote association and pattern switching. The other category of systems is exploratory which involves elaboration or successive refinement of ideas. In similar vein to creativity support systems are conversational DSS (Angehrn, 1993). These systems also attempt to enhance creativity, but are based on a socio-political approach to support human decision making. Such an approach is claimed to offer a more natural setting for problem exposure, discussion and exploration and thus to stimulate reflective learning.

The final example of versatility enhancing DSS are heuristic information systems (Lundberg, 1990). These are used as 'advisory systems' which can support a user in performing a task, particularly for generating alternatives.

4.2 Robustness

While versatility concentrates on the foreseen, robustness is about the unforeseen. Robustness is the ability to respond successfully to unforeseen environmental change (Eppink, 1978). Best et al. (1986) propose robustness is concerned with maintaining flexibility under conditions of uncertainty. Plans are robust to the extent that they contribute to anticipated satisfactory performance of a large number of configurations under many futures. Robustness is the ability to maintain flexibility in a future which cannot be predicted or foreseen with any degree of certainty. This is the domain of planning DSS. Model-bases for this type of flexible DSS are needed for analysing the environment, identifying strategic opportunities (triggering events) and modifying existing applications or developing new systems to meet these opportunities. Three components are critical (Eardley et al., 1997), and DSS have a major role in the first, the capability to model the firm's intended strategy to guide the process. This model may be explicit or tacit, and may be prescriptive or descriptive. Second, analysis techniques should exist for creating 'mechanisms' by which the strategy may be carried out. Third, an appropriate technology 'infrastructure' should be available to put the mechanisms into place. Eardley et al. (1997) suggest a model base that has a *descriptive* tool (for idea generation) and an analysis technique as a *prescriptive* tool used to filter the strategies or manoeuvres created into strategic applications. Feeny and Ives (1990) point out, that there may be a DSS role for the second stage since, 'much of the previous work has focused on frameworks to support "idea generation", but "idea filtration" may be a considerably richer target of investigation. While some sort of risk analysis may help filter ideas, this is only appropriate for quantitative models. The real goal here is for DSS to provide tools to make the unforeseen, foreseen. While it might be argued that any modelling approach does this to some extent

by concentrating on the major issues, structuring the problem, and allowing simulation, again there is a need to go beyond this as most techniques are specific and aim at a single objective or target rather than suggesting a range of possible options. Golden et al. (1986) describe these as decision insight systems. Tools such as COPE (Eden et al , 1985) that enable cognitive mapping have a role here. These tools will need to provide more long-term needs (and therefore provide strategic support) than systems identified from operational needs such as increasing efficiency or removing bottlenecks.

5. INTENTION

The third dimension of flexibility acknowledges that, while environmental change is inevitable, organisations are not necessarily victims, they may try to pre-empt, use or tame the environment. Intention concerns the extent to which organisations are offensive or defensive (Avison et al., 1995; Evans, 1991). Offensive organisations attempt to control change in the environment to gain competitive advantage. Defensive organisations will hope to withstand change and to make the best of it once it the change has occurred.

There are DSS roles in supporting intention. For offensive organisations these entail sophisticated scenario development and use of 'what if' models. However, as with developing robustness there is much more need for creativity support here as future scenarios need to be envisioned (Eardley et al, 1997). In contrast, defensive organisations react to changes and try to minimise the impacts. This suggests a role for complex "now that" modelling. While it is unlikely that specific DSS can be pre-built for this (as this presupposes knowledge of the future), DSS tools and DSS generators to allow rapid development of prototype specific DSS have a role. Using such DSS to be a fast second in the market (especially one dependent on technological changes) may be advocated as an appropriate strategy.

DSS for supporting intention include planning system, creativity support systems, exception reporting systems and conversational DSS. Examples of DSS supporting intention include HANS (Forgionne, 1991) which uses econometric models of need to support the planning and allocation of military housing and WHIMS (Miller and Katz, 1986), a model management system to support policy analysis.

6. FOCUS

The final dimension of flexibility is focus which may be internal or external. Internal flexibility can arise from such aspects as manufacturing, employee flexibility and organisational structure (Das and Elango, 1995). External flexibility is provided by suppliers, alliances, and multi-national operations.

Organisational flexibility is provided through structure. Krijnen (1979) proposes that organisations can obtain flexibility by altering their structure to suit their competitive situation. Bolwijn and Kumpe (1990) believe that an appropriate organisational design is based upon the creation of fast feedback loops, enabling processes to react quickly to changes, while retaining reliability. This suggests a role for DSS in providing both ad hoc and programmed responses, and exception reporting. In essence this type of DSS-enabled flexibility is akin to efficiency-oriented DSS - they enable rapid responses.

There is less role for DSS to enable external flexibility. An organisation can increase its external flexibility by increasing its ability to switch, at short notice, between the products its suppliers produce and also by the ability to switch suppliers if necessary (Piore and

Sabel, 1984). DSS might have a role in environmental scanning and in maintaining intelligent databases of potential collaborators' abilities. Forecasting DSS may also play a role here.

The idea of the network firm and the external flexibility it creates is central to new concepts emerging such as 'adaptive channels' (Narus and Anderson, 1996) and 'quick response' (Richardson, 1996). Adaptive channels are situations where organisations have worked with their distribution channels to make them more flexible and responsive (Narus and Anderson, 1996). Quick response is a strategy for linking retailing and manufacturing to provide the flexibility to respond quickly to shifting markets (Hammond 1990). This is evidenced in the FIPS fashion DSS described earlier. Further, Shen and Khoong (1995) describe a DSS for container shipping where collaboration and co-ordination is the key attribute.

7. DISCUSSION AND CONCLUSIONS

Developing DSS to enable flexibility requires the use of development methods that seek to produce systems based on a broader or more abstract perspective of the systems requirements than business rules or processes. Systems based on a data model are more flexible than those based on models of processes or rules (Eardley et. al., 1997). Further, methods which try to include design inputs from a wide range of stakeholders are claimed to be more robust, as these stakeholders are often able to forecast future changes. Modular DSS will, themselves be more flexible than other types and will allow applications to be developed more quickly and more economically due to module re-use. Both relational technology and object-oriented technology have been claimed to give inherent flexibility (Avison et. al., 1988; Prager, 1996). Yet, IT and hence DSS may cause rigidity and inflexibility (Allen and Boynton, 1991; Lambert and Peppard, 1993; Avison et al., 1995). Boynton (1993) argues that a reason for inflexibility is that existing information architectures are geared towards particular competitive conditions and that new systems for new conditions contain an organisational change challenge. Eardley et al. (1997) argue that rigid information systems (and therefore DSS) *inhibit* the ability of organisations to exploit opportunities by preventing a change in strategy.

DSS have proved themselves to be valuable personal productivity tools. However, they have not contributed to strategic and inter-organisational productivity in the way that their early promise suggested. Yet, there are developments in this domain such as MRP and supply chain management which involve DSS for collaborative forecasting. This paper has attempted to assess the reasons for this by evaluating DSS role in enabling a key organisational requirement - flexibility. The paper has defined flexibility and broken it down into its four dimensions -'time', 'range', 'intention' and 'focus'. For each of these the role of DSS has been explored. The paper has also taken the analysis further by identifying the key metrics of flexibility for each dimension and then categorising the types of DSS that may contribute to each. Examples of each are given. This work highlights DSS strengths and weaknesses as flexibility enablers. DSS are revealed to contribute primarily to efficiency and versatility. They can play some role in intention and a minimal role in responsiveness and robustness. There does not appear to be a co-ordination role for current DSS. This analysis identifies the areas that developers need to address if DSS are going to continue to be a major corporate tool.

8. REFERENCES

Allen B. & Boynton A. (1991). Information Architecture. MIS Quarterly December, pp.435-445.
Angehrn A., (1993). Computers that Criticize You, Interfaces, 23(3), pp.3-16.
Anderson S. (1993). Measuring manufacturing flexibility. Harvard Univ., Cambridge, MA.
Ansoff H. (1965). Corporate Strategy, McGraw-Hill, New York
Avison D., Fitzgerald G. & Wood-Harper A. (1988). Information Systems Development. The Computer Journal 31(4), pp.379-380.
Avison D., Powell P., Keen J., Klein J. and Ward S. (1995). Addressing the need for Flexibility in Information Systems. Journal of Management Systems 7(2), pp.43-60.
Best G., Parston G., & Rosenhead J. (1986). Robustness in Practice. Journal of Operational Research Society 37(5), pp463-478.
Bodi A. and Lees C. (1989), Executive Support Systems, working paper, Monash University.
Bolwijn P. & Kumpe T. (1990). Manufacturing in the 1990's - Productivity, Flexibility and Innovation. Long Range Planning 23(4), pp.44-57.
Boynton A. (1993). Achieving Dynamic Stability through Information Technology. California Management Review Winter, pp.58-77.
Brézillon, P. and Pomerol, J.-C. (1996), Misuse and nonuse of Knowledge-based Systems, in: Implementing Systems for Supporting Management Decisions: Concepts, Methods, and Experiences, ed. by P. Humphreys et al., Chapman & Hall.
Bui, T. and Loebbecke, C. (1996), Supporting Cognitive Feedback Using System Dynamics, *Decision Support Systems*.
Bunn D. and Salo A. (1993), Forecasting with Scenarios, *European Journal of Operational Research*, 68(3), pp.291-303.
Carlsson B. (1989). Flexibility and the theory of the firm. International Journal of Industrial Organization 7, pp.179-203.
Courbon, J.-C. (1996), User-centered DSS design and implementation, in: Implementing Systems for Supporting Management Decisions, ed. by P.Humphreys et al., Chapman & Hall.
Chung C., Lang J., Shaw K., (1989), An Approach for Developing Support Systems for Strategic Decision Making in Business, Omega, 17(2), 135-146.
Das T. & Elango B. (1995). Managing Strategic Flexibility. Journal of General Management 20(3). pp.60-75.
D'Aventi R. (1994). Hypercompetition: Managing the dynamics of strategic manoeuvring, The Free Press, New York.
De Leeuw A. and Volberda H. (1996). On the Concept of Flexibility. Omega International Journal of Management Science 24(2), pp.121-139.
DeSanctis G, Poole M., Desharnais G. and Lewis H., (1991), Using Computing to Facilitate the Quality Improveemnt Process, Interfaces 21(6), pp.23-36.
Eardley A., Avison D. and Powell P. (1997). Developing Information Systems to Support Flexible Strategy. Journal of Organizational Computing and Electronic Commerce 7(1), pp.57-77.
Eden C., Smithin T. and Wiltshire J., (1985), COPE User Guide, Strathclyde Business School.

El-Namaki, M.S.S. (1992), Creating a corporate vision. *Long Range Planning*, 6(23), pp.25-29.
Eppink D. (1978). Planning for Strategic Flexibility. Long Range Planning 11, pp.9-15.
Evans J. (1991). Strategic Flexibility for High Technology Manoeuvres. Journal of Management Studies 28(1), pp.69-89.
Feeny, D.B. and Ives, B. (1990), In search of sustainability: reaping long-term advantage from investments in IT, *Journal of Management Information Systems*, Vol.7, No.1.
Forgionne C., (1991) HANS: A DSS for Military Housing Managers, Interfaces, 21(6), pp.37-51.
Golden B., Hevner A. and Power D., (1986), Insight Systems, Computers and Operational Research, 13(2/3), pp.287-300.
Golden W., and Powell P., (1997), Inter-Organisational Information Systems and the Gains from Organisational Flexibility, in Procs of 5th European Conf on IS, Cork, pp.266-280.
Gustavsson S. (1984). Flexibility and productivity in complex production processes. International Journal of Production Research 22(5), pp.801-808.
Hammond J. (1990). Quick Response in the Apparel Industry. Cambridge, MA: Harvard Business School, 9-690-038
Krijnen H. (1979). The Flexible Firm. Long Range Planning 12, pp.63-75.
Lambert R. and Peppard J. (1993). Information technology and new organisational forms. Journal of Strategic Information Systems 2(3), pp.180-205.
Liang T-P. and Tang M-J., (1991), VAR Analysis, *Data Base*, 23(1), Winter, pp.27-35.
Loebbecke, C., Kronen, J. and Jelassi, T. (1996), The Role of IT in Retailing: The Case of Supporting Fashion Purchasing, *Journal of Strategic Information Systems*, (5), pp.67-78.
Lundberg B., (1990), On the Evaluation of Heuristic Information Systems, *Decision Support Systems*, 6.
Lucas H. & Olson M. (1994). The impact of information technology on organizational flexibility. Journal of Organizational Computing 4(2), pp.155-176.
Loebbecke C., P. Powell, A. Eardley, D. Avison and T. Jelassi, (1998) Limits To DSS: Supporting Vision, Creativity and Future Thinking, Journal of Decision Systems, 6(4), pp.317-331.
Miles R. and Snow C. (1986). Network Organizations: New Concepts for New Forms. California Management Review 28(3), pp.62-73.
Miller L. and Katz N., (1986), A Model Management System to Support Policy Analysis, Decision Support Systems, 2, pp.55-63.
Monteiro L. & Macdonald S. (1996). From efficiency to flexibility. Journal of Strategic Information Systems 5, pp.169-188.
Narus J. and Anderson J. (1996). Rethinking Distribution. Harvard Business Review July-Aug, pp.112-120.
Picot A., Nuuburger R. & Niggl J. (1993). Management perspectives of electronic data interchange systems. International Journal of Information Management, 13, pp. 243-248.
Piore M. and Sabel C. (1984). The Second Industrial Divide, Basic Books, New York, NY.
Prager K. (1996). Managing for Flexibility: The new role of the aligned IT organisation. Information Systems Management Fall, pp.41-46.
Richardson J. (1996). Vertical integration and rapid response in fashion apparel. Organization Science 7(4), pp.400-412.
Sabel C. (1982). Work and Politics, Cambridge University Press, Cambridge.
Shen W. and Khoong C., (1995) A DSS for Empty Container Distribution Planning, Decision Support Systems, 12.

Shim J. & McGlade R. (1984). The use of Corporate Planning Models. Journal of the Operational Research Society 35(10), pp.885-893.
Te'eni, D. (1990), Support Systems for High Level Policy Making, *Information and Management*, 19(1).
Upton D. (1994). The management of manufacturing flexibility. California Management Review Winter, pp.72-89.
Upton D. (1995). What Really makes Factories Flexible?. Harvard Business Review July-Aug, pp.74-84.
Venkatraman, N. (1994). IT-Enabled business transformation. Sloan Management Review Winter, pp.73-87.
Volberda H. (1996). Toward the Flexible Form. Organization Science 7(4), pp.359-374.