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Interaction and Transformation*

Lars Mathiassen
Peter A. Nielsen

Abstract. Soft Systems Methodology (SSM) is a framework for the exploration of ideas, beliefs, and assumptions about human activities, and it offers an innovative and effective approach to many of the problems and challenges involved in organizational learning. The underlying understanding of human activities as transformations is, however, for many of the practical purposes of IS organizations too limited.

It is argued and illustrated that there is a need in SSM for a complementary type of human activity system focusing on interactions rather than on transformations. A specific proposal for how to include interaction systems into SSM is offered, and the implications for soft systems thinking and practice is outlined.

1. Background: Soft Systems Methodology

SSM is a methodology developed at the former Systems Department at Lancaster University. The Lancaster researchers and students have since the late sixties applied various versions and aspects of SSM in order to test, develop, and rethink its structure. Action research has been their research approach. Every claim on the usefulness of SSM or any part of it stems from its application in practice when intervening into private enterprises and public institutions. The general version of the methodology is well-documented and argued for in the works by Checkland (Checkland 1981; Checkland *et al.* 1990b) and specialized methodologies relevant to particular ar-

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eas of management, control, and information systems are most clearly spelled out in the work by Wilson (1990).

SSM defines a process through which its users inquire into purposeful human activity by means of systems ideas. It is a process in which different views and perspectives are formulated and modeled using human activity systems conceived as adaptive wholes which transform input to output in an abstract way. This transformation is done through a set of activities which are logically dependent on each other constituting a coherent whole. Such soft systems are eventually mapped unto the real-world. This mapping of several soft systems makes SSM an interpretative approach to organizational learning and change.

A vast number of attempts have been made to use SSM in the context of information systems (IS) development, some theoretical, some with practical implications, and a few which have been tried in practice. Mingers provides a survey of these early attempts (Mingers 1992). First, the Lancaster approach is to use SSM to develop a consensus model relevant for an information system and from this model derive what information is needed for the various parts of the system, see (Wilson 1990; Checkland *et al.* 1990a, 1990b). Second, there are a number of front-end approaches in which the general version of SSM is used before a traditional information systems methodology to identify the wider system to be supported or partly automated by a new or modified information system, see for example (CCTA 1989; Avison *et al.* 1990; Mathiassen *et al.* 1991). Third, the integrated approaches suggest to use SSM to structure the analysis and design process and the models included in SSM are extended to facilitate mapping of information issues, see (Shafer 1988; Miles 1988, 1992; Mathiassen *et al.* 1991). Finally, there is the belief that SSM and information systems cannot be elegantly linked except through laborious and tedious moving back and forth both manually and intellectually (Doyle *et al.* 1991a, 1991b).

More recently a number of papers have been published on these issue in the Journal of Information Systems (Doyle *et al.* 1993; Gregory 1993; Lewes 1993; Stowell *et al.* 1994). Each of these discuss the relationship between hard and soft systems thinking within information systems development. Gregory (1993) and Lewis (1993) discus the theoretical foundations for combining hard and

soft approaches. Doyle *et al.* (1993) and Stowell *et al.* (1994) are more focused on practical problems of such combinations.

This paper is—like the above mentioned contributions—about an improvement to SSM in general and to its potential application in IS development in particular. But in contrast to the other publications, we will not take the system concept within the SSM tradition for granted. We argue that the underlying understanding of human activities as transformations is too limited for many of the practical purposes in IS development, and we believe that this is one of the main obstacles for bringing SSM into practical usage in this area. We explore and further develop the potential usage of SSM by introducing a complementary type of human activity system focusing on interactions rather than on transformations. A number of attempts have already been made to improve soft systems ideas, e.g. by Atkinson *et al.* (1988) who developed a number of metaphors of "the adaptive whole" including contradictory systems. But in all this work, it is assumed that a system consists of one or more transformations.

We present an argument for our position in the following way. In section 2, we motivate our proposal through a case in which we apply SSM to information systems issues to illustrate the strengths and weaknesses of the transformation-based concept. Section 3 offers a proposal for an alternative soft systems concept based on the notion of interaction. This concept is compared to the classical transformation-based concept. In section 4, we apply the new notion to the case and we outline how conceptual models of interaction systems can be represented. Finally, section 5 concludes the argument and outlines avenues for further research.

2. Motivation: transformations and beyond

We use a case—the Nursing Case as presented by Mathiassen *et al.* (1990)—to motivate this attempt to go beyond transformation-based soft systems. The surgical functions of a municipal hospital were reorganized in response to economic and political demands. Previously, as illustrated in the rich picture in figure 1, there were six independent surgical departments, each with its own nursing supervisor. As part of the reorganization, these departments were turned into six subordinate sections of one centralized unit, which was then to be jointly managed by a new unit manager and the six

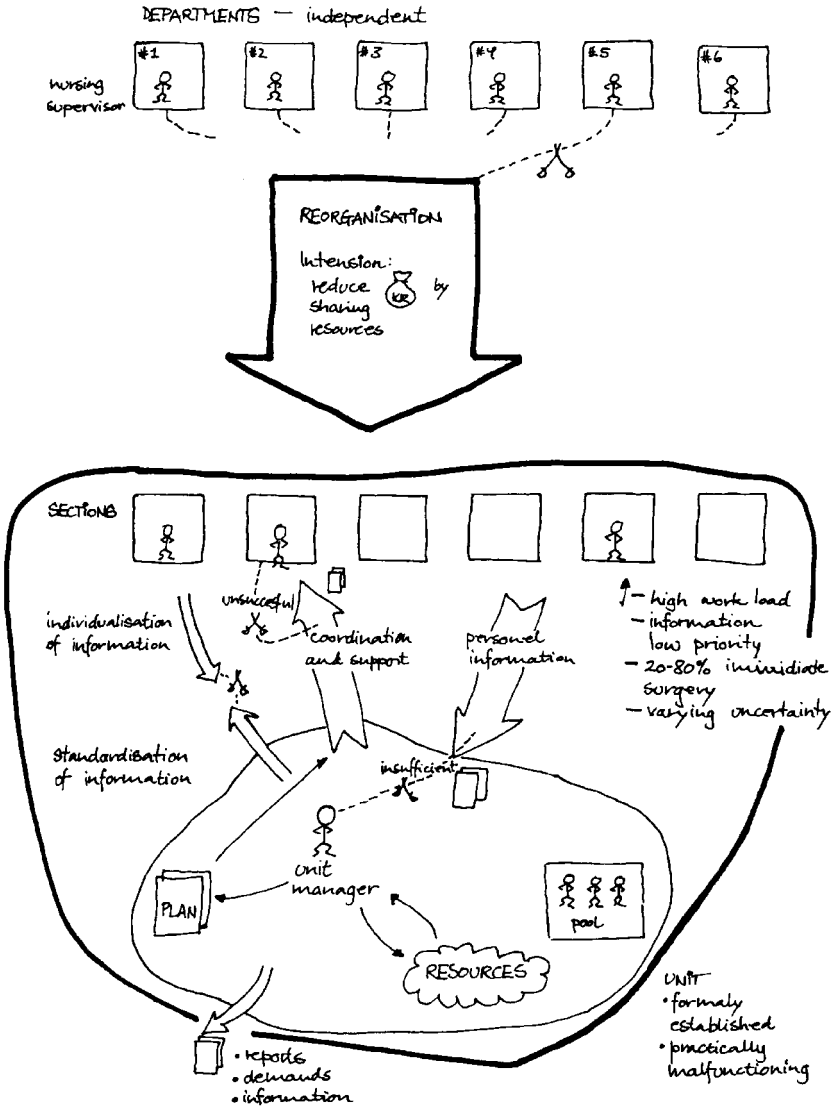

Figure 1. Rich picture of a problematic situation in the surgical unit of a municipal hospital.

nursing supervisors. The intention of this reorganization was to reduce costs by sharing resources. There was also some talk of a shared, central pool of nurses.

For various reasons, this new organizational unit was mainly established as a formality. In practice, the six nursing managers were stuck with their established management traditions. In the Nursing Case, we are facing this problematic situation at a time where the new unit manager and the group of nursing supervisors want to change their established management traditions by using us as consultants. Also, they want the consultants to help them design a computer-based management information system to support their collaboration within the new unit.

In applying soft systems ideas to the Nursing Case, we explored a number of potentially relevant systems:

1 Provision of professional and efficient surgical service for the community.
2 Reorganization of surgery into one unit.
3 Preservation and development of nursing skills and values.
4 Management of resources and personnel within one unit with six sections.
5 Obtaining resources to the unit.
6 Support of sections and coordination between them.
7 Communication between sections.
8 Management of resources and personnel within sections.
9 Provision of information for the unit manager about status in the sections.
10 Provision of information for the nursing supervisors about status in their section.

In addition, we developed the following root definitions for two of the systems:

> Reorganization system (2): A system owned by the nursing supervisors and the unit manager themselves to reorganize their roles and patterns of cooperation based on previous reorganization activities and supported by consultants. The reorganization must lead to an improved competence of the unit manager and the supervisors to manage within the formally established

surgical unit. The reorganization should last less than half a year.

Management system (4): A system owned by the hospital and used by the unit manager and the nursing supervisors to manage resources based on shared plans and communicated status information. The system supports and enhances professional and efficient surgical services under the constraint of limited resources and externally provided surgical tasks of varying types and frequencies.

We also developed conceptual models corresponding to these root definitions of the reorganization and management systems, see figures 2 and 3. In this context, we look closer at some important differences between these two systems as they are expressed using SSM. Further details of the Nursing Case are described in (Mathiassen *et al.* 1990).

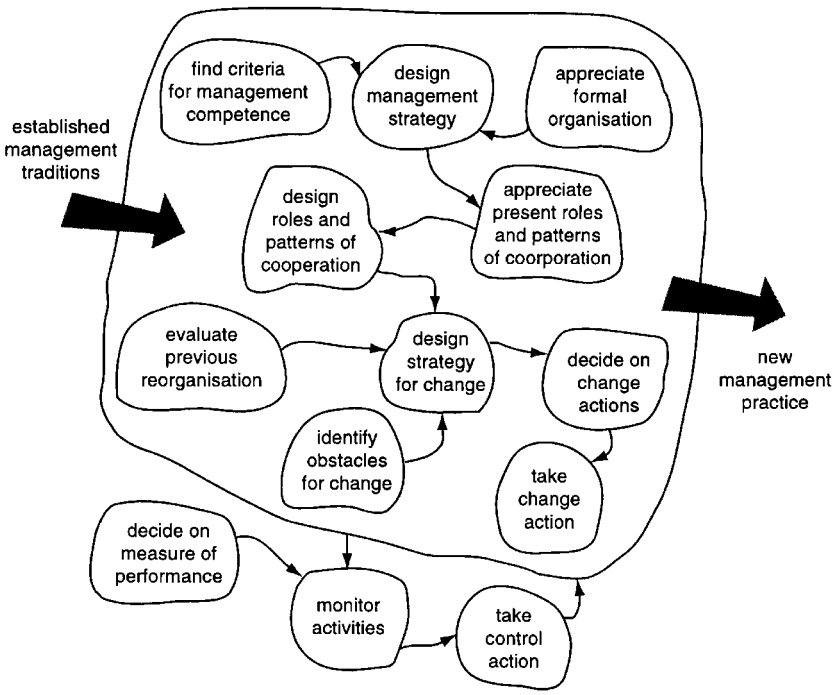

Figure 2. Conceptual model of the reorganization system.

The reorganization system in figure 2 is—in a natural and straightforward way—formulated as a transformation. The input to the transformation is the established management tradition reflecting the independent operation of six departments each with its own nursing supervisor and its own way of dealing with resources, schedules, and emerging problems. The output is a changed management practice in the surgical unit with new roles and patterns of cooperation for the six nursing supervisors and their new colleague, the unit manager:

management tradition → *reorganization* →
new management practice.

The transformation itself is best described as a reorganization. It is performed by the seven nurses in question and it is based on the belief that the reorganization can be successfully achieved by learning from what has already happened during previous reorganization efforts (which obviously did not work out at all)—if properly supported by consultants.

The convention in SSM is to see the other system, the management system in figure 3, as a transformation too. The transformation is management with unmanaged resources as input and managed resources as output:

unmanaged resources → *manage* → managed resources.

This is correct according to SSM, i.e., input and output are of the same kind, it is conceivable that the transformation will be able to transform input to output, and it is consistent with the root definition. It is, however, somewhat redundant that the output of such a "manage" transformation is "managed", and it is rather confusing and sometimes even wrong to characterize the input as "unmanaged". A would-be problem-solver might not be able to find tangible evidence of "unmanaged" resources. A more likely situation would be to find managed resources—some poorly managed, some excellently managed—but nevertheless managed.

This conception does, as a consequence, not contain any more information than a transformation of resources into resources:

resources → *manage* → resources.

Are we to understand the management system simply as a system where there is no significant difference between input and output?

From the point of view of SSM it might be argued that the answer to this question is determined by the would-be problem solver who formulates and models the system. Any variation in the understanding of what is the input and what is the output leads to different systems. In the Nursing Case, however, we formulated and modeled the systems ourselves and we found the notion of transformation to be inappropriate to express the essential properties of the management system—a finding that we have experienced in many other applications of SSM.

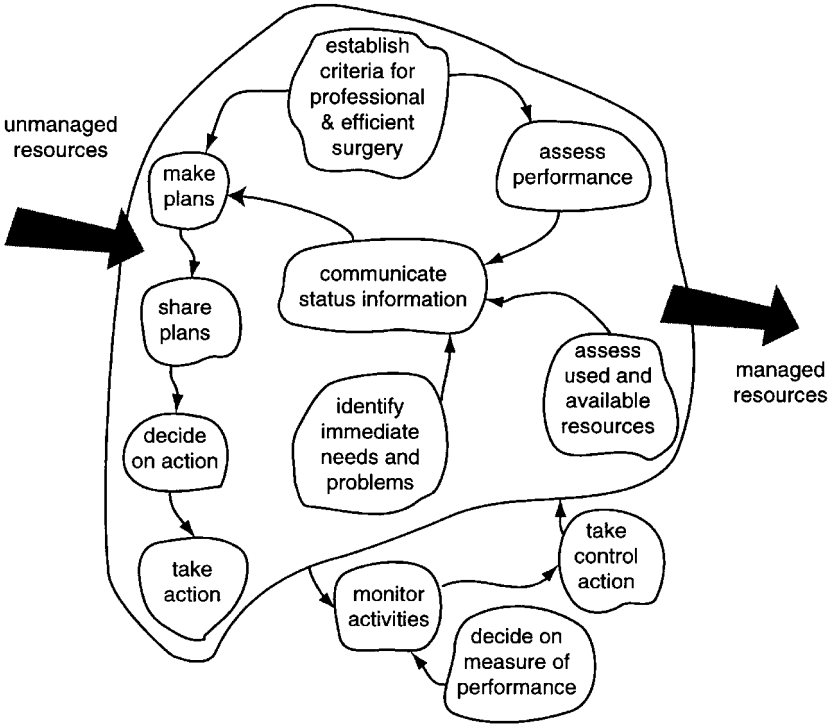

Figure 3. Conceptual model of the management system.

The management system is not easily understood as a relationship between input and output. This becomes even more apparent when going into further detail with the conceptual models, see figures 2 and 3. What we are adressing here is the expressiveness of these models, not their consistency and rigor. For the reorganization sys-

tem it is fairly easy to follow the transformation of input to output through the activities in the model, see figure 2. The activities, by their very names, point to the character of this system. The particular activities in this system is what makes this a unique system. The main idea of the system is expressed by activities like “design management strategy”, “evaluate previous reorganization” and “design strategy for change.” In contrast, it takes some effort to see that the activities of figure 3 transform “unmanaged resources” to “managed resources” and to understand and appreciate the uniqueness of the system from the activities of this model. The main idea of the system, i.e., that management should be based on communicated status information and shared plans, only becomes visible through somewhat artificial addition of activities. One possible explanation is that the main idea expressed is not primarily related to a transformation. It is rather maintenance of some structural properties of resources.

It has been said that the language in SSM for building conceptual models is the largest possible because it consists of all the verbs in our natural language (Checkland 1981). This argument is misleading. IT organizations are concerned with the processes as well as the structural properties of information systems and to accommodate for this we need to emphasize both aspects in our systems thinking. We need to include verbs as well as nouns as important elements of our basic vocabulary.

In our efforts to teach, use and develop SSM we have often faced difficulties modeling human activity systems as the management system above. Such difficulties are expressions of a fundamental dilemma related to the design of SSM or any other methodology, i.e. the dilemma between maintaining simplicity in concepts by only having one systems concept, and obtaining power to express differences between various types of systems. It is not clear, that we should increase the conceptual complexity of SSM, but we find it worthwhile to explore the possibility for two reasons. Firstly, a pattern seems to emerge from the many situations in which we have encountered difficulties in applying the notion of transformation or explaining students what it means in relation to specific systems. Secondly, we want to develop SSM's potential as a framework for information systems development and a possible hindrance for achieving this is the inappropriate way in which interactive systems are modeled.

3. Proposal: interaction and transformation systems

One possible way to characterize two complementary soft system concepts is summarized in table 1. First, we propose to use transformation system and interaction system to designate the two soft systems concepts. The term "transformation" is well-established within SSM and it provides a precise and intuitively appealing designation of the key characteristics of the concept. We propose "interaction" as the complementary term to signify a clear conceptual distance to the other concept, and to grasp one of the key characteristics of this other concept.

	Transformation system	**Interaction system**
Identity	A relationship between well-defined input and well-defined output expressed as a process	An interactive operation on some structural artifact or material expressed as a process
Perspective	Change of material without focus on intermediate states	Invariance of material with particular focus on different intermediate states
Examples	Organizational change Systems development Design & invention Construction Production	Management Information Administration

Table 1. A possible distinction between two complementary soft systems concepts.

Semantically, we propose to distinguish by letting transformation systems denote soft systems that: define a relationship between inputs and outputs with focus on the overall change. In contrast, we let interaction systems denote soft systems that: operate in an interactive fashion on some material (e.g., processes, actors, objects, information) and which focuses on achieving invariance in the state space (e.g., satisfactory distribution of resources, provision of relevant information, effective coordination between individual actors).

A number of typical examples can be given to clarify the proposed distinction. Systems related to organizational intervention and change, to development of computer-based information systems,

to any kind of design or invention effort, or to construction of physical or abstract artifacts are all good examples of transformation systems. Instead, management systems, information systems, and administration systems are good examples of what we here conceive as interaction systems.

Reviewing the systems considered in the Nursing Case, the following are examples of systems which we have thought of as transformations:

2. reorganization of surgery into one unit,
3. preservation and development of nursing skills and values,
5. obtaining resources to the unit.

In contrast, we have thought of the following systems as interactions:

1. provision of professional and efficient surgical service for the community,
4. management of resources and personnel within one unit with six sections,
6. support of sections and coordination between them,
7. communication between sections,
8. management of resources and personnel within sections,
9. provision of information for the unit manager about status in the sections, and
10. provision of information for the nursing supervisors about status in their section.

Some of these systems fall clearly in one of the two categories (1, 2, 4, 8, 9, and 10) whereas others could be interpreted either way leading to somewhat different systems (3, 5, 6, and 7).

We can elaborate further on how these concepts of transformation and interaction apply to soft systems practice by examining the cases by Checkland & Scholes in their book (Checkland *et al.* 1990b). Table 2 contains a classification of the systems contained in the seven cases of this book as either an instance of a transformation system, as an instance of an interaction systems, or as a system which might be interpreted either way. This is illustrates that the designers of SSM use systems of both kinds.

There are two lessons to be learned from this exercise. First, and most importantly, there is quite an equal distribution of trans-

	Transformation	Interaction	Either
Chapter 3		65, 68	70
Chapter 4	105(1)	100, 105(2), 111	
Chapter 5	134, 135, 145		136
Chapter 6	159, 160, 161	168	167, 169
Chapter 7	188, 197	201	189, 196
Chapter 8	211(1), 232	211(2), 220, 231	
Chapter 9	243(2), 254, 259	243(1), 245, 249(1), 250, 253, 255, 262	243(3), 249(2)

Table 2. A classification of the systems in (Checkland et al. 1990b). The numbers refer to pages in the book, and numbers in parenthesis refer to different systems on the same page.

formation and interaction systems. This suggests that the proposed distinction separates soft systems practice into two important areas, each containing a reasonable amount of instances. Second, there are reasonably few cases of systems that might be classified either way. This suggests, that the distinction between transformations and interactions is quite often made in existing practices—even if this is now done implicitly. In the relatively few cases that are difficult to classify, it might have been useful to consider and clarify, in each case, whether to see it as a transformation or an interaction.

4. Application: interaction systems

The distinction made in table 1 is quite abstract. To illustrate it we need to look closer at ways in which to use interaction system ideas in soft systems practice, i.e. we need to illustrate how to make root definitions and conceptual models. Let us look at the root definition for the management system again:

> Management system (4): A system owned by the hospital and used by the unit manager and the nursing supervisors to manage resources based on shared plans and communicated status information. The system supports and enhances professional and efficient surgical services under the constraint of limited resources and externally provided surgical tasks of varying types.

Figure 4 shows a possible way to make a conceptual model of an interaction system. The material of the interaction is placed in the center and the activities refer more directly to the material than to each other. Among the activities are, in more general terms, activities for maintenance of the material (monitor work, make plans, evaluate plans) and activities for accessing the material (communicate status information, share plans, make plans) while peripheral activities (effectuate plans) are not relating directly to the material but to other activities.

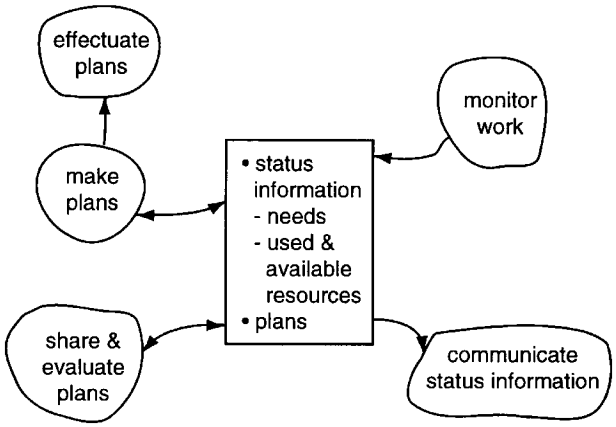

Figure 4. An interaction system for the management of nursing corresponding to root definition 4.

In this system, the material is basically information, but the material in an interaction system may well be of other substances as illustrated by the model in figure 5.

> Management system (4a): A system owned by the hospital and used by the unit manager and the nursing supervisors to manage resources based on shared plans and communicated status *of needs and resources*. The system supports and enhances professional and efficient surgical services under the constraint of limited resources and externally provided surgical tasks of varying types.

The change in the root definition is small but there is a major difference between the nature of the two systems. In addition, we may consider yet another management system quite apart from the

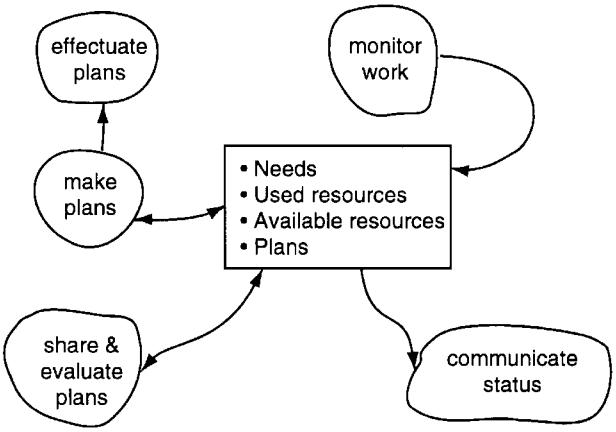

Figure 5. A conceptual model of the interaction system in root definition 4a.

above two systems. This idea is expressed in system 4b and modeled in figure 6.

> Management system (4b): A system owned by the hospital and used by the unit manager and the nursing supervisors to *consider needs and resources and manage these through joint discussions*. The system supports and enhances professional and efficient surgical services under the constraint of limited resources and externally provided surgical tasks of varying types.

Each of these systems relate in a quite straightforward way to relevant information systems within the surgical unit of the hospital, they explicate important activities as well as structural properties related to these systems, and they illustrate how the notion of interaction can be used in modeling human activity systems.

5. Discussion: open questions

We have argued, that SSM needs to be complemented with a different kind of systems concept to facilitate its usage within IS development. This proposal is based on many attempts to apply SSM to the area of information systems and we have motivated it by way of an example. We have proposed a possible distinction between what we call interaction and transformation systems and we have related this distinction to soft systems practice. Finally, we have applied the

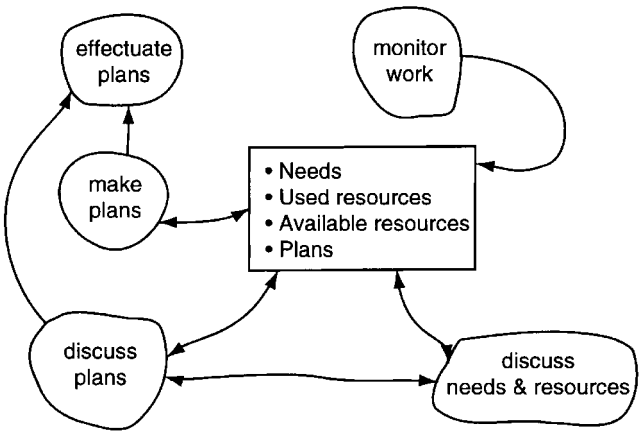

Figure 6. A conceptual model of the interaction system in root definition 4b.

new concept of interaction systems to a specific case and in doing so we have outlined a possible way to represent conceptual models of such systems.

The notion of transformation has been developed an enhanced through decades of systems studies. The notion of interaction is not in the same way well-tested in practice and a number of issues needs to be investigated further. These issues include:

Foundation: According to the theory underpinning SSM a system is an adaptive whole characterized by emergent properties, hierarchy, communication and control. We believe, that interaction systems also should be understood as adaptive wholes, and that the conventional monitor-and-control activities should be considered for this type of system as well.

Distinction: In our experience, SSM needs another complementary type of systems concept to facilitate its usage within IS organizations, but the precise distinction between the two new systems concepts have to be explored further.

Evaluation: The CATWOE (Customer, Actor, Transformation, Weltanschauung, Owner, Environment) test is used in SSM to evaluate the formulation of transformation systems. We propose to substitute T(ransformation) with I(nteraction) in this useful test. During the definition of a transformation

system, a transformation is normally identified together with inputs and outputs. In a similar way, when defining an interaction system, an interaction should be identified together with the relevant material.

Representation: We have outlined a possible way to represent conceptual models of interaction systems. The key feature is to explicate, not only activities and their relations, but equally important the material and the relations between activities and material.

Acknowledgments

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