Conditions for designing different kinds of information systems

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INTRODUCTION

To be able to penetrate the conditions for designing information systems it is relevant to start with definitions of what is information and what is an information system. The properties and purposes of information systems will thereafter be analysed in this paper by using metaphors and Miller's (1995) theory for living systems. Based on these analyses *operative information systems* and *supportive information systems* will be defined and dealt with in some detail. The conditions for these two different types of information systems will be stated. Thereby a foundation exits upon which analyses and conclusions can be made regarding the two rather distinctive types of information systems.

The concept of information

Qvortrup (1993) summarises in an overview the current controversy over the concept of information. He concludes there are many potential definitions of information. At the one end information may be considered as a thing in the (external) real world. At the other end, information may be considered as something which is a result of some cognitive process in the human mind. It is possible to distinguish between four concepts of information according to Qvortrup (1993):

1. Information may be defined as something existing in the external world like heat, electricity.
2. Information may be defined as something in the external world which causes change in a psychic system.
3. Information may be defined as a change in a psychic system which has been stimulated by change in the external world.
4. Information may be defined as something only in the human mind, a concept or an idea.

Hard and soft approaches to information

In systems science there is a distinction made between a *hard* systems view and a *soft* systems view, see for instance Flood & Carson (1993). These views are related to methods of science, how to solve a problem, and how to design a system. The hard approach can be characterised as willing to admit formalised reasoning processes in which logico-mathematical derivation loom large (van Gigch, 1991). Evidence is usually replicable and explanations can be based on proven casual relationships. The need to develop a soft approach arose because hard analyses were found to be inappropriate and ineffective for many messy or poorly structured situations encountered in management and organisational studies. Checkland (1981) pictures complex or badly structured situations as human activity systems. By that he emphasises the human being as an important actor in different processes.

Depending on what aspects are considered in a definition of information, it is possible to speak of hard versus soft specifications of the concept. A hard specification does not include the human being as a party. Information is something by itself outside the mind of the human being. Information is something *objective*. In a soft specification the human being is considered a receiver of data which in a cognitive process will be interpreted as information in the mind of the human being. Information is considered a *subjective* phenomenon.

Considering the classification of information according to Qvortrup (1993) above, it can be concluded that category 1 and 2 are related to a hard perspective, and category 3 and 4 are related to a soft perspective.

A hard characterisation of information is given by Shannon and Weaver (1949). Their view of information is that it is something which is sent from an information source (sender) through a channel or pipeline to a receiver. An important idea in their theory is that information can be treated like a physical quantity such as mass or energy. For Shannon and Weaver (1949) the concept communication was primary, not information. A distinction between data and information is not given in their theory. This specification of information is used by for instance Miller (1995). One reason for applying that perspective is that it becomes possible to quantify and measure information.

An example of a soft specification of information is given by Langefors (1995) when he constitutes what is meant by information in his infological equation. It says: **I=i(D, S, t)** where I is the information produced from the data D and the pre-knowledge S, by the interpretation process i, during the time t. Usually S in the equation is the result of the life experience of the individual which is active in the interpretation process. S in the process is an especially important parameter, since the conditions for getting information out of certain data are given by S. What the equation actually describes is a cognitive process

where data are processed by an observer or user in order to be information. This means that information will always be obtained by a process in which the user tries to apprehend meaning out of certain data. The equation gives a clear distinction of what is data and what is information.

Criteria for choosing a definition of information

Choosing a definition of information is not a trivial matter. It should therefore be important to well consider what kind of perspective of information to be chosen. One way to do that is to specify and use criteria for a choice of a convenient approach of information. The criteria should focus on aspects which when specified together constitute a way of looking at things, or in other words, make up a certain paradigm (Kuhn, 1975).

One important aspect is epistemology. It deals with the two assumptions about the grounds of knowledge, about how one might begin to understand the world and to communicate what has been understood to fellow human beings, and ideas of what forms of knowledge can be obtained. The two opposing extremes are positivism and anti-positivism.

In the following is given a proposal for criteria which may be considered in choosing a definition or specification of information:

- *Pertinence*; an observer wishing to specify the concept of information should be able to do that in accordance with what the observer intends to describe. It is possible to link this criteria to the importance of choosing an adequate method for problem-solving. What kind of method to be used depends essentially on the character of the problem which will be attacked. The observer's epistemological model of reality is here an essential aspect. A hard or soft approach may be chosen.
- *Evidence*; it should be important that a definition is clear-cut to be correctly understood and properly applied.
- *Consistency*; the meaning of for instance data and information and the relationships between them should be coherent.
- *Exhortativness*; certain aspects of information are emphasised which may exhort a certain attitude towards what is information and what is an information system.

Langefors (1995) view of information will be used in this paper, and the reasons for choosing that perspective will be given in the following discussion based on the criteria mentioned above.

Pertinence: A soft view of information will be used. The reason for that is that human beings are essential ingredients in studying information and in design of information systems. It is important to notice that obtained information is related to the experience and ability of the information user, thus the obtained information is subjective and individual. In Langefors' (1995) equation the individual user is emphasised by the pre-knowledge S.

Evidence: Langefors' (1995) equation must be considered clear. Parameters which influence the interpretation process are given and the meaning and distinction between information and data are distinct. It is reasonable to be suspicious and ask if a concise and clear definition really fully describe a certain phenomenon. A test can be made by trying to shade off the concept. In Langefors (1995) a deeper study and examination of the definition is made, and based on that it is here concluded that the definition stays solid.

Consistency: Data is in Langefors' (1995) definition anything which are sent or presented to a user, which the user will interpret to information. Depending on the user's S the user will obtain his/her information. This connection is in accordance with how information is acquired in reality. It is worth mentioning that complexity as discussed by for instance Flood & Carson (1993) is an essential ingredient in the interpretation process when information is formed.

Exhortativness: If a soft perspective is chosen it is clear that the user becomes important. The amount of information obtained and the quality of obtained information depends of the pre-knowledge of the user, that is his/her experience and ability. By applying this approach the designer will be encouraged to co-operate with the user when developing an information system, otherwise only a data system can be guaranteed.

Arguments are hereby given to support the choice of definition of the concept of information. It is also in this context important to specify what is meant by an information system.

The information system

By the definition of information, conditions for what is here meant by an information system are also given. One consequence is that the user is considered a part of the information system. Before defining what is an information system the concept system will be given a meaning. The term system has a number of meanings. A definition of what is a system is given by Miller (1995): "A system is a set of interacting units with relationships among them." (p.16)

A system consists of units which are interacting. That is not enough, however, for units to constitute a system according to Miller's (1995) definition. There must be some kind of kinship or relationship between them. They must in some way or another belong to the system. The units have a function and a role towards the whole system. An organisation with its departments, groups and people is an example of system in this context. Using the definition of information which has been chosen, how should an information system be specified?

An information system is a system where the units or components are information processes or information entities involved in information processes. From earlier discussions it should be known the distinction between data and information. It is therefore necessary that an information entity is combined with a requisite pre-knowledge and an interpretation process. The processes of an information system are *assembling*, *storing*, *processing* and *delivering* according to Buckingham *et al.* (1987). The process *retrieving* should be added to the list. Furthermore an information system is a human activity system which may or may not include the use of computer systems (Buckingham *et al.*, 1987).

THE PROPERTIES OF INFORMATION SYSTEMS

Looking at the more general conditions for designing information systems, some vital factors can be mentioned: *the purpose of the information system*, *the users' information needs and requirements*, and *the presence of dynamics and complexity* in the information system's environment. The property of an information system is related to expectations of the users, but also on what is considered an idealised design (Ackoff, 1981) of an information system. The properties of information systems have changed and is due to change further on. If a metamodeling perspective is applied (van Gigch, 1991), it is possible to describe the properties of information systems by what is called "representative metaphors". These metaphors based on van Gigch (1991) can be described as follows.

The information system as a *mechanism*; an information system is an assemblage of mechanisms, adjunct to the organisation. A clear distinction is made between the information system and the object system, for instance an organisation, which are supported by the information system.

The information system as a *living system* (Miller, 1995); the information system is here seen less as an mechanism and more as endowed of biological and behavioural attributes.

The information system as a an *intelligent* system; this metaphor is an extension of the previous one, the organisation is designed as an intelligent artefact (Simon, 1969) and becomes an information system which incorporates the organisation's intelligence.

It should be noted that the metaphors cover information systems considered as decision-support systems. The metaphors should be looked upon as "evolutionary" stages of information systems. One difference between the metaphors is that the distinction between the information system and object system varies, where the object system is the part which is supported by the information system. In the first metaphor (mechanism) there is a clear distinction between the information system and the object system. In the second metaphor (living system) it is not as easy to separate what is information system and what is object system. Their reality is known through interpretations. In the third and last metaphor (intelligent system) it is very difficult or impossible to separately specify the object system from the information system. They are intertwined. This must be considered an important difference between the metaphors.

What metaphor is applicable to the conditions for a certain information system will have consequences for how it should be designed. It is reasonable to assume that the more the information system and the object system is intertwined, the more is the user looked upon as an essential part in the process of designing the information system. The design of the information system will also have a tendency to influence the conditions for the design of the organisation. Another consequence in this context is that the environment of an information system will be more and more subjected to change and complexity, see for instance Ackoff (1981) and Schön (1971). There will probably be a continuous need for changing the information system (as well as the object system) based on new conditions for the organisation.

The focus of the described metaphors of information systems will in this paper be on the information system as a living system. Both formal and informal information will be considered.

THE PURPOSE OF INFORMATION SYSTEMS

The purpose of an information system is related to its role. The role may be to handle and process data which are strongly related to certain operational activities. Another role is to support an object system in the process of decision making. By specifying different needs in an organisation, it should be possible to manifest heterogeneous purposes of information systems.

Considering systems science and especially the living systems theory by Miller (1995) it is found that the *organisation*, which is one of eight levels in his theory, is looked upon as an open living system. An open system has the attribute of exchanging matter-energy and information with the environment. Miller (1995) has identified 20 critical subsystems which are related to matter-energy and information. Miller (1995) defines the critical subsystems as:

> *"Certain processes (which) are necessary for life and must be carried out by all living systems that survive or be performed for them by some other system." (p. 32)*

Of the 20 critical subsystems 10 of them process information. They are described in Table 1. An analysis of them will be made and based on that analysis purposes of information systems will be identified. Even if Miller (1995) applies a different view of what is information than what is used in this paper, the critical processes which he has identified are notwithstanding relevant to consider.

Subsystems which process information	**Processes**
Input transducer	The sensory subsystem which brings markers bearing information into the system, changing them to other matter-energy forms suitable for transmission within it.
Internal transducer	The sensory subsystem which receives, from subsystems or components within the system, markers bearing information about significant alterations in those subsystems or components, changing them to other matter-energy forms of a sort which can be transmitted within it.
Channel and net	The subsystem composed of a single route in physical space, or multiple interconnected routes, over which markers bearing information are transmitted to all parts of the system.
Timer	The subsystem which transmits to the decider information about time-related states of the environment or of components of the system. This information signals the decider of the system or deciders of subsystems to start, stop, alter the rate, or advance or delay the phase of one or more of the system's processes, thus coordinating them in time.
Decoder	The subsystem which alters the code of information input to it through the input transducer or internal transducer into a "private" code that can be used internally by the system.
Associator	The subsystem which carries out the first stage of the learning process, forming enduring associations among items of information in the system.
Memory	The subsystem which carries out the second stage of the learning process, storing information in the system for different periods of time, and retrieving it.
Decider	The executive subsystem which receives information inputs from all other subsystems and transmits to them information outputs for guidelines, co-ordination, and control of the system.
Encoder	The subsystem which alters the code of information input to it from other information processing subsystems, from a "private" code used internally by the system into "public" code which can be interpreted by other systems in its environment.
Output transducer	The subsystem which puts out markers bearing information from the system, changing markers within the system into other matter-energy forms which can be transmitted over channels in the system's environment.

Table 1: Critical subsystems in Miller's living system theory which process information. (Miller, 1995)

Looking at an organisation as a system, it should be of interest to specify the activities of the system (organisation) where information is needed. The following activities can be observed:

- purposes and goals of the system must be specified.
- the system must be able adapt to changes in the environment.

- the system must be able to learn from own experiences and from experiences of other systems.

Focusing on the first activity, if the system should be able to specify purposes and goals, the decider must get information from the environment, or from the suprasystem in Miller's (1995) terminology, regarding threats, expectations, and possibilities. The experience of the decider should be another input to the process. Also the status of the system must be considered in specifying purposes and goals. To conclude, the following subsystems are together with the *decider* primarily involved in the first activity: *input transducer, internal transducer, timer associator, and memory*. With reference to Mc Pherson (1995) it possible to categorise the types of information needed in activities. Based on Malmsjö (1997) two types of information will be considered here. They are here called *supportive information* and *state-of-the-art information*. Supportive information is obtained by for instance studying documents, retrieving data from databases, by observations, or by interacting with experienced people. State-of-the-art information specifies the status of a phenomenon. What is happening in a certain field of knowledge? Overviews, trends, new developments are examples of that kind of information. In Miller's (1995) model, information of this type is provided by the input transducer.

In the second activity, to adapt to what is happening in the environment, again the *decider* and decision-making is focused on. The *input transducer* is particularly important in this activity, since it is essential to get information from the environment. The other critical subsystems primarily involved in processing information are: *Internal transducer, associator, timer and memory*. The type of information used here are *supportive* information, *state-of-the- art* information and *feed-back* information according to Malmsjö (1997).

The last activity covers the development of a system, see for instance Ackoff's (1981) definition of development. The *associator*, the first state of the learning process, and *memory*, the second state of the learning process are of special interest here. Other subsystem which are important here are the *input transducer* and the *decider*. The decider is important because the development of a phenomenon is an act of consciousness. Other subsystems may be involved, but those mentioned are considered most important in this case. Types of information which are found here are essentially supportive information. There exists more "general" supportive information which describes, for instance, experiences from other systems, and more "specific" supportive information based on evaluations of the performance of the system *per se*. It should be noted that this last activity overlaps the other two activities, since experiences are obtained by evaluating these other two processes.

There is one type of information which Miller (1995) does not cover explicitly. In a matter-energy process there is data and information involved,

otherwise no functional process would be possible. This kind of information is here called *operative* information (Langefors, 1968).

OPERATIVE AND SUPPORTIVE INFORMATION

Operative information is necessary for accomplishing a matter-energy process. Without it no matter-energy process would be possible. Miller (1995) specifies critical subsystems which are involved in a living system's matter-energy processes. These subsystems are described in Table 2, as well as the subsystems which process both matter-energy and information.

Since a living system is an open system it exchanges matter-energy and information with the environment. It should be evident that information is an essential ingredient in these processes. For instance the *boundary* excludes and permits entry to the system. Information is a necessity to solve that task. The *distributor* carries inputs from outside the system or outputs from its subsystems around the system to each component. Information is necessary for the distributor, so that it knows what to send where, and how much. Analysing all the other critical subsystems, it should be clear that information must exist otherwise no matter-energy process would be possible. An example of an operative information system is a travel agency's ticket ordering system, where the matter-energy process is transportation of people from one destination to another. Operative information is necessary for the system irrespective of the environment is considered static or dynamic.

Supportive information has earlier been described as a kind of information which is obtained by retrieving data from for instance computerised databases, from documents, or from experienced people. The need for supportive information can come up urgently, when for instance a matter-energy process has to be designed or redesigned due to changing environmental conditions, when problems in the matter-energy process have to be solved etc. The supportive information plays also an important role in developing the system. Supportive information is not necessary when the environment is static but advisable when the environment is dynamic and complex. Needs related to supportive information is by Orr (1970) called episodic needs.

The conditions for operative information systems

The conditions for an operative information system are given by the particular matter-energy process or activity which are supported or will be supported by the system. The users of the operative information system are usually known. They are working or are active parts in the matter-energy process. The information system is generally tailor-made for a specific matter-energy process. It has earlier in this paper been concluded that operative information is necessary

Subsystems which process matter-energy and information	Processes
Reproducer	The subsystem which carries out the instructions in genetic information or charter of a system and mobilises matter, energy, and information to produce one or more similar systems.
Boundary	The subsystem at the perimeter of a system that holds together the components which make up the system, protects them from environmental stresses, and excludes or permits entry to various sorts of matter-energy and information.
Subsystems which process matter-energy	**Processes**
Ingestor	The subsystem which brings matter-energy across the system boundary from the environment.
Distributor	The subsystem which carries inputs from outside the system or outputs from its subsystems around the system to each component.
Converter	The subsystem which changes certain inputs to the system into forms more useful for the special processes of that particular system.
Producer	The subsystem which forms stable associations that endure for significant periods among matter-energy inputs to the system or outputs from its converter, the material synthesised being for growth, damage repair, or replacement of components of the system, or for providing energy for moving or constituting the system's outputs of products or information markers to its suprasystem.
Matter-energy storage	The subsystem which places matter or energy at some location in the system, retains it over time, and retrieves it.
Extruder	The subsystem which transmits matter-energy out of the system in the forms of products or wastes.
Motor	The subsystem which moves the systems or parts of it in relation to part or all of its environment or moves components of its environment in relation to each other.
Supporter	The subsystem which maintains the proper spatial relationships among components of the system, so that they can interact without weighting each other down or crowding each other.

Table 2: Critical subsystems in Miller's living system theory which process both matter-energy and information, and critical subsystems which process only matter-energy. (Miller, 1995)

for the matter-energy process. Since what is happening in a certain matter-energy process always is something unique, the operative information system can not be obtained from any other source or information system. There are no alternatives to the operative system. Reconsidering the discussion on what is an information system, the complete list of processes are assembling, storing, retrieving, processing and delivering. Langefors (1995) distinguishes the main processes or main functions of an information system by concluding that information systems would not only retrieve information but also process information. It is here claimed that it is possible to distinguish what is the main process of an operative information system. A matter-energy process is dynamic and if an operative system should be able to support the matter-energy process it must represent that dynamic in its system, and processing is considered its main function. This means that all the other functions, that is assembling, storing, retrieving, processing and delivering are also used by an operative information system, but a focus or emphasis is on data processing.

The conditions for supportive information systems

The detailed purpose of a supportive information system may be possible to specify only if it is designed with a certain application in mind. Operative information systems are always related to some known purpose, *while that need not be the case for supportive information systems.* This is one major difference between operative and supportive information systems. Sundgren (1995) identifies systems with *partially unknown purposes*, meaning for instance that the designer of a system may not be able to find out who are all the future users of the information system. It is not possible to specify all purposes a supportive information system may have, but in designing such a system the designer must have some general application situations and some kind of general user categories in mind otherwise it would not be possible to properly design such a system.

Examples of supportive information could be results of research work, experiences of using methods, guidelines, problem solving techniques, results of evaluations, methods of evaluations etc. Data or information carriers, or markers in Miller's (1995) terminology, may be databases, books, journals, reports, experienced people etc. Analysing the contents and markers of supportive information, it can be concluded that the information is rather static and should be so. Updating markers is usually necessary, but the need to process is not evident. Therefore, it is considered that the main function of the supportive information systems is *retrieval*, to find relevant information based on the user's need. In Table 3 a characterisation of operative information systems and supportive information as discussed in the text is given.

	Operative information systems	Supportive information systems
The users of the information system?	Known	Partially known
The purpose of the information system?	Known	Partially known
The need for the information system?	Necessary	Recommended
The main function of the information system?	Information Processing	Information Retrieval
Can the information provided by the information system be obtained from any other system?	Seldom	Usually

Table 3. A characterisation of operative and supportive information systems.

CONDITIONS FOR DESIGNING DIFFERENT KINDS OF INFORMATION SYSTEMS

Conditions for designing operative information systems

An information system design or development methodology is here defined as an assemblage of procedures, techniques, tools, and documentation aids which will assist the system designers in their efforts to develop or re-design an information system. Avison and Fitzgerald (1995) have identified objectives of information system's methodologies. These are:

1. To record accurately the requirements for an information system.
2. To provide a systemic method of development so that progress can be effectively monitored.
3. To provide an information system within an appropriate time limit and at an acceptable cost.
4. To produce a system which is well documented and easy to maintain.
5. To provide an indication of any changes which need to be made as early as possible in the development process.

6. To provide a system which is liked by those people affected by that system.

These objectives make sense, but they are not focused on the problematic and more detailed side of designing information systems. A rather detailed discussion of fundamental problems of systems design is for instance found in Langefors (1995). The level of the objectives are notwithstanding quite reasonable for this discussion. Analysing the six objectives from an operative information system's perspective, it should be evident that all aspects are relevant and possible to achieve thinking about the conditions for operative information systems. The reasons for that are the following:

- the operative information system has a relatively well-defined set of potential users.
- the needs of these users can, at least in principle, be specified based on interactions with the users.
- the basis for considering dynamics and change is defined by the matter-energy process which is a unique and unambiguous process.

What is important here is that the users are known and they are according to Langefors (1995) infological equation a necessary part in the development process if an information system should be able to be the end product. From the objectives above can be drawn the conclusion that the methodologies have been developed for information systems with *known users* and *known applications*. They are not applicable to the design of information systems were the users are unknown or partially known. Sundgren (1995) means that information systems with known purposes, like operative information systems, it is a rather engineering-like task to design and implement the information system. That seems to be a relevant conclusion if a hard approach to systems design is chosen. If a soft approach is chosen, the characterisation must be considered doubtful. The design of information systems is a complex and dynamic process, but the more that are apparent the better are the conditions for developing an information system which will be "liked by those people affected by that system".

Conditions for designing supportive information systems

Analysing the six objectives by Avison and Fitzgerald (1995) above in the perspective of supportive information systems, it will be found difficult or even impossible to attain some of the objectives. Those objectives which are especially difficult to handle are 1, 5 and 6. The first (1) objective: *to record accurately the requirements for an information system*, is troublesome because all users and their purposes of using the supportive information system can not be specified. The designer has to base his/her specifications of needs and requirements on at best a part of the users and by judgements of reasonable common needs, and by analysing possible purposes of using the information system. The fifth (5) objective: *to provide an indication of any changes which need to be made as early as possible in the development process*, will be hard to achieve, because a necessary condition is close interactions with the users. This may at best be partly possible which has been discussed. The sixth (6) objective: *to provide a system which is liked by those people affected by that system*, is difficult to attain because it builds upon a knowledge of who are the users and what do they mean by an appropriate information system. The reasons for the difficulties to obtain the objectives can be summarised as:

- the supportive information system has not a well-defined set of potential users.
- the needs of the users can at best partially be specified.
- the possibility of considering dynamics and change for the supportive information system can be accomplished only on a meta-perspective.

These reasons are supported by evaluations of information services by Malmsjö (1993; 1994). It was by the evaluations found that the users in the applications were not clearly specified. It was difficult to specify the needs of the users. The purposes of the information services were unclear and defensive. Other supportive information systems had not been considered when the services had been developed. The possibilities of getting the users interested in the information systems were overstated.

By the analysis above it can be concluded that the existing methodologies for designing information systems do not consider the conditions for supportive information systems which usually are not tailor-made. It can also be concluded that the conditions for designing supportive information systems are much harder since the users are often many and so elusive. Another factor which is applicable to supportive information systems is that the information they can provide can also be provided by other supportive information systems. For example information about a certain research project could be found in the following different kinds of supportive information systems/sources.

- In a database via one or more computerised on-line information retrieval systems.
- In a journal, if a paper has been written describing the research work and its results.
- In a review article where the research project has been covered in an analysis.
- By interacting with the researchers who have been involved in the project. They can describe the work; argument for used methods, achieved results etc.

It is not only possible but reasonable that information on a phenomenon which is judged to have some kind of external interest will be found in *different* supportive information systems/sources. This observation is supported by Malmsjö (1993; 1994). The description of the phenomenon will usually vary in the different information systems as to the rate of detail, as to availability etc. One conclusion of this is that when making a supportive information system

available to different users in different situations, there is a possibility that the kind of data/information which you want to make available already is available in another supportive information system, where the data/information is probably available in a different way and in another form. It has been identified that the users of operative information systems are usually forced to use a designed operative information system. This is usually not the case for users of supportive information systems. The users have to make a choice. It is known that *quality* and *availability* are important factors when a user is to choose a supportive information system or source (Gerstberger and Allen, 1968). Another more metaphorical way to characterise the last conclusion is to claim that there exists some kind of *competition*, explicitly or implicitly, between different supportive information systems. If a designer should be successful in introducing a supportive information system, the designer must pay regard to the already existing supportive information systems and present an information system which in some way or another is better in the eyes of the users compared to the already existing systems. If that is not successfully accomplished, *there will be a risk of a failure*.

The conditions for designing operative versus supportive information systems differ a lot. Most methodologies which have been developed are related to operative information systems or systems where the users or potential users are known and where the purpose of the information system can be identified. It can be concluded from the analyses above, that the conditions for designing supportive information systems are worse than the conditions for designing operative information systems. Furthermore the users of operative information systems are more firmly linked to the system compared with users of supportive information systems. It can therefore be seen as a paradox that *the domain methodologies for designing supportive information systems are so relatively little developed compared with the domain methodologies for designing operative information systems*.

CONCLUSIONS

It has in this paper been found that definitions of information can be categorised as having either a hard or a soft approach. It is considered important to apply an appropriate definition in a certain application or discourse. The following criteria are proposed for choosing a convenient definition: *pertinence, evidence, consistency*, and *exhortativness*. The properties of information systems have been discussed and the metaphor *living system* has been used for characterising an information system. In the analyses which have been performed the following conclusions can be made.

1. The concept of information system is not a clear-cut concept. It is possible to specify different kinds of information systems where the conditions for the

systems differ. In this paper analyses have been made of operative information systems and supportive information systems based on Miller's (1995) theory of living systems.

2. Arguments are given to consider that the main function of operative information systems is *processing* and the main function of supportive information is *retrieval*.
3. The conditions for designing operative information systems versus supportive information systems differ. The main reason for this is that operative information systems has a relatively well-defined set of potential users, while that is not the case for supportive information systems.
4. It has been found that the conditions for designing supportive information systems are more ambiguous compared with designing operative information systems.
5. Information systems methodologies, that is procedures, techniques, tools, and documentation aids, are applicable to operative information systems, but usually not suitable for supportive information systems. Therefore there seems to be a need to develop methodologies for supportive information systems. Since that is not dealt with in this paper, it will hopefully be treated in another context.

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