11

Management support systems principles and concepts

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Providing information to management is much more than an intellectual challenge: it is the art of organizing complexity, of mastering multitude and avoiding its bastard chaos as effectively as possible. (Adapted from Dijkstra 1982)

This chapter reviews the concept of management support systems (MSS) - their purpose, solution techniques and development methodologies. MSS is a category of software solutions that are intensely user oriented and includes systems known as Decision Support Systems (DSS), Executive Information Systems (EIS), Executive Support Systems (ESS), and Expert Systems (ES). These various systems are categorised by purpose, a definition is developed for each and their function described.

The term MSS is used here to refer to any computer based system that aims to support a manager or professional in a decision making environment. It is an extension of the older concept of a DSS to include a wider range of computer based support systems. MSS has a wider meaning than just the quantitative models that have traditionally been referred to as DSS.

MSS are supported by the use of various modelling methods. The role of both analytical and non-analytical models is discussed together with a brief outline of what each method entails. Next, the alternative development methodologies, crucial to the successful implementation of an MSS, are presented and discussed briefly in the context of this paper. Finally, the role of MSS as a potential factor in organisational change is explored, especially when used by senior management as is the case for an EIS.

DSS, MIS and MSS

The term decision support system is used by many different groups in the computer industry, in management, and amongst workers in operations research. One of the traditional views of DSS is that it implies the use of mathematical or statistical models. Such systems focus on a single or recurring decision area and will usually support one decision maker or a small management team working on the one management problem. The problem must be at least semi-structured, but is more likely to be based on a well structured problem and the resulting

DSS is model oriented. Standard operations research tools such as linear programming, queuing theory, inventory theory and simulation (Turban 1993) are well suited to such systems. This type of decision support system is problem oriented with a major contribution of the system being in the area of problem definition. A disadvantage is that being problem oriented the system must continue to be restructured, updated or expanded as the problem changes.

This definition of a DSS is too narrow. No matter how it is viewed, the process of management is fundamentally one of decision making, and the process of making decisions and acting on them is the business of management. Any decision support system must contribute something tangible to the decision making process. It must either enable the manager to make the decision more efficiently, or enable the manager to make a more effective decision. Hence the increasing use of the term MSS to include any computer based system that supports a decision making process.

Another type of MSS is the computer based system which transforms data into information which is useful in the support of decision making. It is commonly referred to as a management information system (MIS) (Thierauf 1987, Turban 1993). It is characterised by the use of internal data which is often stored, manipulated and reported on using relational data base technology. Management use is usually restricted to reports that may be printed or reviewed on screen although access to the MIS using a structured query language (SQL) may be given to management in some cases. However, unless the decision maker is a computer professional or occupies the lower levels of management it is unlikely that enough time will be invested in learning the query language for this to be useful. In fact the manager is unlikely to learn enough for the integrity of the MIS to be secure.

By their nature the development of an MIS tends to require a long lead time. They require a large investment in the analysis of the problem and of the data that will be processed to provide the information.

Considering automation and the state of computing technology today, it is common to see office automation and computing support for all levels of management in both private and government organisations. That technology cannot supply management support in isolation. The state of the technology is such that with the purpose that an MSS implies, it can bestow great benefits on the user in terms of productivity and effectiveness. Equally, without that purpose, an ill defined system will bestow confusion, lack of direction and worts of all it will distract the manager from the complex decision processes that it is supposed to support.

Management levels

Decisions are made by people and DSS are designed to support those people. That we now see an emphasis on the term *user oriented* (Thierauf 1988) implies that that component of decision support systems may not have received sufficient attention in the past. Some of the work in the field categorises decision makers according to their place in the hierarchy, and according to the types of decision making that they engage in (Jaques 1976, Khadem 1986, Rockart 1988). This has been discussed elsewhere (Whymark 1989, 1991a), but a summary of some of the concepts is presented here to help establish the place that the function of management has in the development of MSS.

The information needed to support decision makers at opposite end of the management hierarchy is fundamentally different. Figure 11.1, taken from Thierauf (1987, Figure 3.2) divides it into *control information* and *planning information*. Lower management will spend almost all of their time using control information which tends to be centred on the internal environmental factors. On the other hand, the information required by top management will largely be planning information that centres on the external environmental factors. Government guidance on financial expenditure is a good example of the latter in public administration.

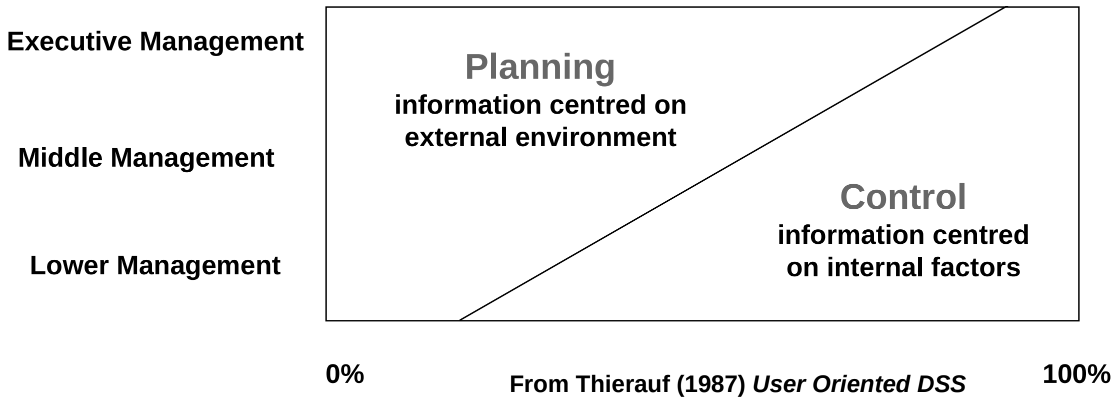

Figure11.1 Information requirements for control and planning processes. *Source: Thierauf (1991)*

Elsewhere, Thierauf (1988, page 36) categorises the decision maker according to the type of activity using a similar model to that first described by Jaques (1976). Figure 11.2 (taken from Whymark 1991a) is a simplification of the model and is a useful guide in identifying the type of DSS required. Lower management is concerned with operational control. Therefore the type of information required is often detailed and accurate, and is sourced from within the organisation. The middle manager, according to this model, is concerned with organising programs into systems of work and ensures that goals are being met. The activity is referred to as managerial control and is tactical in nature. Reports that support this type of activity need to be comprehensive and may include some external information.

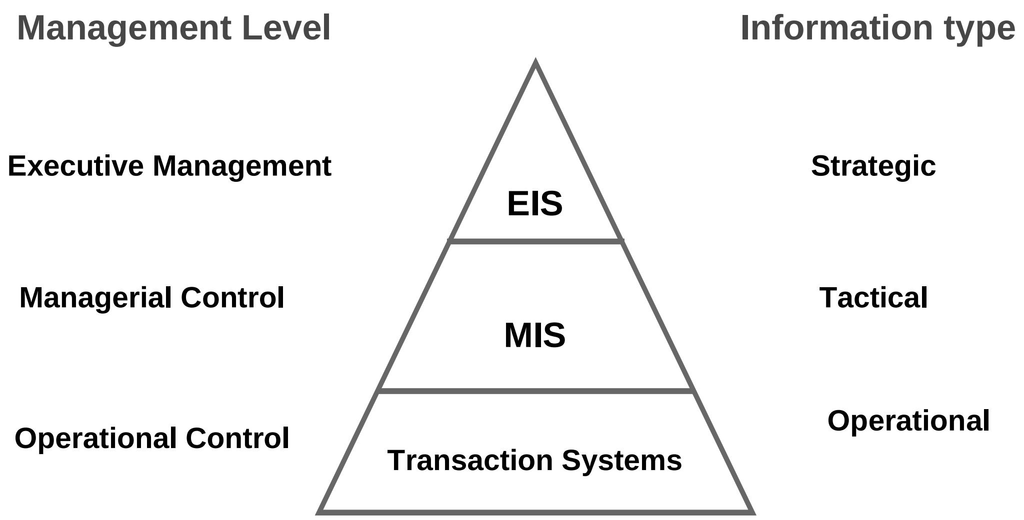

Figure 11.2 Management level and information need. *Source: Whymark (1991a)*

As an example, the use of the characteristics of executive management to identify a system that supports executives (EIS) is described in Whymark (1991a), Watson (1992), and Turban (1993) among many others. Such managers are characterised by the strategic nature of their decision making, their long term goal seeking, and the higher level of abstraction in the mental models they use in managing their corporate affairs.

Components of information support systems

Another way of viewing and categorising an MSS is from the technology viewpoint. Figure 11.3, adapted from Sprague (1980, 1993) shows a convenient and often used description of four major components of a DSS. These are the database management system (DBMS), the model base management system (MBMS), the dialogue generation and management system (DGMS), and the most important, the user. Another component added by recent authors (Turban 1993) is the Knowledge Base Management System (KBMS), in recognition of the role knowledge base systems play in information support systems.

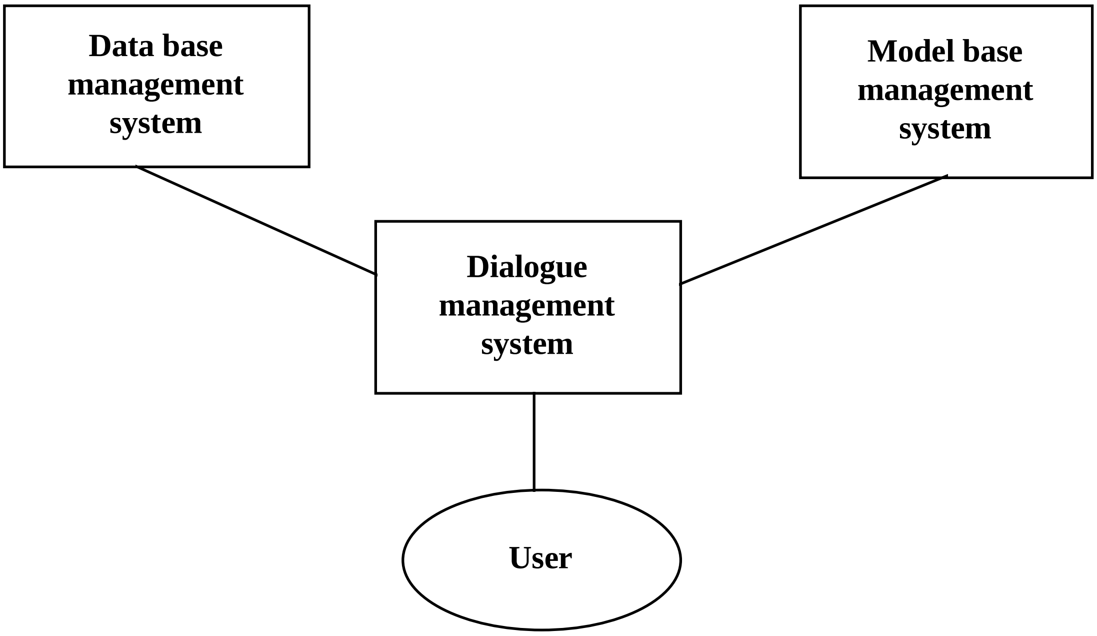

Figure 11.3 Components of information support system. *Addapted from Sprague & Watson (1993)*

The model is used here to help describe the components of all management support systems. In doing so, the discussion has been kept as brief as possible as space precludes describing each modelling technique. Turban (1993) and many others provide further reading and references.

Modelling in MSS

There is much discussion about the relative merits of expert systems (ES), DSS, operations research and artificial neural networks. Often each is represented as an alternative to DSS. In reality each of these techniques is but one in a range of modelling techniques that can be used to form all or part of the model base for an MSS. The modelling techniques are described elsewhere (Turban 1993) and the discussion here concentrates on their relationship and their application in the decision making environment.

The use of models enables the analysis of large and complex scenarios. They can compress time for the decision maker, and allow the manipulation of variables to play *what-if* and *goal seeking* exercises as part of the decision making process (Turban 1993). They also enhance and reinforce learning, and providing they match the decision makers mental model of the decision environment, they can also greatly enhance the decision makers ability to reduce the complexity to simpler and easily handled decisions. The DBMS component also plays a part in this process.

To the non mathematically inclined, the concept of modelling can seem to be little more than a black art. However, the various modelling techniques can be treated as parts of a toolbox from which the appropriate tool for the job is selected.

The overlap of the different modelling techniques is illustrated by Figure 11.4 (Smyrk 1992). This figure is a simple venn diagram drawn in the problem space of MSS. Each technique is suitable for use with certain problems, and for parts of the problem space more than one technique will perform. It depends on the skill on the MSS developer to choose the one that is most appropriate. Even without specific examples, it is now clear that a one method toolbox will no longer suffice.

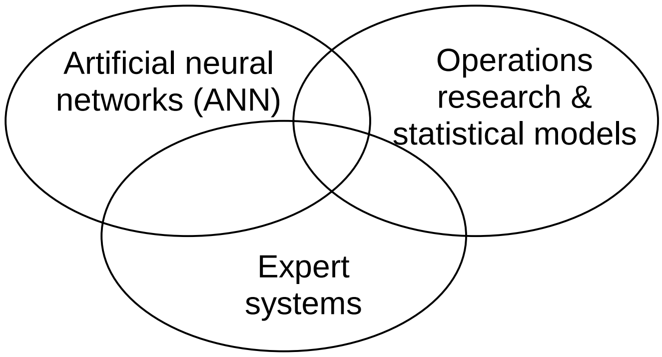

Figure 11.4 Techniques used to model information and knowledge. *Source: Smyrk (1992)*

Data structures for MSS

Data models play an important role in MSS, far bigger than in most traditional DSS. The reason for this is twofold. First, the improvement in data base technology and distributed systems has made the access to data far easier for the MSS developer. Secondly, the role of data modelling plays a much bigger role than the model base in many modern MSS. This is particularly so for executive information systems and MIS that support middle managers in data intensive decision environments. The modelling of the data starts to play a crucial role in the enhancement of the users mental model of the scenario and in the users learning from the process.

Two data modelling technologies are useful here. The first, using the relational model and usually refereed to as a relational data base management system (RDBMS) is described in another chapter. Most modern corporate systems are implemented using the relational model, and many large transactional systems uses RDBMS. There are now many proprietary systems that can provide an easy to access interface for managers at all levels to gain access to corporate relational systems.

The second approach to representing data in an MSS is called multi-dimensional modelling (MDM). The data is presented to the user as hypercube, with each dimension representing one way in which the decision maker breaks down the information for the problem at hand. An example might be a financial report that can be broken down first by organisational unit, secondly by service provided (administration, clinical, etc), thirdly by forecast, estimate and budget, and lastly by month and year. The data for this example could be presented to the user as a four dimensional hypercube which can then be interrogated by selecting components of different dimensions to gain the particular combination required. This is sometimes called *slicing the hypercube*.

MDM is an excellent way of presenting the data as it usually closely resembles the mental model used by the decision maker. This technique is further explained in Whymark (1991a), and is available in many MSS software packages such as EXPRESS and EPIC. SYSTEM/W is a mainframe product that uses multi dimensional modelling for financial reporting systems as well as for MSS. A key property of these systems is that unlike a spreadsheet, the logic for calculations and consolidation is separated from the data and usually one logic file is used for many data files. This makes for much easier management of the underlying logic model than is the case with a spreadsheet approach. The technique also provides a powerful tool for financial reporting as the hierarchical structure of the dimensions makes for easy and efficient consolidation from cost control centres.

The interface

A typical MSS combines both the modelling and the data base systems to provide seamless support for a decision making professional or manager. The interface is the third component of the technology necessary for this seamless operation. Fortunately the technology has improved substantially to the point where serious MSS can be developed without a lot of technical expertise or help, especially when the support system relies mostly on the data modelling. EIS are a good example of this type of system, but the idea is also extending down to other levels of management.

It is important that the interface matches the user's needs and skills. Executives need a system that is *executive friendly* (Whymark 1991a), but other MSS users may need training programs before using the system. The knowledge required by the user before using an MSS is an often overlooked aspect of system development.

The user

Thus we return to the fourth and most important component of any MSS, the user. The type of MSS ultimately depends on its purpose, and the purpose depends on the needs of the user. Understanding these needs can often be gained by considering the level of management practiced by the user, the information required, and the type of decision the user needs to make. This determines the model types and data base technology to be used, and also the type of interface required.

Development methods for MSS

The purpose of this section is to highlight the software development life cycles (SDLC) that are often most appropriate for the development of MSS. It is not intended to review basic software engineering theory in this paper, and the references used here (just a few of the many written on this topic) will provide further detail for the reader.

The classic life cycle of computer based information systems is described in Section 2 (Figure......), and should be the basis of the development of any transaction based operational system, especially those used by lower and middle management. MSS are different. In general, they have characteristics that will cause a project manager to adopt an approach that allows for greater flexibility in identifying the users needs, and that allows for flexibility throughout the life of the system. A caution is in order at this stage that, and that is that a review as brief as this one attempts to provide general guidelines, and there will always be exceptions.

Common prescriptions for MSS development include the following.

- It must focus of the user, the decision process and the problem.
- It must involve the user in both development and change.

- It will induce change in the organisation, the MSS itself, in the users work and in the decision making the MSS supports.
- The design process must be flexible.

This implies that one of two approaches to system development should be adopted, the iterative design approach or the adaptive design approach (Ahituv 1990). Both are similar to a general category of system development approaches called prototyping (Ahituv 1990, Pressman 1988) where the definition of the user requirements and final performance of the MSS is gradually refined during development. It is particularly useful in situations where both user and analyst have great difficulty in determining the functional characteristics before the system is built. It is almost essential in situations where the system is expected to change the way the user or the organisation will conduct work. MSS can be expected to perform in this way.

Iterative design

Iterative design (Ahituv 1990) is a series of rapid cycles or iterations through the full life cycle process. In each iteration the full life cycle is compressed into a very short period of time, and then repeated. It is a process where flexibility can be operationalised.

The steps in the iterative process are as follows.

- User and designer jointly define the problem.
- A small, useable system is developed.
- The system is refined, expanded and modified.
- The system is evaluated by the user, and the process continued.

The process of formal evaluation and modification of the problem definition is essential to the iterative design approach. The length of the cycle will depend on the size of the project.

Adaptive design

The adaptive design approach assumes that the final system must evolve through usage and learning. Whereas the iterative approach still relies on formal specifications, this approach relies on a prototype to define the system performance.

The basic principles are as follows.

- Find out quickly what is important to the user.
- Provide the user with something concrete.
- Define a clear architecture for the MSS so that it can be easily developed and modified.
- Pay careful attention to the user-MSS dialogue.
- Emphasise the importance of use learning in terms of using the system.
- Emphasise getting started rather than getting finished.

In some ways this approach reflects the philosophy of an old maxim for succeeding in any venture - *fail early*. The principles are in sharp contrast to those of the traditional SDLC. The designers job goes well past the need for design in conventional systems as they become closely involved in the decision situation with the user. They also have to be responsive to the user and help to stimulate exploration and learning in all users.

The system continues to develop and evolve as the user develops further knowledge about how the system can be used, and most importantly, on what its impact on the decision making process will be. This was the approach used in developing EDIS, the EIS developed for the Royal Australian Navy. It is also the most appropriate development life cycle approach for most management support systems.

Application of MSS

EIS are one type of MSS that is easily identified by the users supported. They are highly focussed on the needs of the executive and the executive friendly software used for implementation of the system. The software used does not define an EIS, and it may be used to provide information support to other managers as well. The information content, style of delivery and the decision processes supported are unique to executive management, and it is these aspects that define the system as an EIS. Many examples of EIS will be found at the end of this chapter.

Managers in the health industry have the same needs and can be categorized in the same way as managers in other industry sectors. Executives are concerned with strategic planning, and so need external as well as internal information. Middle management also have similar needs in the administrative functions. These managers can be served by similar technology and development methods to managers in other industries.

The needs of clinical managers is the challenge of the nineties. The technology is available, the development process is well understood, and the clinical processes are well understood. It is not clear however, just what impact the technology may have on process redesign and hence on the needs for information support by clinical management. Much of the software tools will be specific to professional practice.

Two commercial systems recently developed in Australia serve as examples. The first is a patient dependency system designed to be used by nursing staff at the ward level. Called TDS (Total Dependency System), it is a cross between a transaction processing system and an MSS. It provides a means of capturing ward based activity and provides nursing management with information to support both operational and strategic decision making.

The Ca$eMax system is a true MSS. The developers worked in close liaison with hospital managers to develop an application that supported their needs in a casemix environment. It is tailored to the needs of the Victorian hospital, but like all good MSS, these sorts of systems can easily be tailored to other environments. In this case the data are stored using multidimensional modelling techniques, and this allows the manager to easily compose a report that suits the needs of the moment. The interface is intuitive and is executive friendly. The system supports executive management with their internal data needs in the casemix decision making environment, and so will not provide all information needs for management.

This highlights another important point. It is rare that MSS or DSS are able to supply all the information a manager needs. The aim is to always provide as much of the routine requirements as possible, so freeing the professional or manager to concentrate on the non-routine.

MSS as a factor in organisational change

Information: the sixth resource

The five resources necessary to conduct any enterprise are people, machines, management, material and money (in past times referred to as the five Ms). information is now an equally important commodity and can be considered to be the sixth resource. The information revolution has been likened to the industrial one of the eighteenth and nineteenth centuries, but has occurred in the space of about 20 years instead of over a period of a century or two.

Information is power in modern and is essential to decision. Not only is information power, but changes to the information flow can and will transform an organisation. Since many MSS deal directly with both the information and its flow within the organization, they can act as change agents in a number of ways. This can happen by design or by accident. MSS can

- change the lines of communication,
- change the lines of power and control,
- change the organisational structure, either directly or covertly, and
- support a corporate memory or knowledge base.

Impact at the personal level

Modern MSS (including interactive MIS) have the capacity to improve job satisfaction as well as job productivity, as decision making is pushed down to the lower levels of management. In addition, many professional workers will see the improved technology available in MSS removing the complexity imposed by multitudinous data inputs, therefore bringing them closer to the real problem and the real decision process required of them.

MSS are also increasing the flexibility of organisations and individuals. For example, expert systems have the capacity to bring expert knowledge to many others in the same profession. Many tasks that now require greater experience and knowledge will be carried out by *lesser experts* in the profession.

As our knowledge and skill at implementing computer human interaction (CHI) improve there will be less need for computer skills and more need for business and management skills. This is already evident with EIS, and is heading that way with ES. The trend is the same of MSS in general. It means a much closer relationship between the ultimate users and the development of the MSS, and this will further improve the job satisfaction of the professional and the middle manager. They will attain their proper position as directors of development instead of merely acting as receivers of inadequate technology.

Impact on training

The impact of new trends in MSS on training (more so than education) will be twofold. It will effect the type of training required, and secondly, it will effect the way that training is delivered.

As MSS provide more guidance to all levels of management and use modelling techniques more appropriate to the problem domain then the skills required to use the systems will change. The trend will be towards a requirement of greater skill in the decision making process, and less in the use of technology as such.

The way training will be delivered in the future will also be affected by the linking of MSS development and computer aided learning (CAL) systems. Research is very active in this area and results are starting to reach industry. This is another technology that gained a false start in the late sixties and early seventies, but is likely to deliver over the next decade. The ability of many MSS to provide a learning environment in addition to the primary purpose of decision support will support the integration of MSS and CAL.

Social impact

There are many aspects of our society that have been affected by MSS. Many problems solved using traditional DSS could not have been solved economically, if at all, with traditional computer based information systems (CBIS). Some of the positive implications can be far reaching and include furhter opportunities for the handicapped, working at home or telecommuting, and improvements in the quality of life for some workers (Turban 1993).

There are always negative affects. In the case of MSS they may include changes in employment availability and opportunity and changing gaps between socio-economic groups, a potential for new types of computer crime, problems with the centralization of power via integrated computer systems and corporate data base systems, and an increasing “blame the computer” attitude.

Conclusion

MSS is a category of software solutions that are intensely user oriented. It includes systems known as decision support systems (DSS), executive information systems (EIS) and expert systems (ES). Each of these has been briefly described and categorised according to their purpose and the level of management serviced.

MSS are supported by the use of various modelling methods and the role of modelling techniques in MSS was discussed. The development methodology used is crucial to the success of an MSS, and the alternatives were presented here in the context of MSS. A case was made for Ahituv’s adaptive design approach as the preferred development life cycle for MSS implementation.

Finally, the role of MSS as a potential factor in organisational change has been briefly explored. This potential is particularly important for project managers to understand as it has such a big impact on the success of the project. Senior management also need to be aware of the potential and to make a clear decision as to whether they wish to avoid or to take advantage of that potential.

To date, most MSS use has occurred at the lower levels of management, but the impact is increasingly being felt at all levels. Management support systems are taking over routine tasks and freeing decision makers to concentrate on the crucial decision making process. Is this an opportunity or a threat?

MSS support the decision making process. This gives the MSS developer the potential to change the process and even affect the decision making style of the manager. By shortening the intelligence phase of the decision making process MSS give the manager or professional the opportunity to concentrate on problem specification and problem finding, rather than just “putting out bush fires”.

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