SYSTEM MAINTENANCE MANAGEMENT

organizing system maintenance with effective maintenance objects

PASYN:0015
Since 1984, we have participated in the system maintenance arena in Sweden, and in the last 15 years we have contributed to knowledge development in this field. We have contributed to the extensive system maintenance work of Riksdataförbundet (nowadays known as Dataforeningen), we have published two dissertations; a licentiate dissertation and a doctor's dissertation, and we have authored three books about system maintenance. Furthermore, we have written Swedish and international articles about system maintenance. Together with our colleagues at På AB, we have conducted about 260 maintenance management implementations of our model Business Oriented Maintenance Management in ca 60 organizations.

This series of papers – PASYN (“a glance at”) – is a new way of contributing to the knowledge development in the maintenance field. During the coming years, we intend to continuously publish reports that describe phenomena in the system maintenance field. They will all be based on practical experience combined with theoretical foundations in research – our own or others.

PASYN addresses those who study these issues, those who work in maintenance and those who have a general interest in what system maintenance is all about.

PASYN:OOIB is a summary of the doctor's dissertation System Maintenance Management – organizing system maintenance with effective maintenance objects by Malin Nordström. The dissertation was presented and approved at the Institution of Computer Science at Linköping University on April 20th 2005. The dissertation (in Swedish) is available from www.pais.se.

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I. BACKGROUND AND PROBLEM AREA

System maintenance is a rather large business in many organizations. Vast sums of money and vast amounts of time have been invested in computerizing businesses. Originally, the common purpose was to rationalize businesses and increase productivity, but with the passing of time, the purpose has more often become to increase the quality of decisions and administration (Falk and Olve, 2000). However, the value of IT-systems cannot be measured until they are in use, i.e. when the IT-system is in a maintenance situation. In use, the IT-systems must change at the same pace as the business they support (IEEE, 1998) – that is, be maintained at the same time as they support the current business. Thus, system maintenance can be something of a paradox. It must deliver stability to the ongoing business at the same time as it delivers change to support internal and external change processes (compare Thompson, 1967). Since there are other things than IT-systems that are maintained, for instance roads, buildings and stock portfolios, it is probably relevant to speak of objects in maintenance. In existing system maintenance theory (Pigoski, 1997; Kitchenham et al 1999; Kajko-Mattsson, 2001) the IT-system per se is considered the maintenance object. In the subject area of Informatics, it is customary to start with business analyses in development or change of IT-systems (Andersen, 1994; Krutchen, 2002; Goldkuhl, 1993). This also goes for other change attempts such as Business Process Reengineering (Davenport, 1993) and in the Quality area (Bergman and Klefsjö, 1991; Axelsson and Bergman, 1999). In international system maintenance theory there is no such tradition, which may partly be explained by the development of system maintenance theory mainly having been conducted in the Software Engineering area. The business that the IT-systems support is implicit in the line of theory, Chapin too (2003, p 1) says, "...maintenance is a main way of making intentional changes in how organizations work". If it is the main way may be questioned, but it certainly is one of the ways.

The main purpose of the research process has been to contribute to the development of a conceptual framework for organizing system maintenance with the help of effective maintenance objects. But also to increase the knowledge of maintenance for those interested in the subject, scientists as well as practitioners. A conceptual framework refers to a form of meta model that contains concepts and that may contain models, methods and tools (Jayaratna, 1994). The research process has meant testing the results from my licentiate dissertation (Bergvall', 1995) and the developments that are described along with the development of the concept of Business Oriented Maintenance Management (Affärmässig Förvaltningsstyrning, Bergvall and Welander, 1996; Nordström' and Welander, 2002). Since the licentiate dissertation was presented in 1995, I have worked as a consultant in helping organizations to organize system maintenance. The practical work of helping organizations increase the manageability

1. Bergvall now called Nordström
2. Nordström formerly called Bergvall
has made me reflect on what constitutes effective maintenance objects in an organization. By effective, I mean what is appropriate to manage in order to achieve a high business value (Nordström and Welander, 2004). The principal reason for my choosing to carry out the present research was that I could not find answers to my questions about the role of maintenance objects when organizing system maintenance.

The research process has had a qualitative approach with literary studies, source studies and case studies with an action research strategy as research methods. The source studies have meant studies of 180 maintenance plans that describe how maintenance should be organized for specific maintenance objects, while the case studies have been carried out in three Swedish organizations where system maintenance is a considerable part of the internal activities. The research perspective in existing literature is often characterized by a life cycle reasoning (Kitchenham et al, 1999; Kajko-Mattsson, 2003) where system maintenance theory is based on a development metaphor. Moreover, there is an inclination to motivate the existence of system maintenance based on how large share of the work that can be seen as development (Pigoski, 1997). This results in the alleged negative status of maintenance in organizations often being pointed out as a problem area in system maintenance literature, since the comparison seldom is in favour of system maintenance (Parikh, 1988). My view is that system maintenance deserves to be researched and knowledge-developed as a separate business and not automatically from a life cycle perspective. This would probably be easier if the metaphor for knowledge development in the system maintenance area is changed. This thesis presents a different metaphor — the assignment metaphor.

The organizing term is used in the thesis according to Weick (1969), who said that organizing is something more than just organizational structures and management. He believed that organizing aims for reducing the number of events that can occur, and that the activities of organizing aim for establishing a working level of security — and thereby predictability. The thesis is built on four central terms; maintenance assignment, maintenance object, maintenance organization and maintenance activities. They are all related to the organizing term through the three first being means of organizing maintenance. One may ask whether organizing is an objective or a means? Here, organizing is seen as an objective that aims to create manageable maintenance — and this makes organizing as such the knowledge contribution of the thesis. The thesis is to be read from a perspective where a manageable maintenance has no self-purpose, but is in turn a means for conducting welladapted maintenance that supports the intended business.
2. MAINTENANCE BUSINESS

When the term business is used, it signifies what is done (Goldkuhl and Röstlinger, 1998), with or without IT-systems. However, the term business has often come to be used as a name for the organizational unit that conducts the business that the IT-system supports (Andersen, 1994). When speaking about economical business, one often refers to the economy department, even though economy activities are carried out in other parts of the organization. This mix of business and organization may have considerable consequences in system maintenance since the giver of the assignment and the performer of the assignment are often in the same organization. In order to analyze system maintenance businesses, I have had a need to refine the concept of business through different sub categories. My problem has been that the language usage varies between organizations, which leads to a need for being generic and still distinct enough. The term object business is used here to describe a business – of any kind – and thus I am dependent on a generic term to be used irrespective of which business is intended (compare to Langefors, 1995, object system). The prefix is added in order to avoid the lack of distinction that I find in the field of practice concerning the business concept. By IT operations, I mean the technically oriented work that is carried out to handle the IT-systems. By maintenance business, I mean the work that is carried out in a maintenance situation.

Figure 1 shows the relations between these three types of businesses.

![Diagram showing relations between Business, IT Operations, and Maintenance]

In the present thesis, maintenance is regarded as a sub business to object business and IT operations. This results in object business and IT operations having a sub category – business related maintenance (field B in figure 1) and technical operations (field D) that create the maintenance business. Field C is formed by a common management of field B and D that arises since maintenance is a sub business to the object business and IT operations (Bergvall, 1995). This activity is of a managing character (giving assignments).
The analysis of maintenance business (field BD in figure I) has been made with practice theory as a starting point, with the help of Theory of Practice (Goldkuhl and Röstlinger, 1998). ToP aims to describe businesses and their relations to their surroundings. A business is considered to be some kind of practice, which means that it is not only performed once, but is of a repetitive character. Further, a business is intentional, which means it aims for a result. The result is defined as the product of the business (ibid).

In the thesis, four activities are generated that can be seen as typical for a system maintenance business; support activities, change activities, maintenance management and technical operations. Possibly the most notable category is technical operations, since it is often treated as a separate business. In my analyses, I have found that the product (i.e. the result) of technical operations is availability to the maintenance products. Thus, from a users point of view, the other maintenance activities and technical operations are intimately connected since maintenance products that are unavailable are unusable. From the reference definition of the sub-activities and the business analysis of system maintenance in the thesis, I have created the following reference definition of the system maintenance concept:

The work of continually managing, supporting, preserving and further developing permanent maintenance products where IT-systems are integral parts, for the purpose of securing availability and the intended use in the object business. This definition is meant to serve as a reference definition, since each specific maintenance business has a need for a pragmatic definition that also serves as a definition of the maintenance assignment at hand (Bergvall and Welander, 1996). In system maintenance theory, there is a tradition to regard maintenance from the point of its underlying cause; corrections, adaptations, perfections and preventions (Lientz and Swanson, 1980; RGF, 1987; IEEE, 1998). Instead of the traditional change categories, I would like to recommend a classification of change activities that is based on the analysis of my empirical data, where maintenance can be divided in two main types, based on partly contradictory purposes; to guarantee stability as well as change. This would mean a classification of:

- Preservation
- Further development

Thus, preservation guarantees the stability of maintenance products and IT-systems, whereas further development guarantees the change of them (compare Thompson, 1967). The main area of interest should be how these activities are handled and managed in order to increase the use of the change, not mainly what caused the change.
3. ORGANIZING SYSTEM MAINTENANCE BUSINESS

3.1 The Maintenance Object

The idea that the base should consist of "something more" than only IT-systems originates from Riksdataförbundet (1987), which also included manual data treatment in the base. The first idea about businesses also being included in the base is found in a further development of the result (Berntsson and Welander, 1991). The motivation for this was that through a clear division of responsibilities, one could secure the knowledge about how to handle the IT-system. In order to make this manageable, the authors meant that the business should be divided into business areas and these and the IT-systems should be mapped out. Another study that stresses the importance of the business is Bendifallah and Scacchi (1987). They conducted a study of system maintenance from a user perspective and thereby studied the business processes and how they interact with the IT-systems. The conclusion was that in order to understand the problems of system maintenance, one must understand the surrounding business and the situation of the users and maintainers.

In my licentiate work (Bergvall, 1995), and then in my continued work in the field of practice, I have discovered that object businesses seldom attract any attention in system maintenance. Instead, it is the IT-systems that are maintained, more or less isolated. Thus, the idea of maintaining "something more" than the IT-systems seems to have had little impact on the field of practice even though analyses of businesses in connection with development of new systems is not a new phenomenon. Hence, a central part of the research has been to define and find the basics for demarcating maintenance objects. Maintenance products, i.e. the result of maintenance that is used by the object business, have a central role in the conclusion concerning definition. In order for a maintenance business to be meaningful, there must be something to maintain and thus, maintenance products may form the basis for, as well as the result of, the business. The maintenance business itself will then result in a change of status in the base. This thesis presents a classification of products that divides maintenance products into permanent and processing products. The permanent products are often products that are generated from the IT-systems and that are used by the object business. Hence, the conclusion is that the permanent maintenance products are part of the maintenance object together with the IT-system. This is illustrated in figure 2.
The object model in *figure 2* has its origins in Affärsmässig Förvaltningstyrm (Nordström and Welander, 2002 p 11), and has been developed as a part of the research. Originally, the “piece of cake” in the object model was used as an alternative to isolated IT system maintenance. Instead of letting the maintenance object contain merely the IT system (layer 3), the object business was also included (ibid). The contents and names of the layers have been tested empirically and theoretically in connection with the research, and the result is an object model with three layers (*figure 2*). The IT system and the permanent maintenance products are a part of the object, whereas the object business products should demarcate the object. This may result in a maintenance object that contains several IT systems, for instance, and that parts of an IT system may be included in different objects. The purpose is to consolidate the IT support for a certain object business. Thus, one can create maintenance objects that yield high business value. This thesis presents a model for demarcation and definition of maintenance objects.

### 3.2 System Maintenance Assignments

This thesis proposes the necessity of an assignment perspective in system maintenance businesses, in order to secure that the maintenance is conducted according to the intentions of the assignment givers (Goldkuhl and Rostlinger, 1998). The assignment situation in maintenance is of a complex character, since maintenance is a sub business to object business and IT operations (*figure 1*).

The assignment in system maintenance is an assignment where actors in the object business are assignment givers, but since IT systems have a special character as agents in businesses, it is also necessary that actors in the object business take part in the maintenance assignment as co-producers. They conduct the object related maintenance and together with actors in IT operations they conduct maintenance business. IT operations are assignment takers in the maintenance business. The maintenance assignment is given from the object party to the IT-
party, but in order to put the assignment into operation, a maintenance organisation is formed, that represents the object business and IT operations. This means a clarification of the assignment situation but at the same time the overall complexity increases, since the involved parties get more assignments to work within. The thesis identifies five different types of maintenance assignments as shown in table 1.

<table>
<thead>
<tr>
<th>TYPE OF ASSIGNMENT</th>
<th>ASSIGNMENT GIVER</th>
<th>ASSIGNMENT TAKER</th>
<th>DIRECTION</th>
<th>ORIGIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role assignment</td>
<td>Management</td>
<td>Maintenance Organisation</td>
<td>Vertical</td>
<td>External</td>
</tr>
<tr>
<td>Forward Role Assignment</td>
<td>Object Owner</td>
<td>Object Manager</td>
<td>Vertical</td>
<td>External</td>
</tr>
<tr>
<td>Product Assignment</td>
<td>Object party</td>
<td>IT party</td>
<td>Horizontal</td>
<td>External</td>
</tr>
<tr>
<td>User</td>
<td>Maintenance Organisation</td>
<td>IT party</td>
<td>Horizontal</td>
<td>External</td>
</tr>
<tr>
<td>Forwarded Product Assignment</td>
<td>Object Manager</td>
<td>IT System Manager</td>
<td>Horizontal</td>
<td>Internal</td>
</tr>
</tbody>
</table>

Table 1. Different types of assignments and their assignment parties.

When organizing system maintenance, all assignments should be clarified in order to create system maintenance that is a continually developing business. Analyses in this thesis show that in cases where the maintenance assignments are treated as a forwarded version of the organizations external assignments, self-generating maintenance businesses often occur. This risk also turned out to be present when the forwarded product assignment was focused. The research results show that maintenance contracts can be productive means to use in managing maintenance businesses by assignments. Further, the thesis defines what these contracts should contain.

3.3 The Maintenance Organization

Many organizations that decide to organize their maintenance start by assigning responsibilities to individuals in a maintenance organization (Nordström and Welander, 2002). The system maintenance organization is a way of organizing the cooperation between object business and IT operations, for the purpose of operationalizing the maintenance assignment between the object party and the IT party. The theoretical analysis presented in this thesis shows that there is a need for a maintenance organization that is related to the kind of business at hand.
It has a hybrid structure that can be compared to the committee form (Robbins, 1990). A maintenance organization is a kind of micro organization and is built from roles that conduct their work in various types of work groups and decision-making groups. Riksdataförbundet (1987) suggested that there should be a maintenance organization for each IT system. Against the background of my research results about maintenance objects as means for reaching increased manageability in maintenance, I would like to take Riksdataförbundets recommendations one step further and instead suggest that there should be one maintenance organization for each maintenance object. I have chosen a set of role names that I find appropriate based on the primary area of responsibility of the role in relation to the maintenance object. The maintenance organization, as shown in Figure 3, follows the same principles as the assignment managed organization model presented in Affärsstämmor (Nordström and Welander, 2002).

<table>
<thead>
<tr>
<th>Level</th>
<th>Party</th>
<th>BUSINESS</th>
<th>IT-OPERATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUDGET LEVEL</td>
<td></td>
<td>Object Owner</td>
<td>IT-System Owner</td>
</tr>
<tr>
<td>DECISION MAKING LEVEL</td>
<td></td>
<td>Object Manager</td>
<td>IT-System Manager</td>
</tr>
<tr>
<td>OPERATING LEVEL</td>
<td></td>
<td>Object Specialist, Channel</td>
<td>System Developer, Operator etc.</td>
</tr>
</tbody>
</table>

Figure 3. Maintenance organization after theoretical and empirical testing.

Here, it may also be appropriate to discuss the owner concept. The system owner concept was introduced by Riksdataförbundet (1987) as an element in their strive for increasing object businesses involvement in system maintenance issues. System owning must today be seen as an established concept in organizations, much in the same way as system maintenance. However, since this thesis delimits system maintenance as a form of internal business (i.e. the object related maintenance business is internal), I find that the owner concept is not quite relevant. It is rather about a responsibility that can be assigned to a role in an organization. For instance, a manager in the line organization is not called business owner, but he or she is responsible for a business. But since the owner concept is established in the area, I choose to use the term supplemented with the object concept. Because in the same way as maintenance can be directed towards different objects, the ownership may be directed at different objects. Riksdataförbundets basic idea was to assign responsibility (ownership) for the IT systems to the object business in order to increase their involvement. I would rather have it that the IT party owns the IT systems - and by that I mean is responsible for the IT systems and conducts well-defined assignments for the object business.
In terms of the object model in figure 2, this means that each party owns its own layer, and perform assignments based on their products to other parties in the organization. This differs from the approach of Riksdataförbundet, where the ownership of the whole object was belonged to the object party. However, in order to clarify that it is the IT system that is referred to, I have added the prefix it to the role name system owner in accordance with the distinction between business and IT system that is made in this thesis.

Through this change there is a possibility for the IT party to take a real responsibility for the technical development, without the object business parties regarding themselves as owners of parts of the technical environment.

Conducting system maintenance that is managed by assignments makes great demands on the manning of the maintenance organization. Thus, the manning discussion is given special attention.

3.4 Summary of Organizing
Maintenance objects, maintenance assignments and maintenance organization are means for organizing system maintenance businesses. Below, a short summary of the conclusions about how system maintenance should be organized is presented by;

- demarcating effective maintenance objects from object business products
- letting the maintenance objects contain IT systems and permanent maintenance products
- managing maintenance objects through well-defined maintenance assignments that are documented in contracts that in turn are instruments of control for the maintenance business
- organizing the cooperation between the object business party and the IT party in a micro organization that ensures change as well as stability

a manageable maintenance business can be achieved that contributes to giving system maintenance a business developing character.

4. SUMMARY OF CENTRAL CONCEPTS
As a result of the research process, a number of concept categories have been generated at different levels of generalization. The most central ones are briefly described in this summary. In figure 4, the concepts are related to each other in a concept graph. The concept graph is normative and describes the relations between the concepts. The overarching concepts maintenance business and maintenance organizing are left out of the graph, since it would become too overarching otherwise. The graph focuses organizing, but the result is a manageable maintenance business (see the initial objective/means-discussion).
The central concepts in this thesis are marked in grey in figure 4 and I choose the same starting point in going through the graph as I have done in the research process – maintenance business. To continuously start out from the actions has been an element in creating a pragmatic framework for manageable system maintenance. Maintenance activities consists of four main activities: support activities, change activities, maintenance management and technical operations. Maintenance activities is managed by different kinds of maintenance assignments between two parties. The maintenance organization is the producer of the maintenance business and conducts maintenance business. The maintenance organization consists of roles that are manned by individuals that represent the maintenance parties. The maintenance organization is responsible for a maintenance object that is demarcated by business products and contains IT systems and permanent maintenance products. The maintenance object is base for as well as result of the maintenance business. The maintenance object, the maintenance organization and the maintenance assignment are described in a maintenance contract that is the steering document for the work of the maintenance organizations, the maintenance business.
5. FURTHER RESEARCH AND DEVELOPMENT

The purpose of this thesis has among other things been to find a meaningful way of understanding and discussing system maintenance and thereby also make it more manageable. This purpose has resulted in a relatively wide scope concerning concepts and their relations to each other, and thus, there is a need for deepening the parts of the framework. As a next step, it would be interesting and natural to deepen the parts of the framework, in order to gradually develop it. This may for instance mean:

- deepening experiences and knowledge of maintenance businesses
- a deepened analysis of internal role- and product assignments
- strengths and weaknesses in the principle for maintenance organization in connection with different organization structures
- consequential analysis concerning IT systems that are parts of several maintenance objects
- trying the relevance of the channel concept in system maintenance businesses.

Apart from turning the research results into practical action, and thereby test and develop the framework further, I feel a need to interact on the international research arena. This is an activity that has been set aside for the purpose of performing thesis work and consultancy assignments during the last few years. This summary should be appropriate as a base for a research contribution to the international conference International Conference on Software Maintenance (ICSM) in the autumn of 2005.
REFERENCES


