COMIC

Issues of Supporting Organizational Context in CSCW Systems

Abstract

This report documents the work in Strand 1 of the COMIC project concerning the nature and support of what has been termed "organizational context" in CSCW systems. The report provides a variety of approaches to understanding concepts of organization and context, and their implications for computer support.

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Table of Contents

Introduction

This report documents the work in Strand 1 of the COMIC project concerning the nature and support of what has been termed "organizational context" in CSCW systems. While the term "organizational context" itself has been the subject of much debate — due to its multiple interpretations — both within the COMIC project and outside, it may usefully serve as an umbrella term for a variety of concerns that are discussed in some detail in the ensuing chapters. This Report consists of six major chapters, one from each of the partners involved in this deliverable, devoted to a conceptual analysis of concepts of organization and context, their utility, and the role of computer support. In addition, the report contains two appendices. The first appendix provides some further background papers, examples of the variety of working papers that have been produced in the first year of the Strand 1 project work, and the second appendix provides a list of all the reports — working papers, background papers, notes, etc. — produced during the year. This Introduction to the report provides an entry into the issues discussed in the subsequent papers. Note also that the initial paper in the report, the contribution from GMD, contains several sections that can be viewed as an extension of this Introduction.

We can take our starting point in the description of this work package — Strand 1 — in the COMIC Technical Annex:

> "The aim of this workpackage is to investigate the impact of organizational context on CSCW systems and how the salient features of organizations can be incorporated within cooperative systems. This will necessitate research from both a social science and systems development perspective. An examination of the role of the organization within CSCW systems and how much of this can be modelled will be undertaken from a social science perspective. Particular attention will be paid to the dynamic, flexible and locally determined character of cooperative interactions within organizations. The computer scientists within this theme will examine how these characteristics map onto computational models and the role these models can play in supporting cooperative work by CSCW applications. This examination will be combined with the development of techniques to allow organizational features to be supported within CSCW systems."

More specifically, the initial work — for the first year — on this theme was focused on "identifying the basic requirements of the representation of organizational context." This should serve as the basis for the further development of the conceptual framework and computational model of organizational contexts in the later stages of the work of this Strand.

So, what has been achieved to date in Strand 1 of the COMIC project? One of the early achievements of the work has been to surface some of the inconsistencies and ambiguities underlying the use of such terms as "organization" and "context" when discussing information systems use in organizations and to re-formulate the underlying issues in a more coherent and systematic way. This has not implied any unity of viewpoint — nor should it — on the appropriate perspective or conceptual apparatus to employ. This issue — of perspectives or approaches — is a central theme in the initial work of Strand 1 and grew out of discussion of the early work being conducted by member sites in the project. As such, it was grounded in spe-

cific concerns evident within the group, rather than being ephemeral. This has lead us to perform work in the early stages of Strand 1 that we had planned delaying until year 2, but it became impossible to divorce some of the concerns of the year 2 work on models of cooperative work incorporating organizational context from the year 1 work on understanding requirements. Thus it should be noted that we have already achieved some progress in our planned year 2 work in the initial year's work. Since this issue of perspectives played such a central role in our year 1 work, let us investigate it a little further, in order to clarify the nature of the problem we are addressing. The problem is encountered in both Strands 1 and 2 (systems development and work settings) and arises from the perspectival (and disputatious) nature of the social sciences, perhaps most especially sociology. The aim of computer scientists in seeking to build systems which effectively support complex patterns of work leads them to take increasing note of the "organizational context" within which they are to situate their systems. They want to understand both the way in which the organization provides an environment within which the system will eventually be embedded, and they also want to understand it in terms which will help them determine how the organization may relevantly be represented within the system itself.

It is not surprising, therefore, that they should begin to turn to the social sciences in search of such understanding, for the social sciences have a long standing involvement in the attempt to understand and provide models of organization. However, confrontation with the literature making up 'organization studies' is likely to prove initially bewildering, because it may seem that its contemporary condition is one of disarray. At the very least, it presents a multiplicity of unresolved issues. The history of organization theory has not been one of the development of a consensual and accumulating paradigm, but instead, one of multiplying perspectives, which follow on from each other only in a temporal sense, the transition from one to another typically involving a radical change of direction. There is, amongst organization theories, much of the same heterogeneity that we found in our review of methods of requirements capture at the end of Strand 2 — heterogeneity, that is, of (disciplinary) background, of problems, of objectives and of users, at least. Some of the theories of organization have a predominantly academic/scientific motivation, whilst many have a strongly pragmatic purpose at their heart, and there is a corresponding variety in the identity of those who are meant to find interest or utility in the theories. Thus, there are theories whose primary audience is other theorists, but there are those which are addressed to those who seek, in one way or another, to restructure organizations.

The study of organizations originates in various of the social sciences, including economics, the administrative sciences, psychology and sociology, with, of course, accompanying and significant differences in central problems and in conceptions of the methods through which solutions can be sought. The disparate nature of approaches to organization and the discontinuity between them has brought the situation to the point at which there is, within 'organization studies', a strong and growing sense of crisis. Though some have mounted vigorous defenses of the

more 'traditional' conceptions within the field, others have taken the patent plural-ism of the field and the contentious nature of the relations between the various po-sitions to indicate its near terminal state, — its entry, at least, into a 'postmodern' condition in which many of the hopes which motivated it can only be abandoned. The idea of the 'grand narrative' was certainly one which long infused organization theory, the primary objective being to provide an account of *the organization as a totality*, but there is now within the field of organization studies a widespread scep-ticism about the prospects for any such all-round account, a scepticism which does not occur only to those who themselves hold 'postmodernist' views. Thus, Schmidt's (Risø) contribution to this deliverable concludes that 'there is no overar-ching scheme for the analysis of organization — and none is required.'

It is against this background that Bower's (Manchester) summation and critique of Gareth Morgan's influential book *Images of Organizations* is situated. Morgan's work condenses and characterizes some of the central conceptions of organizations — as brains, as machines, as systems of domination, and so forth — which have made up organization theory. Morgan's approach is to suggest that there can be neither outright contest nor simple complementarity of the various approaches to organizations. Each has a certain validity but involves, also, a crucial and limiting selectivity from the empirical complexity that is an actual organization. Thus the re-lationship between the approaches is not such that they could be combined in some more all-round portrayal, e.g., it can be argued that the essential character of certain conceptions of organization is such as to obscure the very phenomena which other approaches are designed to highlight.

The increasing recognition given to the diversity of purpose and the heterogene-ity of viewpoints within organizations does not, however, imply that one must thereby despair of an understanding of organizations, for, indeed, this recognition proposes a new — but no less systematic — way of understanding them, one which emphasizes the extent to which organizations are themselves comprised of and *enacted* through a diversity of viewpoints. It is to this conclusion that the con-tributions of Bowers (with its 'performative' conception) and Schmidt (in its rejec-tion of an organizational 'Leviathan') are clearly pointing. Such conclusions are comfortably in accord with the work pursued in other contributions to this strand: For example, the early work on TOSCA at GMD primarily embodies a structural view of organizations and explores possibilities for its computer based support. It was precisely while discussing the pros and cons of such a perspective on organi-zations in one of the early workshops in the project that we realized the need for addressing anew the whole issue of frameworks and perspectives on organization and context. This search for a more fully —informed view on the topic can be seen in all of the contributions to this report. Progress has been made by all the sites on re —formulating their concerns in this area to take account of the ongoing theoreti-cal discussions.

As noted earlier a conspicuous feature of work in Strand 1 has been the inter-weaving of social and technical approaches to questions of supporting organiza-tional context in CSCW systems. The various sites involved in the work are deeply

involved in re —working both their conceptual bases and their practical work in order to accommodate or at least investigate other approaches. At another level, the work in Strand 1 obviously is affected by, and affects, work in other Strands. In particular issues of heterogeneity of viewpoints and a focus on organizational issues overlap with concerns appearing in the Strand 2 work. Indeed several of the sites involved in Strand 1 are also active in Strand 2, so they are being mutually informed. Likewise, there are obvious links between the work on Strand 3 on models and notations and the work of Strand 1, especially in the coming year as we develop our conceptual and computational models in the area of organizational context. Contact on these issues has already begun and a joint workshop is planned in year 2 of the project. Various issues surfacing in Strand 4 concerning interaction and awareness through computer systems are obviously relevant to the work of Strand 1, and again there is overlap between the sites and the Strands. The fruits of these collaborative activities should emerge in future work. Already, in terms of planned activities we see evidence of these developments, both across sites in Strand 1, and also in connections across the existing Strand demarcations.

Let us briefly indicate some of the progress made by each of the parties in their work during year 1 of the project in Strand 1 and planned future work.[1] The Manchester group has assisted the work of the Strand as a whole by providing a useful synopsis of earlier organization theory work, as well as contributing substantively in arguing for a performative approach to understanding organization. While the full implications of this approach are still to be worked out, exemplary cases have been described. In addition, Manchester has been exploring the relevance of concepts of organizational memory and the role of computer support. This work is ongoing. The major work for the next year will be on explicating in greater detail and investigating empirically the performative view.

At GMD, an initial prototype system (TOSCA) was based on a particular model of an organization. During the project the system was extended with an object administration and modelling design tool for the extension and creation of different organization models and views. In the next project phases this will be used for two purposes. First, the Manchester work which has identified different views on organizations will be applied and appropriate models will be developed as an experiment. Second, the Milano transaction model presented in chapter 3 will be combined with TOSCA. In the longer term, the UPC work on "scale" and the proposed application of ODP models will fertilize our work. We believe that we will benefit substantially from the discussions and application of the different views and models. Another focus of our work was directed towards the aspect of "awareness". We believe that this plays an important role for the provision of an organization feeling in a distributed organization. In this context, our contributions to strand 4 include a model for the provision of awareness information in an object system. A

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1   It should also be noted that during the first year work has also been done in the strand by a number of other institutions than those named above. Their work is included in the list of working papers in Appendix B.

first demonstrator has been build for TOSCA. Future plans include the further elaboration of that model under consideration of the boundary concept. This can be used for the provision of information about activities in the organization on different levels. TOSCA will be used as an underlying system that provides information about the organizational structures and boundaries and that facilitates the "awareness information" distribution.

At the beginning of the COMIC Project, Milano dedicated some months to the definition of a model of cooperative work settings as networks of work processes. Among the interesting features of this definition there were, on one hand, the ability of representing both the procedural as well as the informal dimensions of work activities and, on the other, the ability to relate the complexity of a work process to its transaction costs. The model was then partially applied to a real case, in order to evaluate its effectiveness (Milan-1-2). The discussion within Strand 1 on organizational context allowed Milano the possibility to define the organizational context of a work process, and to describe how it could be represented within a knowledge basis. Next steps of Milano's work within Strand 1 will be: (1) reformulation of the Milano cooperative work settings model on the basis of the observations of other partners (Risø, Manchester…) (in cooperation with the whole Strand 1); (2) the extension of TOSCA to model the organizational context of a work process in accordance with the Milano model (Work processes in TOSCA, W–TOSCA) (in collaboration with GMD); (3) the definition of new conversation and work flow models (in cooperation with Strand 3); and (4) a discussion of the applications of transaction costs theory on the analysis and design of cooperative processes (in cooperation with the whole Strand 1).

Work at Risø has been undertaken on a number of fronts. Firstly, further elaboration and clarification of cooperative work arrangements, with particular reference to how such arrangements relate to traditional conceptions of organization (see deliverable contribution). This has included a critique of the transaction costs approach popular today, and will undoubtedly form the basis for further work in year 2 with other Strand 1 groups and outside experts. Field studies of cooperative work arrangements in different settings with a view to grounding discussions of computer support for such arrangements are ongoing (see Appendix). Further work on organizational modelling will tie into the work already underway at Risø in Strand 3 on notations and formalisms for designing mechanisms of interaction.

At UPC, the focus has been on problems involved in "scaling up" cooperative work arrangements and the problems of their computer support, even across traditional organizational boundaries. This work is influenced by and will influence not only CSCW technologies but also distributed systems technologies such as *Open Distributed Processing* (ODP), and business integration technologies such as *Enterprise Integration* (EI or Enterprise Engineering). Two central concepts used in this work are federation and trading. Federation is an organizational structure which enables loosely coupling of previously disjoint organizations or work units: the organizational context of a large scale arrangement may include more than one organization. Trading is a key function which enables work articulation. It provides indexes

to services, structures, other intersecting arrangements, statutory constrains, in a dynamic fashion, supporting the evolutionary nature of work. This work is very important as too often research is carried out within particular traditions, and a key feature of the UPC work is to both export ideas from the COMIC CSCW milieu out into other domains where some of the problems being tackled are similar, if not identical, for purposes of debate and discussion, as well as ensuring that the COMIC work is informed of, and takes into account, related work done by other bodies.

At Oulu, the early work on the project has been concerned with examining the utility of the activity theoretical framework with respect to such issues as organizational context, and exploring the feasibility of empirical research efforts. Due to administrative delays the work in Oulu started six months later than the main project. Therefore the main results to date within this strand are the definition of the conceptual framework and planning of empirical work and practical experiments. These will be carried out in three areas: in a cooperative setting between a health care center and a hospital, in an office of teaching administration and in a team doing software testing. For the two latter areas, an experimental prototype system based on the ideas suggested in the section will be built and tested during the next year. The results will be used in refining the framework itself.

In sum, the parties involved in Strand 1 of COMIC have accomplished quite a lot within the first year. As well as examining aspects of requirements for supporting organizational context via computer systems, they have proceeded a long way down the road towards agreement on the need for heterogeneity of approach, and in delineating the strengths and weaknesses of different approaches. Further, there has been considerable debate and discussion among the sites concerning the relation between their different initial conceptions of organizations, the nature of work, and what constitutes organizational context, to such an extent that each of the parties is actively engaged in modifying their framework in the light of these discussions. Thus the Strand has already begun to attack the core issue for the next stage of the work in Strand 1 — developing a conceptual framework for describing organizations.

Aspects of Organisational Context in CSCW

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GMD

This paper presents our view to the notion of organisational context in CSCW systems.

Organisational context is introduced as the sum of the social, organisational and technical environments of the organisational working processes. A set of key aspects is highlighted each of which can be regarded as candidates for computer support and it is shown how these aspects interrelate in a real world organisational setting.

Four basic dimensions of systems design are introduced, which focus on important cooperation enabling aspects of organisational context in CSCW applications. An investigation of these categories with respect to already input ideas in the COMIC Strand 1 working group leads to requirements and new approaches in application development.

Finally the paper presents specific requirements for one aspect that has been identified in the first part: representing the organisational structures and setting.

1. Introduction

Computer Supported Cooperative Work (CSCW) is defined by Bannon and Schmidt [Bannon, Schmidt 1991] as "an endeavour to understand the nature and requirements of cooperative work with the objective of designing computer-based technologies for cooperative work settings". Support for cooperative work settings in general is based on top of a certain organisational configuration in which cooperation takes place. This configuration can range from organisations like big insurance companies or governmental administrations with more or less precisely defined flows of work to organisations with only a few people involved but with much more dynamic activities in the process of work involved (e.g. a power plant). Of course this classification is far from being complete — we can imagine any organisation but it is obvious, that there is no "all purpose CSCW system" being able to give sufficient support for all types of organisations.

The term organisational context is often used in literature concerning CSCW systems as an unspecified and somewhat fuzzy notion to refer to those parts of the system that explicitly deal with the concrete background of the underlying organisation [Grudin 90]. It is our belief, that the key to success of systems in this application area is a clear understanding of the various requirements imposed by the underlying organisation and of how these requirements can be modelled in the framework of an application. The COMIC project has devoted its research activities in Strand 1 to explore these requirements and derive appropriate support mechanisms of organisational context in CSCW platforms.

The intent of this paper is to develop an approach to concentrate the research issues of Strand 1 on a few key aspects making up together the notion of organisational context in CSCW, an attempt to divide the whole topic into smaller ones. It is shown how different phenomena of organisational context may interrelate and why support of cooperation cannot be achieved without a sophisticated treatment of them on the application side. On the other hand — because the proposed classification of the main problem is very general — we can say that the different issues that are developed in this paper form a set of cooperation enabling requirements. A detailed treatment of the different aspects leads to a set of more precise requirements and points that have to be further investigated. Of course we do not claim that our refinements are complete.

Another objective of this paper was to integrate different inputs (especially in Strand 1) to COMIC and show how the work that has already been done fits under this framework, and in this way get to a common understanding of future activities in this Strand.

In the first part of the document we develop our understanding of organisational context as a set of interrelated semantic/social and technical phenomena of the organisational work processes and work out some key aspects which can be regarded as candidates for computer support. Additionally we show how these aspects interrelate in a real world organisational setting.

The second part of the document introduces four dimensions of relevance to the notion of organisational context in the framework of CSCW applications. It is shown how different phenomena of organisational context influence these dimensions and an extensive investigation of resulting requirements in systems design is elaborated.

Finally the paper presents specific requirements for one aspect that has been identified in the first part: representing the organisational structures and setting.

2.   Aspects of the organisational context of a working process

Various discussions at the Barcelona meeting of the topic "organisational context" have shown that many views exist and that organisational context is not a category which can be easily described by a single definition. Therefore we follow in this paper the approach to describe our view on organisational context by an identification of its major aspects. Thus it is not our aim to present a comprehensive description of organisational context, but we will try to identify those components of it which are relevant for the computer support of cooperative work.

We consider the organisational context of cooperative work as the social, organisational and technical environment of a working process. Considering the organisational context of a working process, two directions for further consideration can be identified (Fig 1).
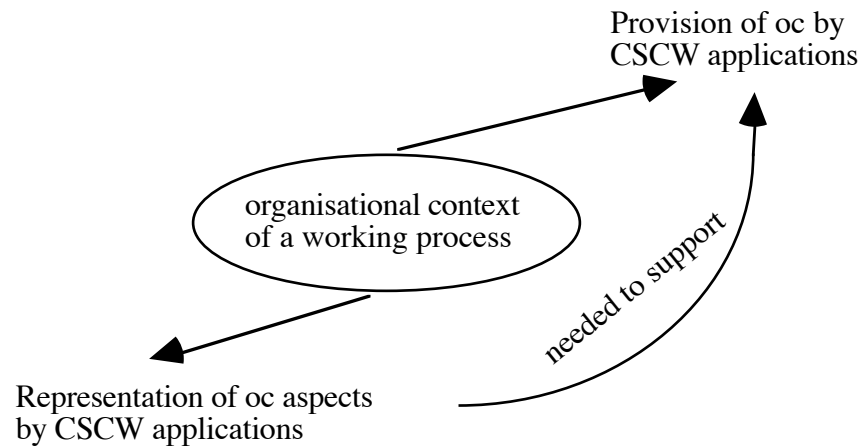
Fig 1: Organisational context: representation and provision

First, we can turn our view on the working situation and its organisational framework in order to support it by a computing system. This results in a computing system that represents the organisational structures which determine and underly the working process, which supports the management of the working resources (e.g. documents, information bases), and that provides tools for the coordinated resource processing (e.g. editors, spreadsheets, communication and coordination systems, etc.) in order to fulfill the working process. It is the standard way for the support of groups with (CSCW)-computing equipment.

The other view regards the fact that electronic or virtual organisations or offices[1] will become more widespread with the availability of communication links, bandwidth and cooperation support tools. To give just two examples, such organisations will be formed for locally distributed projects such as COMIC or for the quick establishment of task forces which collect experts from different places. Today these organisations are supported quite weakly. It is a goal of CSCW research to make such organisations as productive and enjoyable for its members as physical organisations, i.e. organisations which are located at the same place.

An important prerequisite to reach that goal is not only the provision of communication facilities and appropriate working tools, but also the provision of facilities and information that serves to increase the awareness about the organisation and its state of affairs with the goal to provide the same organisational feeling to electronic organisations than to physical. This is what we mean with "provision of organisational context". Media spaces are one example for an approach that contributes to that goal. However, while that approach is focussing on "synchronous awareness" we believe that the asynchronous provision of information about actions, activities, events, etc. plays an equally important role to keep people up to date with, and involved into the organisations affairs.

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[1] Unfortunatly none of these terms describes the idea correctly, but the right term has not yet coined.

This idea of providing or supporting the creation of an organisational context is more directed towards the social aspect. The need for that is probably not that demanding when we look at organisations whose members work locally with frequent personal contact, e.g. a project group at one of the COMIC organisations. But when we look at distributed organisations such as the whole COMIC project where people meet only from time to time and where a lot of communication breakdowns occur in between these meetings, then we see very quickly the big difference between the organisational context of the COMIC organisation and the local project group: the difference of cooperation bandwidth and the different levels of awareness about the overall working process.

With cooperation bandwidth we mean the possible means by which people can communicate. This ranges from simple mail exchange (low bandwidth), via phone or video conversations to face to face meetings (high bandwidth). But, with bandwidth we mean more than just the amount of data that can be exchanged between partners. It includes also the fact that working together at the same place allows for a wider range of interaction mechanisms and in many cases it provides a much higher awareness about the status of the overall working process. Although both aspects are related we will consider them separately for our further consideration of organisational context. In particular we see the awareness aspect as a crucial factor for the provision of organisational context in a distributed organisation.

The meaning of the term awareness in cooperative work is manifold. Awareness can be understood as a persons knowledge of the abilities and competences of somebody else in his group or organisation. This type of awareness can be supported with organisational information systems in which profiles of the organisation members are maintained. That approach is discussed in [Press 92]. The Chaos [deCindio 86] system aims to gather that information automatically by the coordination and observation of structured communication between people. Another meaning is the awareness of the current ongoing activities in the organisation. That approach is supported by so called media spaces (EuroPARC). These systems support awareness about currently ongoing activities, i.e. synchronous awareness. Less research has been focused on the support awareness for mainly asynchronously working groups of people, like the COMIC project members. Our experience shows that in such groups a lot of communication can be identified as meta communication, i.e. explicit communication to exchange the status of the group. It is our believe that a more implicit support of asynchronous awareness is very important for the provision of organisational context or in other words, of a cooperate work feeling for the members of a distributed working group.

To sum up, we have collected a set of aspects of organisational context of a working process. Obviously this cannot be an exhaustive list. Many other aspect may play a role, but we consider organisational context from the viewpoint of computer support. Thus the aspects we have mentioned here are those of which we think that they are relevant for the consideration of computer support for cooperative work.

This leads us to the following working definition for organisational context from a computer support viewpoint:

The organisational context of a working process involves

- the organisational structures of the organisation,
- the working resources, i.e. objects which are processed,
- the working tools which are provided to fulfill the process,
- the cooperation bandwidth that is provided for cooperation among people in the same context, and
- the mutual awareness about the overall aspects of the working processes.

The term organisation is used to reflect any kind of organisation from the organisation of a local project group or the organisation of a distributed project such as Comic up to an organisation such as a research institute or university. The aspects organisational structures, communications and awareness refer to the social dimension while the resources, tools, and communication facilities mainly refer to the technical dimension.

The aspect of organisational context are one side of the medal, the properties of an organisational context are the other. Working processes are interrelated and the organisational context of these processes are interrelated and influence each other. We can identify changes between the organisational context within an organisation and interrelations between the organisational context of different organisations. This is illustrated in the following figure.
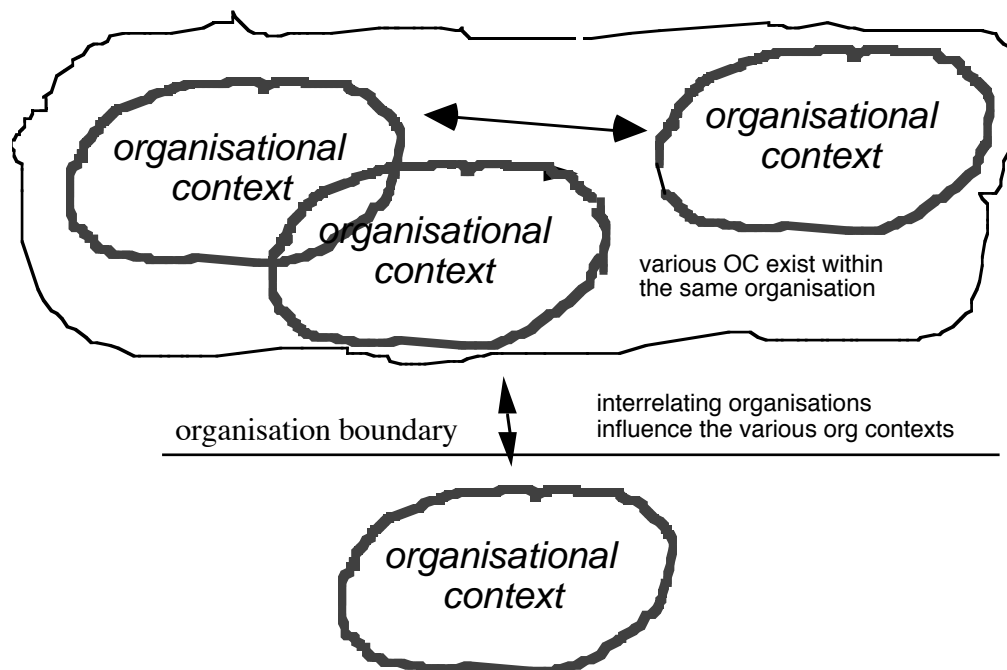
Fig. 2: Interrelations of Organisational context

The figure might erroneously suggest that an "organisational context" is a well defined boundary around a working process. Obviously the boundaries of a

working context can not be well defined, but we must consider them as an open ended and and not well defined field with different intensity. That must be further investigated in the next project phases in order to identify the properties of an organisational context and to develop a basis for the modelling work in year three.

The following interrelations and reasons for changes between an organisational context can be identified:

- it depends on the current work process of a person and therefore it changes with the users focus on different work processes
- the context can change within a working process, e.g. in COMIC when the communication bandwidth changes: when people meet or when they cooperate via mail.
- working processes are pretty much interrelated and thus the organisational context interrelates with a lot of other contexts and influences them as well as it is influenced by others.
- work process which overlap between different organisations (e.g. in COMIC: the comic organisation and the local home organisation). Both organisations influence each other and imposes possibilities and constraints on each other. These have to be regarded by applications which support the cross boundaries. In chapter 6 of this deliverable, further considerations on that problem can be found.

In addition to these reasons for the interrelation of organisational contexts it is important to investigate how the different working processes and involved contexts influence each other. Chapter 5, section 5 lists additional considerations on overlapping and intersecting organisational context. Future work of the project will focuss on a further conceptualization of these aspects.

For the comprehensive support of cooperative work and the provision of an organisational context it is important that the CSCW applications provided to a user reflect the issues of organisational context identified above appropriately. We will discuss later in this paper how these aspects can be combined to identify four basic requirement domains for CSCW applications.

Obviously all requirements can not be met by a single applications nor does a single application support just one aspect of organisational context. Instead, applications support various aspects of the organisational context while they probably focus on one. This happens because the aspect are closely interrelated. How they are interrelated is discussed in the following sections.

2.1. Relations between the organisational context aspects

Working resources, tools and organisational structures form a triangle with the following relationships:

work process

working tools

transforms

working resources

is embedded into
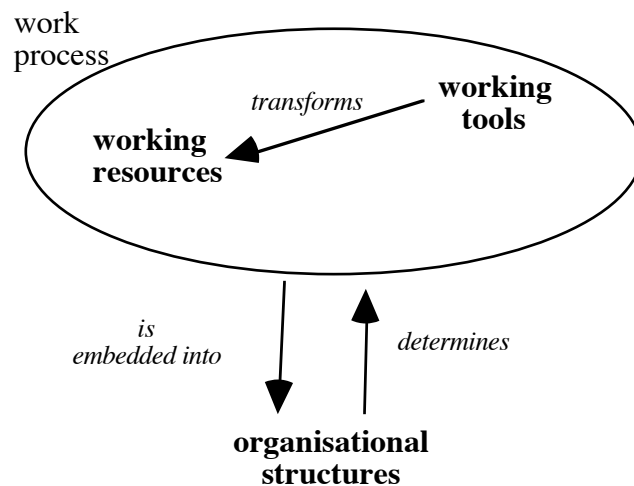
determines

organisational structures

Fig. 3: Relationship between working resources, tools and organisational structures

Working tools perform a transformation on the working resources. These can be documents, messages, e.g. objects which themselves are computer artefacts or things like screws, engines which can be represented in a computing system only. According to the type of the resource the working tool is either a computer tool (e.g. editor, workflow system) or also something that exists outside the computer world. Although also for the non computerizable application case a CSCW support is possible we will focus our main attention on those tools and resources which can be represented in a computer system.

The application of tools on resources is done by users in order to perform a work process. This work process is embedded into the structures of the organisation for which the work process is performed. This can be seen from two sides: the work process is influenced from the regulations and constrains that exist in that context. Thus the working resources and tools are linked and embedded into the organisational structures. This link can be also seen as an indice into the larger context of work that is currently performed by a person, i.e. an indice into an organisational context. The use of the working tools and the effect and visibility of their use is determined by the organisational structures and the context in which the user is embedded. This influence is not that big when the work process in which the tool is used is local and isolated. But it becomes more visible when this is a process that involves other users, i.e. when it becomes a cooperative process. Then, the organisational context determines the distribution of consequences of that effect and the awareness information that cooperating users will receive. This leads us to the following figure.
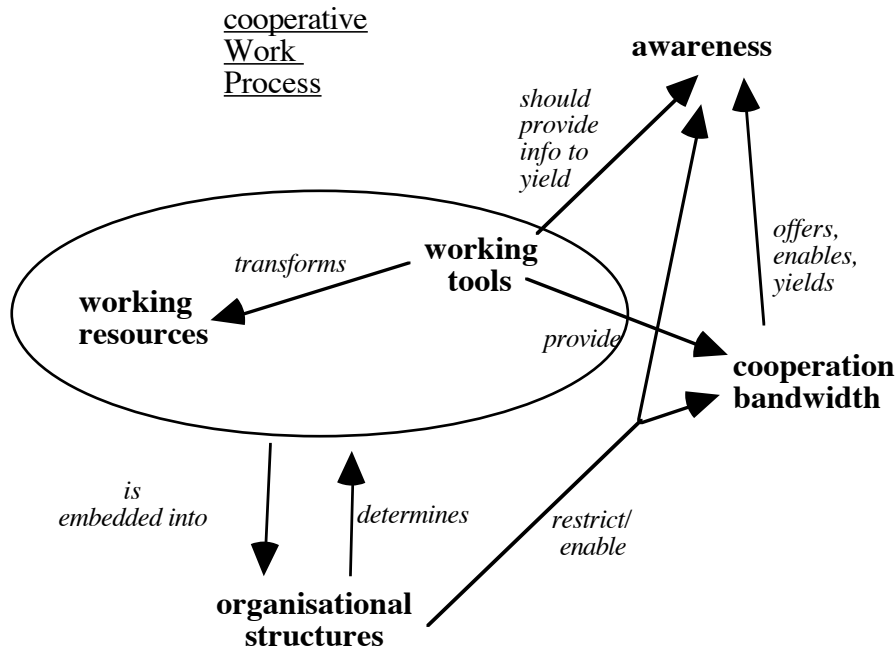
Fig. 4: Relationship between the oc aspects in a cooperative work process

The possible bandwidth of cooperation is determined by the organisational structures and the working tools available. So, if we consider the structure of a distributed organisation like COMIC, cooperation between the members is restricted by the working tools we have available. These are mainly mail and phone, perhaps in the future video conferencing between several sites. For the COMIC members within an organisation there is a much broader spectrum of possible communications means and working tools available. Thus cooperation possibilities also depend on the organisational structures which in this case reflect geographical distances.

But cooperation is not only enabled by explicit communication tools like mail or phone. Also the fact that a new document is placed in a file server can be considered as communication provided by the working tool ´ftp´.

But, who would know about the fact that this had happened without an accompanying email? Nobody! Thus it is a strong requirement that working tools which process information with shared access, should provide information about the process to the group of people who are involved in a working process or in the same organisational environment or in other words, working in the same organisational context. This information supports the individuals awareness about the current status of the whole working process. A first attempt on how this information can be gathered and distributed can be found in the strand 4 deliverable and in [GMD-4-5] and [Mariani, Prinz 93].

The relationships between different organisational context determine the further distribution or exchange of events, consequences, awareness information, etc.

between different contexts. Crossing the boundaries may cause transformations of information. It is a further and ongoing work item to identify the set of transformations and to develop a computational model for this [GMD-4-6].

2.1.1. Relationship between cooperation bandwidth and awareness about the working process

With cooperation bandwidth we denote the available communication media and interaction facilities of cooperating users. There is a close relation between this aspect and the awareness aspect. Awareness about the status of the working process is often transported as a side effect of communication or cooperation. The higher the cooperation bandwidth, the higher the amount of awareness is. For example: Two people working together at the same place, perhaps even in the same office have a much higher awareness about the things going on in a project than two people who are working in distributed places. The distributed working people spend much more time and effort on explicit synchronisation and mutual information of there working processes than the locally working people, where most of that is done implicitly on the fly.

CSCW researchers tried to tackle that problem with the development of tools which support the explicit coordination of distributed work [Kreifelts, 93]. In addition to these applications we need systems which provide awareness about ongoing activities at different places in an implicit way, i.e. without explicit actions of the cooperating people. The lower the cooperation bandwidth the more systems are needed which provide information to yield implicit awareness by other means.

2.2. Organisational context in COMIC

We believe that distributed organisations such as COMIC are of particular interest for organisational context considerations. Therefore we will give a description of the currently available tools for the provision of organisational context in COMIC according to the five categories identified above. Furthermore we will give a list further requirements[1].

Organisational structures:

Current State

The organisational structure of COMIC is mainly determined by the four strands, the programme management committee, the people responsible for certain tasks and the project members. The most detailed representation of the organisational structure of COMIC is available in the Technical Annex, but this is information which is not available to computer applications.

The only computer representation of the COMIC structures are the distribution lists at Lancaster. However, these lists are black boxes which can be used for message distribution only. They are not visible, i.e. members from the outside cannot see who is a member of a DL and thus a member of a strand, etc. The only infor-

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[1] This list reflects issues of a brainstorming session at one of the meetings.

mation we get about the actual members in COMIC are the hotel booking or participant lists for a meeting.

Further Requirements:

- an accessible and modifiable structure representation of COMIC. This would help to know who is working in which strand. Who else can I contact at an organisation if I can not reach the prime contact point. It would also help in the organisation of meetings, e.g. the expected number of participants, etc. More important is that information for the appropriate distribution of awareness information. According to the structures of COMIC, information about changes in the member list, of the availability of new documents can be distributed in different forms to different groups. For example whenever a new document has been placed on the ftp server an automatic notification that contains details about the new document is mailed out to all members of the appropriate strand, while all other strands just get the information that changes have occurred. This is just a simple example, but in the context of awareness provision in a large group such as Comic a representation of the underlying organisational structures is necessary to guide the information flow and to avoid and awareness information overload.

- Beside the pure structure and address information it is very useful to provide information about the situation of work. It is useful to know where people work and how the surrounding of the office looks like. This is normally achieved by visiting people. Another solution for that would be the provision of videos in addition. The goal is to achieve a feel of the place were the other members are working.

- Comic is not an isolated task at the member organisations. A lot of links exist between Comic and its environments: secretaries of members, overlapping with other projects, peripheral members, etc. It would be helpful to have that information available for the provision of export and import mechanisms between COMIC and its related organisations.

- etc.

Working Resources:

Current State

The major working resource of Comic are documents. The only support for 'sharing' these resources is the ftp server.

Further Requirements

- a shared resource management system which is integrated into the normal working environment

- etc.

Working Tools:

Current State

Microsoft Word, Mail, and ftp are the tools commonly used in Comic.

Further Requirements

- support for organisational procedures: the management of COMIC involves a large set of organisational procedures, such as the distribution of documents, planning of meeting, etc. It would be useful to have some sort of automated support for that.

- managing impressions: for the facilitation of discussions it is useful to have early access to ideas or unfinished documents. That is easy to achieve in an organisation were people are collocated, but difficult for a distributed organisation like Comic. The idea is to have a COMIC cookie program that pops-up, ideas, metaphors, deadlines, etc. at login time, or other occasions. It would be nice to have such an application in COMIC available.

- support for inter organisational cooperation within an organisation this tackles the problem that cooperation in COMIC is a cooperation between different organisation which involves a lot of organisational and technical problems.

- etc.

Coordination and communication:

Current State

The major media for communication is mail. However, most communication between members regarding planning and synchronisation happens at meetings where face to face communication is possible.

Further Requirements

- Video links between all sites would be nice, but this can not be expected in the time scale of this project.

- etc.

Awareness:

Current State

Awareness information is provided only explicitly , e.g. "I've placed a new document on the ftp server". This information must be distributed actively by the acting users. The tools we currently use do not provide this information implicitly.

Further Requirements

- working focus: instantaneous or current

  for contacting other people it is useful to know whether they are reachable at all, or what their current working focus is. This avoid s delays and disturbance of other people, but it includes also a big privacy issue.

  For example we could use xhtalk, a tool that uses "finger" to check whether people are logged in and which then allows to open a talk connection. It could be used in COMIC to provide information about the reachability of other COMIC members. It will be interesting to see whether it will increase ad hoc communication between Comedians.

- informal checking of (working progress), e.g. the progress that has been made on a document, or on the input papers for the next meeting, etc.

- more automatically provided information about things which happened in COMIC, e.g. new document released, new members involved, etc. In order to avoid an awareness overloading we need filtering and transformation mechanisms which allow the provision of different awareness levels based on the source of the action which produced the awareness information.

- etc.

3.   Dimensions of Organisational Context in CSCW systems

3.1. Overview

After having considered some of the basic aspects making up the notion of organisational context in real work settings we now turn our attention to CSCW systems and highlight the basic issues that we consider to be important in order to support these aspects by information technology. The approach taken here has the objective of being as general as possible in the sense that we project the crucial systems properties into only a few problem spaces that need all be treated extensively in order to achieve true support for cooperative work.

We distinguish four dimensions of support in CSCW systems that inherit their requirements from the various aspects of real organisational context:

- Structure
- Information
- Process
- Awareness

With Structure we denote the requirements and properties of CSCW systems to represent and make available all the things that together make up that particular organisation. This does not only include a description of the organisational hierarchy but also involves the working resources as well as communication infrastructure and tools. With Information we associate all the issues in systems, that are concerned with providing the user with some sort of information in order to enable him to carry out a certain task. The term Process considers the problem of computational support for the (cooperative) working processes in an organisation, especially we pose the question on how we can design these support tools under quality aspects. Awareness finally is concerned with the aspects of giving the user an implicit overview on the working situation, especially we look at the issues on what we can additionally gain by using CSCW systems as compared to real organisational awareness

The different dimensions are closely interrelated as will be shown later, and we cannot distinguish them always in a rigid fashion. The distinction of these different problem spaces in systems design however allows for a more systematic treatment and investigation of the multiple relationships between organisational context on the on hand and implications and design decisions concerning CSCW systems on the other hand. It will be shown that the derived characteristics in these dimensions cannot be obtained by a 1:1 mapping of the phenomena of organisational context under consideration into a domain of systems properties and requirements. Instead, the different dimensions in CSCW get influenced by multiple aspects in real world organisational context.

3.2. Structure

3.2.1. Motivation

If we want to design systems for the support of cooperation in organisations it is essential, that the aim of the design process is an integrated working environment in which every member of the organisation gets a look and feel which is as close as possible to the traditional working situation. An environment consisting of a set of isolated applications that do not know about what is going on in the whole organisation besides their own domain of responsibility will not meet this requirement. We do not only have to model the processes of work but we also have to embed them in a representation of the organisation as a whole.

So, in CSCW applications we need an abstract description of the basic organisational settings and rules which together form a framework for the different cooperation supporting parts of the environment. This backbone of organisational representation is what we denote with the notion of Structure concerning systems support of organisational context. Whereas the real world organisational structure introduced in the preceding chapters mainly considers the formal organisational hierarchy the term is in this context also associated with representation of the working resources, tools and also communication infrastructure and bandwidth as well as the multiple relations and metastructures linking the different parts together.

3.2.2. Generality

An Implementation has a multitude of possibilities to formally represent the Structure. Tools for the support of well defined tasks are always based on an abstract model that enables the description of the desired functionality. This model has to be chosen very carefully in order to meet the requirements imposed by the task (efficiency, tailorability, extendibility, etc..) For example in DOMINO [Kreifelts 84] a system for the support of strictly regulated processes the workflow is represented by Petri nets. In the etiquette message system of Tsichritzis and Gibbs [Tsichritzis 85] the underlying model is essentially a deterministic acyclic graph (DAG). Messages may be sent from a given node to all nodes, that can be reached by following the edges in the DAG starting from that particular node.

But in a CSCW environment we want to be able to integrate many applications that are responsible for different tasks and that have to share the same Structure. So the Structure of a CSCW environment needs to be of a more abstract or generic nature. In [Aiello 84] the Office Expert System is introduced, which is a tailorable all purpose CSCW description formalism that allows for a specification of the whole palette of organisational structure: atomic objects like employees or salaries and whatever is in the focus of interest, more complex aggregates like departments and the like as well as abstract representations of organisational rules and activities which can in turn affect the organisational structure itself. In this formalism, the organisational structure of CSCW-systems can be viewed as a carefully laid out dynamic interaction of a set of different components ranging from basic objects to complex structures and rules, with the property, that every (imaginary) step of interaction yields a new set of structural settings.

In terms of implementation this model relates to a general object model that allows for the definition of the whole spectrum of structural components. An example for that can be seen in the organisational object server TOSCA, described in [Prinz 93], [GMD-1-4]. The underlying object model can be used for the definition of fine grain atomic organisation related data, as well as for abstract objects, that are instantiated depending on some state of context together with application adaptable relations. The object oriented paradigm furthermore provides the necessary encapsulation and hence separation of the traditional notion of implementation data and functionality which results in the required flexibility of the overall system. The same arguments apply for the desired extendibility of resulting applications and their ability to cooperate: we can avoid isolated applications by applying the same object model.

3.2.3.   Sharing

When people cooperate, one of the most basic observations is the existence of a common object of work (Two people carrying a table into another room). So, in order to achieve systems, that really support shared work in organisations the implementation of the structural representation of the organisation needs to be able to deal with objects that can be shared and synchronously modified by different users.

In Strand 4 of the COMIC project much effort has already taken place in order to develop a shared object service [GMD-4-1], [GMD-4-2], [LANCS-4-2].

3.2.4.   Reflecting changes in organisational context

As shown in chapter 2 the organisational context may change in different working settings. Organisations can have multiple sites which may be located in different cities or even countries. As the members of organisations move to another working context, it is important for support systems to reflect this change. A manager who is involved in supervising a production process in different locations needs to get system support according to the different organisational settings. The description and relations of these different settings are another task of the structure, which has to be nested in the same way as the whole organisation.

3.2.5.   Export mechanisms

Organisations often cooperate. This form of cooperation is usually not a global agreement for collaboration as it is (or should be) the case inside a single organisation. Instead, cooperation usually is restricted on a certain project and those parts of the participating organisations that are not involved in the project normally continue working isolated from the other organisations or even in competition to each other. An example for an inter-organisational cooperation is the COMIC project. Typically, in these forms of cooperation we observe that social interaction of the participating members is at a minimum level: the people involved usually see each other very rarely and knowledge about each other's interests and skills is often very low. The locations of the participating members may be spread across different countries and it is almost impossible to get an overview on the current global activities in the project. In this scenario CSCW systems have a good chance to find acceptance if they are able to overcome these problems.

A system that unifies the appropriate structures of the participating organisations would imply a certain transparency of the overall organisational situation and working activities with respect to the people using such systems. This is of course an insight that no organisation is willing to grant to a competitor. So in inter-organisational cooperation we need some export facilities that allow the publication of a restricted subset of each Structure and a mechanism to form a new Structure out of that to enable the cooperation partners to work in a new virtual organisational environment. This environment could then offer a user the same functionality and familiarity he had before because it is only extended by the other cooperation partners and related structural components while the parts of their old environment that do not relate to the project are invisible to him.

Technically speaking, this could be achieved by making use of the X.500 directory service [GMD-1-3], [CCITT 92], [Prinz 90] which provides a means for organisations to export organisational information, which can be accessed worldwide. ODP [ISO 91], another standardisation effort supports large scale open distributed processing which could be used to realise the provision of a common inter-organisational structure and to implement the necessary interaction mechanisms between the distributed cooperation partners . The basic key words in this respect are Federation and Trading. These mechanisms are treated in detail as input to COMIC-Strand 1 in [UPC-1-1].

3.2.6.   Conclusion

To sum up, the term structure denotes a description of the global organisational architecture that forms the backbone of the overall system. Using a carefully laid out shared object model to implement this backbone provides us with flexibility and the ability of applications to cooperate. Another important issue concerning the Structure dimension can be seen in export mechanisms to combine different structures in order to create new ones.

The concrete form of the phenomena that we observe in the organisational context should be the basic guideline for the design of the Structure in CSCW applications, rather than the technical settings and properties of systems that are used as the environment where the applications are implemented. This contradicts strongly to the usual way, how systems are designed currently, e.g. by using a file hierarchy as a means of structuring the application. In this way, the support can be modelled according to the real work situation.

3.3. Information

Besides some sort of more or less production-oriented functionality, one of the most significant tasks of CSCW systems probably is to provide users with some kind of information. A mail tool not only lets you edit, send and read messages, it also should provide you with information about the number of messages in your mailbox, status information of messages, or it should let you retrieve old messages from a given user and the like. The term Information denotes here the dimension of CSCW-systems that is concerned about provision of information. The problems in this dimension range from information display and request specification to different views and orientation aspects. In the framework of organisational context it is also important to provide information in different contexts and to look at security issues. Finally, we believe that communication in organisations is also a facet of the Information dimension. However, with the term Information we do not associate the aspect of information representation because we believe these issues to belong to the Structure dimension.

Since the desire of a user to get information may involve potentially anything in an organisation, it is necessary, that the phenomena of interest in real world OC find their denotation in the Information dimension of computer support. This can only be achieved by applying the following design criteria in the development process.

3.3.1. Access control

Access to information is usually not open to all users in the system. It is sometimes the case that special users like supervisors etc. use the system in a privileged mode in order to gain information on what is currently going on in the whole system whereas others can only retrieve information related to their work process. The DOMINO system is an example for that. Users have to enter a password to gain supervisor status, which is needed to retrieve information concerning the global workflow. On the other hand, it is common in many systems, that users can define a private information space of some sort and restrict access to that information from other users. Most operating systems have that feature.

However the term access control does not always imply such a restrictive nature of control. There is also a filtering component which should be taken into account : However, a mandatory requirement for CSCW systems is that access control is performed according to the context of work and the role of the user.

3.3.2.   Information display

Another issue that comes up when talking about Information is the problem of displaying information. In times when computer screens only had poor graphics facilities, information could only be displayed in textual form. Because screens often were slow the amount of information output had to be kept small. This led to the problem that users needed a certain amount of expertise to understand different kinds of information display syntaxes. The UNIX operating system is a famous example for a system where these problems were especially severe. Similar considerations like the above also apply to the problem of specifying by the user what information is requested.

Today it is common to have window oriented systems, where information is usually displayed in a homogeneous fashion in different applications using scrolled lists, check boxes and so on. Hypermedia systems can be used to link Multimedia information and provide a web of information where the user may navigate through. For example SEPIA , a cooperative hypermedia authoring environment lets the user arrange (Multimedia) information as a nested net of information units which may be connected by argumentative and logically typed links, together making up an argumentation space where the reader can navigate through and get an overview of the logical interrelation of the different issues [Streitz 92]. Additional techniques for browsing information are presented as input to COMIC Strand 1 in [NOTT-1-1].

3.3.3.   Orientation in the information space

The above example also points to a serious problem related to the topic of information display: nested levels and views on information often have the disadvantage that the user who is viewing the information looses the orientation concerning the issues he was originally looking for. Advanced graphics facilities and high resolution screens of today's workstations have led to the desire of more sophisticated information display mechanisms. Three dimensional interfaces, where information can be displayed as objects in space are now under development [Benford, Fahlen 92], where the user can navigate through, allowing the representation of more fuzzy information. E.g. the notion of similarity between informational objects might be represented by spatial collocation. In this way the user is provided with more than just information display: he also is given an orientation in the information space which can help him to avoid the problem of getting lost.

3.3.4.   Access to information in different contexts

As another important point it should be noted that a carefully designed CSCW platform should provide information access independent from what the user is currently doing. The different tools in the system have to be able to provide information not only related to the tasks they are responsible for, but also about other tools on the platform. The way to achieve this goal is again the provision of a homogeneous object server platform as the basis of the CSCW environment, where all

applications can request information as needed and all tools should provide the user with a homogeneous information-viewing and -navigation facility.

3.3.5. Different views

Information retrieval from different contexts also leads to the general issue of providing different views on information. Different context here means different tools or applications as well as different users (members of the organisation playing different roles): When retrieving information about an employee in an organisation, a clerk in the department responsible for the salaries is only interested in the number of hours the employee spent at work and the salary group of the employee, whereas the boss of the employee is interested in different things, e.g. he might be interested in what the employee is currently doing. A CSCW-system should always know the working context in which users interact when retrieving information because such facilities help to reduce the amount of unnecessary information.

3.3.6. Information and Communication

The last example leads to a further point to be mentioned: no database or object server can be complete — neither in the amount of information that is contained nor in the range of services it offers. We still need a way to get access to informal knowledge provided by specialists. This means that a good communication infrastructure is mandatory in a CSCW environment. The organisational knowledge browser in TOSCA e.g. allows ad-hoc communication via email or video conferencing from every object to persons related to it and thus people who might serve as specialists in that respect. Another general work-platform, the KnowledgeNet [Marmolin, Sundblad 92] explicitly has the problem of getting information by specialists in focus. The users of the system form a set of peers with every member exporting a certain range of knowledge that she/he agrees to share with others. Using a rooms metaphor CoDesc, a graphical interface for the KnowledgeNet arranges the different peers in groups, providing easy access to the knowledge available in the groups, and allows for spontaneous communication to the desired people.

3.3.7. Conclusion

Providing information is a central task of CSCW systems. The basic problems concerning this task are issues of information access and display as well as orientation and individualisation of views on information. In contrast, communication can be seen as ad-hoc information provided by a human being through the system. In either case, organisational context should be the design objective for all of these tasks in order to structure the information space as natural as possible. In this way, it is left to the users intuition and especially to it's working experience where to look for or whom to ask for the right thing.

3.4. Process

3.4.1. The traditional approach

Another view of the problem of defining organisational context can be seen in the approach of regarding organisations in terms of the work processes. In terms of implementation this concerns the decomposition of the whole cooperation setting according to the particular organisational environment into a set of interrelated sub-processes. At the end of the development process is the implementation of a set of tools responsible for supporting these processes with well defined interfaces among each other. Well known examples for early CSCW systems, that explicitly supported the working processes of organisations are Officetalk-D [Ellis 82], [GMD-1-2] and DOMINO [Kreifelts 84].

These systems were especially designed for the support of strictly regulated processes and their underlying Structure as introduced earlier is designed for the maintenance of a predefined process setting. This means that these systems usually have to be configured and fine tuned by specialists in order to work correctly and modifications of the functionality is a rather tedious task. What is needed in CSCW platforms instead is a dynamic specification support that allows for the creation, deletion and modification of support tools. Such an approach is faced with the following problems:

- It is essential that the representation of the structural organisational model allows for efficient and extensible tools.
- The concrete procedural units in organisations almost never match the formal organisational structure, instead cooperation always crosses the boundaries of departments and does not follow the paths of predefined hierarchies. Responsibilities and management in organisational units are often interdependent.
- Tools have to be especially flexible when global workflow does not obey the rules of strictly regulated processes, i.e. in organisations with significant communication and coordination needs.
- It is in general unpredictable what happens, and thus hard to resume when a breakdown in one of the processes occurs. Hence it is desirable that support systems for organisational processes are autonomous enough to prevent global breakdowns and give sufficient recovery support.

In order to find suitable solutions to the above mentioned problems different approaches to tackle the aspect of procedures in organisational context have been proposed in Strand 1 of the COMIC project so far:

3.4.2. An Activity Theory approach

In Chapter 4, an analytic approach to the problem of specifying the work processes in organisations is proposed, which will be summarised here very shortly. The authors show how activity theory concepts might be used to overcome some of the

insufficiencies mentioned above. An activity is introduced as "a fundamental type of context" associated to some unit of work under consideration. This context is minimal with respect to the surrounding complexity to enable the recognition of the essential phenomena, as well as maximal enough to avoid oversimplification — both is needed to give sophisticated computational support. An activity basically consists of an active subject and an object to be transformed. This transformation is mediated by a tool and according to Kuutti and Arvonen the smallest structural model to capture the notion of activity is shown in the following diagram.
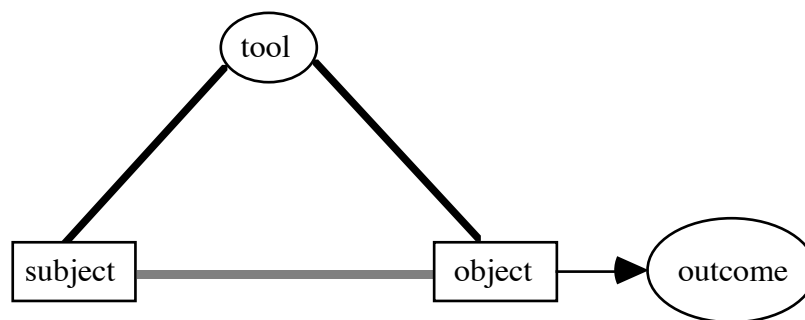
So the binary transformation relation between subject and object is replaced with two mediating relations subject — tool and object — tool. By extending the model with a community component and two additional mediating relations (subject-community via rules and object-community via a division of labour) we can also bring into consideration the dynamic relation between an individual and it's (social organisational) environment. The activity model then looks like shown in the following diagram.
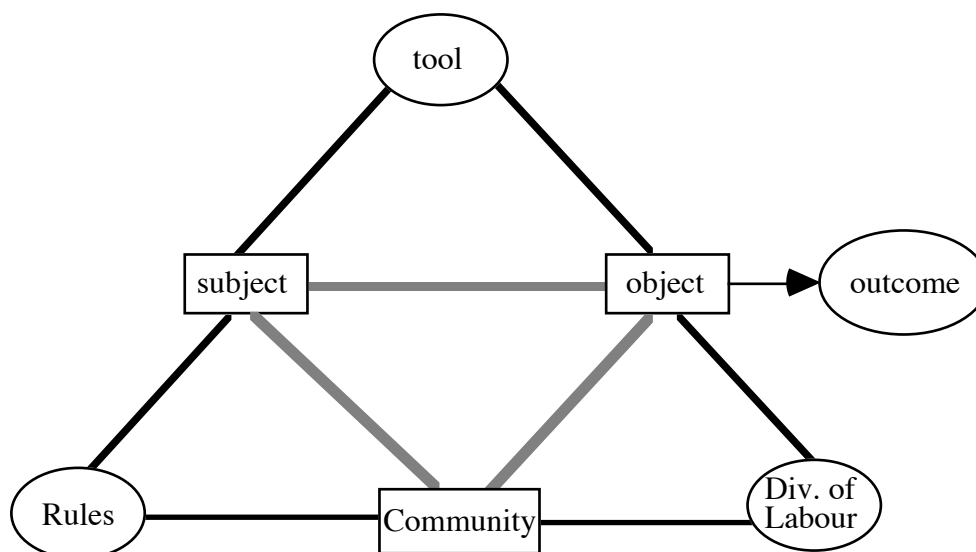
The authors show, that by finding the characteristic activities in organisations, we end up with communities of active subjects sharing the same objects which is what we need in a computational model to support cooperative work. The model is in close harmony with the intuitive definition of the basic work units to be supported and allows the description to span from the individual to the organisation-wide level, at the same time being more flexible than the traditional concept of formal organisation. On the other hand it is shown that the activity theory approach overcomes common problems resulting from the fact, that structural organisational settings not necessarily coincide with the units of activities in organisations, by considering also an organisational community environment with the active subjects sharing a common object. Having specified the activities with the above characteristics it should be straightforward to develop the tools supporting them.

3.4.3.   Transaction costs

A second way to approach the problem of organisational work processes can be found in Chapter 3 which gives consideration to organisational work processes from a complexity point of view. Starting point is the definition of organisational context as a flow of actions which are embedded in a customer-performer relation giving them a meaning. The actions may be nested, i. e. in order to perform an action, the performer may open another one, this time being the customer of the newly created action. The performer, together with all participants in the sub-processes constitute the cooperation network of this particular work process. From these cooperation networks we can abstract the flow of actions as well as the flow of communication. From the tight interleaving of action and communication for the participants in the cooperation network we can derive the observation of complexity as the basic characteristics of work processes. The above leads to the investigation of transaction costs of work processes as the fundamental measure of their economic value. Among other factors, the transaction costs heavily depend on the threshold of sustainable complexity which can be described as a maximum number of work-activities a person is able to participate in at the same time. The author shows, that enhancing the threshold of sustainable complexity can effectively improve the overall workflow in the cooperation network and this in turn is shown to depend strongly upon the quality of tools used. Thus, such an enhancement allows to improve the overall workflow without a need to restructure the organisational workflow as a whole. The author proposes finally some examples of requirements for the tools to overcome the following common problems that can occur in the organisational procedures which can be regarded as enhancements of the threshold of sustainable complexity.

- breakdowns within procedures
- coordination problems
- collaboration problems
- organisational noise and organisational opacity
- multiplicity of tasks

3.4.4. Conclusion

It is evident that the design and the functionality of tools in CSCW systems depend upon the working resources and tools in real organisations. In terms of the notion of process as introduced above however we also get dependencies from the organisational structure because the definition of activities is very much determined by them. According to the work of De Michelis there are additionally many influences from the communication bandwidth as it can enhance the threshold of sustainable complexity and thus reduce the overall transaction costs. The two approaches of describing working processes, presented above differ in their aims. The activity theory approach tries to isolate the characteristic activities in real organisational settings and define a suitable social environment to enable the provision of computational support whereas the second model doesn't care about how we get to the working processes, instead it tries to define a measure for the quality of computational support.

So an innovative way of developing support for the processes in the organisational context might be, as the first step, the specification of the characteristic activities and second the development of tools to support these activities with respect to the requirements needed to solve the above problems.

3.5. Awareness

3.5.1. Introduction

Awareness is not a dimension of organisational context that considers architectural aspects. Instead similar to the notion of information discussed earlier it is more a requirement. The main distinction between information and awareness might be characterised as information being a requirement concerning the object of work whereas awareness concerns the user or subject in the organisational context. Common to both concepts is also that awareness — like information — can potentially involve all OC aspects of real organisations including real awareness (I probably want to be aware that somebody is aware of me). In a general concept of awareness the distinction between awareness and information inevitably becomes floating as it is shown in the following sections.

3.5.2. A metric for awareness

There have been lots of activities in the COMIC project (especially in Strand 4) going on to capture this feature in CSCW systems: in [GMD-4-5] a concept of awareness in shared object systems is introduced. Awareness in such systems may be defined

- between different users (working in some context of shared object domain)
- between users and objects (awareness of objects that are in some sense related to the set of objects the user is currently concerned with)

- between different objects (objects being aware of changes that have occurred to other objects where the former have a special interest in).

Examples that clarify why these three basic kinds of awareness are useful might be in the first case that a user notices suddenly that another user enters the same object space he is currently working in and then has an immediate possibility to get into contact with him (e.g. by opening a video connection) to discuss problems that have been encountered. Entering the same object could mean in this context that the user performs some kind of operation on some of the objects that the other one is currently working on. In a specialised working environment, the fact that someone works in a certain object domain implies a high probability, that he has a special amount of competence in the area related to this set of objects. An example for the second type of awareness might be that a user which is new in an organisation is viewing some description (a document or a more intelligent activity object) to organise a certain task and suddenly he becomes aware of another object that describes a closely related topic. This probably leads to useful conclusions and can serve as a help to get familiar in the new environment. Finally, awareness between objects themselves can be very useful in a cooperative environment when objects know about the existence, creation or deletion of related objects (and of course about their own stages of existence), in this way being able to tell the user, currently working on them, that something potentially important for him has changed since the last time he was working on the object. So the last type of awareness is closely related to the notion of history in object systems.

Although we now know about the importance of awareness in collaborative object systems, we still don't know how to achieve the desired behaviour of the objects. It is obvious, that the key issue to achieve this is embodied in a suitable definition of the notion of "nearby" as a relation between objects. Such a definition could then be extended to include objects and users in order to model the three kinds of awareness introduced above.

In [Mariani, Prinz 93] the authors propose a basic event mechanism together with a metric in object systems which can be regarded as an approach to define a "nearby" Relation. This can in turn be used to implement awareness in the above form: an event handler creates a new event object every time an operation is carried out and notifies all parts of the system that are interested in this event. On a single object level a calculus to measure awareness as a function between objects and types of operations is introduced. An awareness factor measure can then be obtained under consideration of the kind of operation that happened to an object, the number of additional objects, that have also been involved in this operation and a special importance factor of the object allowing for a differentiated treatment of the various object types in the system. This calculus is not only useful to measure awareness of users accessing the same object, but also provides a means to calculate the awareness of users accessing similar objects where again similar means some sort of semantic vicinity.

3.5.3. Spatial representation of awareness

Another approach to gain awareness in CSCW systems that is currently discussed in the COMIC project considers awareness as a way to define the communication and interaction in a populated information terrain ([NOTT-4-1], [NOTT-4-3], [NOTT-4-4], [NOTT-4-5]). In this approach awareness is defined in a virtual world environment, where users and objects are represented as spatial artefacts, able to navigate and explore a three dimensional information space. In such an environment users can meet each other, they can access and use objects and tools, they can share resources , collaboratively create documents and so on. In a real organisational setting this world could be structured in a virtual building consisting of offices, public tool rooms equipped with printers and the like up to meeting rooms, libraries, seminary rooms and (why not?) floors between them. In large scale organisations this immediately points out a demand for some basic mechanism to schedule the potential of interaction and communication supported by the system so that users won't get overloaded with information and communication they are not interested in, and of course to prevent systems resources from getting used up.

In the papers listed above a spatial concept of interaction is introduced allowing users in the system to cooperate. The basic key words in this approach are the notion of nimbus , focus and aura which can be thought of as geometrical attributes of the objects that can be directed in space and that are used to regulate interaction. Communication and transactions may only occur, when the auras of the according objects/users intersect. Awareness can then be defined as a state of intersection of the nimbi and foci of two or more users and objects. Hence we could describe this approach as management of attention in a shared multi user CSCW environment.

3.5.4. Summary

The awareness support model from Prinz and Mariani provides a suitable metric and event mechanism to implicitly provide shared awareness in object systems. A sophisticated spatial treatment of awareness can be seen in the approach of Benford and Fahlen. Whereas the first approach seems to be suitable for both synchronous and asynchronous work situations, the second one focuses on management of synchronous communication (management of attention).

However in CSCW platforms for the support of organisations there has to be an additional possibility for users to define a certain scope of awareness according to their working environment in order to limit the domain of events they are interested in. At the same time they should be able to announce a special interest in events that do not directly relate to the object space they are working in. Both requirements have to be solved by a suitable mechanism in the Structure and are another open question that has to be answered in COMIC Strand 1.

Systems often get classified by the well known CSCW matrix for support systems, which is shown in Fig. 5.

	same time	different time
same place		
different place		

Fig. 5

This classification has commonly been criticised as being to rigid to describe the real nature of cooperative work arrangements. Systems that can be assigned to one of the fields in the matrix usually do not match the work they should support, because the work usually ignores these boundaries. It is in fact exactly this weakness, which may be eliminated in CSCW systems by providing sophisticated mechanisms in order to let the user be aware of synchronous and asynchronous events in a cooperative arrangement. In this way, we have a chance to develop systems that can no longer be classified in the above schema, but instead treat work practices as wholes, and may thus be placed into the following one-field matrix:

	any time
any place	

Fig. 6

3.3. How do CSCW applications deal with the different design dimensions?

Now we will consider a specific CSCW platform, the TOSCA system [Prinz, 93] in order to identify how that tool supports the different dimensions, that have been introduced in the preceeding chapter.

Structure:
- The basic design method of TOSCA consists of a Semantic Net. The net describes organisational objects and relation objects.
- The object oriented approach guarantees the flexibility to model various organisational structures and domains. The system provides a specific Object Model Designer tool and is thus extendible and provides a means to visualise the Structure.
- Nevertheless, there is no explicit sharing support incorporated in the basic object model, nor does the system provide any export mechanisms as

introduced in the preceding chapter. The Structure has global character, in the sense, that there are no individual dynamics in the responsibility of single users.

- The obvious application of the TOSCA System is the modelling, visualisation and maintenance of organisational structures and thus the system serves as an all purpose information base for CSCW systems.

Information:

- One of the design goals of TOSCA is the provision of a framework for access control in object spaces, that is embedded in an organisational Context. This feature however is not implemented yet.

- Information display is provided by a hypermedia interface, that allows for searching in scopes restricted according to multiple organisational criteria, as well as browsing through the web of organisational objects along the relations.

- The orientation problem is tackled in TOSCA via construction of organisation charts, that help the user locate his position in the information space. An organisation chart basically consists of a graph that represents the relations of the organisational structure according to the current position. Because there is only one level of context visualised, the system does not provide a global overview.

- As a CSCW information platform, TOSCA provides an application programming interface that allows any application to access the whole information space. Thus it is left in the responsibility of the applications to provide information access in different contexts. The browser could be used by any application for that purpose and is able to present different views to objects: objects may have specially object-specific representations (e.g. person objects) as well as generic views, constructed out of the object's attributes.

- The object system supports communication as an important issue in organisational settings; there are multiple predefined communication channels defined, which can be attached to objects. The different types range from conventional communication media like telephone and fax to electronic media like email, or broadband video channels. If available, the channels may be accessed directly in the browser via special communication panels in the browser interface (e.g. it is possible to launch a video conference in the browser if the object under consideration has the required facilities defined). Another communication service in the system which is defined for all objects can be seen in the "yellow notes": small messages, that can be attached to objects and that may be read by anybody.

Process:

- The type of process that is directly supported in TOSCA is not the traditional one as introduced in the preceding chapters. The actual work that the system supports can be called organisational orientation based on shared organisational information. This work can be done by applying the browsing and modifying tool.
- As an information platform, TOSCA offers the possibility to develop applications that make use of the information and support the specific work processes of a particular organisational setting, thus providing indirect cooperation support.

Awareness:

- Similar to the Process dimension, we can argue for the Awareness dimension, that TOSCA can be regarded as a framework for the implementation of mechanisms that aim to give the users a shared awareness in the organisational context. In this sense, we can say that TOSCA incorporates a static information basis that model organisational boundaries and domains which are a basis for such mechanisms.
- There are however also some more dynamic facilities realised in the system: e.g. the "yellow notes" mentioned above serve to give the users an implicit awareness about the activities, problems and experiences with other users who have accessed the same object and were thus working in the same context. Currently, effort is spent to extend the system by a special CSCW event mechanism, which will be capable of representing and managing the required information that allows a treatment of the awareness problem in a local i.e. organisational context embedded fashion. This mechanism will hence increase the dynamics of the system which is needed in order to give the users shared awareness of the work setting.

4.   Specific requirements for the representation of the organisational setting

The aspects of organisational context which have been identified in section one lead to the idea that some of them might be supported by a particular service within a CSCW system. This section presents the basic requirements of an Organisation Information System (OIS) which would support the first aspect: representation of the organisational structures of cooperative work.

These requirements are derived from all four domains that have been presented in the previous chapter. However, most determining were the domains of structure, information and awareness.

4.1. Representation and provision of organisational structures, entities, and relationships

Organisational structures are the skeleton and basic organisation instrument of an enterprise. It is therefore essential that they can be appropriately represented in an OIS, because they are needed for the provision of overviews and information about the enterprise organisation, for the description of functions and services (who is doing what), and for the organisation and administration of the OIS itself.

Their representation and provision involves the following aspects:

• Structure components and functions

Elements of the organisational structure are organisational units (departments, projects, committees, etc.) and associated with those are roles. Roles are used for an abstract description of certain functions and responsibilities within a unit. From the cooperation support viewpoint, an OIS must support the modelling of organisational units and appropriate roles to support the identification of relevant and appropriate services in an organisation. This enables to answer questions such as: Who is responsible for a certain task or who should I contact for contract questions in the legal department?

• Organisational entities

Organisational entities are the employees, roles, departments, committees, groups, resources, etc. of the organisation. This OIS model must represent these entities including information about their role and use in the organisation, which is needed for the support of cooperative actions.

• Organisational relationships

Organisational relationships describe the associations and assignments of organisational entities to each other and to the organisational structure. They relate an organisational entity to the framework of the organisation and to the context of its work setting. These relationships cannot always be described in a static one to one mapping. Therefore the OIS model must provide means for a dynamic modelling of organisational relationships.

• Administration

Although organisational structures are primarily established for the organisation of work, they often determine the organisation of technical systems and domains, too. An OIS must reflect this for the own administration (e.g. in the naming scheme) as well as for the provision of administrative information (e.g. , access rights) to other services.

• Dynamism & Flexibility

Organisations, their structures, and the composition of organisational units are subject to dynamic changes. The structure modelling capabilities of an OIS must allow an easy and consistent tracking of these changes. The structure model must be flexible and it should not hardwire the structures and its modification should not imply major data reorganisations.

The structure model should not presuppose a specific — e.g. hierarchical — model of the organisation structure. It must be adaptable to various kinds of organisation, e.g. matrix or branch organisation.

• Visualisation & Multi-Media

For information and browsing purposes, the OIS user interface must provide means for the visualisation of overviews (e.g. as organisation charts) and rapid browsing through structures. Detailed information about particular organisational entities must be also presented. Often this information can be best presented when different media types are utilised. Thus the OIS should be capable to manage and represent beyond textual descriptions different media types, at least photos, graphics and audio information.

4.2. Provision of information about organisational services and procedures

In addition to the structure information, an OIS model must be capable to represent information about the services of an organisation and how they are handled. This information is useful for two purposes.

First, it provides members of the organisation with information about the services offered by the various departments of the organisation and it explains how these processed. This helps novice employees to find around in an organisation, but also experienced employees will profit from this when they need help with a specific organisational problem.

Second, this information is required by CSCW applications that support the handling and carrying out of office procedures. The early developments of these types of CSCW applications [Ellis, 1980] have experienced some criticism recently by [Robinson, 1991] or [Schmidt, 1991] because of their inflexibility and non-observance of the situatedness of work [Suchman, 1987]. Nevertheless it can be foreseen that, with the widespread use of electronic mail in organisations, user demands emerge for more intelligent and active mail systems [Borenstein, 1992], which support a multi hop mail exchange according to organisational or problem-specific message flow requirements of the transported information [Shephard , 1990].

According to the experiences with office procedure systems and representations [Kreifelts , 1991] the following issues must be considered .

• Representation of recommendations

Experiences show that it is not adequate to represent the complete organisational handbook. No employee obeys these rules and procedures correctly. One is tempted to say that this is a major reason why large organisations work at all. People use these descriptions mainly as resources [Schmidt, 1992] for their coordination of work. Thus an OIS should represent organisational procedures more in the form of outline than in the form of a formal procedural descriptions. Nevertheless these representation should be interpretable by a computer application.

• Provision of alternatives

Alternatives to a given procedure are often more interesting for a user than the procedure itself. Thus the OIS model for the representation of organisational procedures should provide means for alternative descriptions or for the demonstration of relationships between relative procedures.

• Individualisation

Information about organisational services or procedures must be individualisable. For example: It is of much more help for a user to get the information that he may get support by "Person Smith" than getting the general information that he should contact "somebody in the legal department". The individualised information is at the same time a prerequisite for its use by a computer application which has no understanding of "somebody". The selection of the appropriate person may depend on different criteria, such as the name, project, department or role of the requesting user. Suitable description methods must be supported by the OIS.

4.3. Flexible and extendible organisation model

The OIS model must be flexible enough to be applicable to various kinds of organisations. It is impossible to develop a single, fixed organisation model that fits a range of organisational forms and needs. Thus as the basic data model layer, a data model must be developed that allows the representation of basic organisational entities, relationships, functions, etc. On top of that an organisation model layer should define building blocks for the representation of basic organisational entities. This layer should have a tool kit character, i.e. the entities defined in that layer will be refined to be applied for the modelling of a specific organisation. This approach allows a compatible modelling of different organisations. The development of the organisation model should be supported by appropriate modelling tools.

Organisational reorganisations may require not only data modifications but also additional model modifications. Therefore it is essential that the organisation model can be adapted to organisational changes that happen after the development of the initial model.

For the integration and adaptation into the personal working environment it is useful when groups or even individuals can refine or extend the model for their

needs, i.e. for the definition of special address objects, message type objects, or project document objects. This functionality raises the requirements that model modifications can be made distributed on site by privileged users and that this can be done at runtime, since the whole system can not be stopped and reconfigured for each model modification.

The OIS should also provide visibility of the modelling concepts [Schmidt 91], i.e. the organisation model entities should be visible for the interested user, so that not only the organisational data is presented, but also the concepts that have been applied to model this data.

4.4. Data security and access control

Experiences with the introduction of the X.500 Directory, a world-wide electronic address book, into our own organisation have shown that people are very sensitive about the provision of their communication addresses and simple interest profiles to a (potentially world-wide) information system. Most people wanted their information being visible only within the organisation or department and not to the outside.

This experience shows that access control is a crucial factor for the success and acceptance of an OIS. Own experiences with DIMPLE, an early X.500 Directory prototype, show that a too complicated or too fine grained model is too difficult to manage, which results in the fact that it is not applied at all. Thus, the access control description model should allow a flexible and easy modelling of access rights, supported by the provision of organisational default rules.

4.5. Communication support information

For the support of CSCW applications the OIS must provide extra support for the representation and supply of communication information. This involves the aspect of communication addresses and reachability information.

• Communication addresses

Beyond the common postal, phone and e-mail addresses, nearly every new CSCW application requires its users to manage and memorise new communication addresses, e.g. users login-, computer-, or host names for shared applications [Sietec, 1993] or broad-band communication net addresses for video-conferencing [Fuchs, 1993]. The OIS should serve as a general communication address directory for users and applications. This requires that the OIS data model is open for new communication addresses and types. Characteristic for many addresses is their construction by a hierarchical concatenation of several address part, e.g. the phone number of an employee is composed by an organisation number[1] plus extension. For consistency and manageability reasons the OIS must offer means for modelling and representing the construction of hierarchical addresses.

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[1] this includes already the country and area code.

• Reachability information

Communication addresses represent technical reachability information. In addition it is desirable to represent working context dependent reachability information, i.e. user preferences for different communication media in different circumstances. This includes support for the selection of alternative, context dependent substitutes in urgent cases when the person is not available. Context dependent means that depending on the request for which the person is contacted different people may be chosen as a substitute. At least we can distinguish between formal substitutes in personnel or organisational decision cases (often the superior) and substitutes in technical questions (often one or more colleagues).

On a higher level similar information must available: organisational units often provide the boundary and on the same hand the entry points for the distribution of information. This involves the internal information distribution among the members of a group and information about suitable access points for external information request or input. This information helps people requesting information from a project or department to find directly the appropriate person or secretary without a need for searching around by several phone calls.

4.6. Support for distributed management of the organisational information

It is obvious that the organisation data can not be administered by a single organisation expert. Different people are responsible for the management of different bits of data. This ranges from the user itself to technical administrators of communication services to the personnel department. As a basic requirement the OIS model must provide means for modelling and enforcing these responsibilities. In addition it would be useful to support the coordinated management of the data. The example of including a new employee entry in the OIS shall illustrate this: The personnel department creates a new entry with the basic personal data of the person. Then the technical administrators are automatically informed about the new employee. After they have installed the appropriate services for the new user, they add the appropriate communication addresses into the persons entry. A report is given to the user or to the personnel department, when all formal data is included and the new employee may now include additional information. Similar procedures may be started when data in the OIS is modified that involves the modification of data by other technical administrators.

This example shows that in addition to responsibility information the OIS should include dependency information for organisational data which allows the initiation and control of distributed administration procedures.

4.7. Integration with the X.500 Directory

An approach chosen in [Hennessy, 1993], that has been investigated in [Prinz, 1992] too, is the application of the X.500 Directory for organisation modelling.

X.500 is a CCITT and ISO standard for an electronic address book [X.500, 1992]. With its potentially world-wide distribution, its methods for distributed data management, and its standardised service interface, it fulfills simple requirements for a distributed address directory. However, shortcomings arise when the directory is applied to a more detailed modelling and administration of organisational information. [GMD-1-3].

Nevertheless, an OIS should benefit from the existence of X.500, and access to this information service should be integrated. This allows additional access to address information of other (cooperating) organisations. The X.500 system can then be used as a bridging system for different OIS. X.500 access should be integrated transparently, i.e. the OIS users shouldn't need to switch to another system for the retrieval of X.500 information. References from OIS data to X.500 information should be supported too. This allows for example the modelling of groups which include non-organisation members. When this information is accessed, the request is automatically forwarded to X.500 and the result is returned in the same way as OIS data is returned.

Beside the integration of X.500 into the OIS, access from X.500 into the OIS is needed to avoid the administration of two different services within the same organisation. This can be achieved in a simple way by exporting OIS data into the organisations X.500 agent. Another, more integrated, alternative is the provision of a direct OIS access point to X.500. In this case the OIS must provide an X.500 Directory access port.

4.8. Integration of external applications and resources

Since the OIS represents communication address information its user interface should include direct access to the according communication services whenever possible. Thus the user should not be forced to switch applications after an address has been retrieved. This requirement has effects on the user interface and on the OIS model. The user interface should provide means for the inclusion of external services and the OIS model must be capable to represent the combination of communication addresses and knowledge about the initiation of local communication services.

In addition, the OIS cooperation support benefits when the resources of cooperation and communication such as documents, calendars, structured message types can be integrated with the context in which they are used. The OIS should therefore support the association of this information to its organisational context, i.e. by linking it to the projects, departments, etc. where they are used or to the people who use it. This allows access paths to resources based on their organisational embedding and it additionally supports the distribution of news about resources to the relevant recipients.

4.9. Provision of awareness about organisational changes

The dynamics of organisation requires that its members are periodically informed about organisational changes. Today, this information is often provided by the distribution of periodical bulletins to each employee [1]. The OIS can support, replace and enhance that information service by the electronic distribution of information about changes that happened to the OIS. These can be either changes to the organisation model (e.g. availability of new model entities) or modifications of the OIS data (e.g. new document templates, new or modified organisational services, new employees). Depending on the modification type or modified entity and its embedding into the surrounding organisational context, different groups of people must be informed. In addition it is thinkable, that different groups are supplied with different information details. The automatic selection of recipient groups depending on the origin and organisational context of the news, in combination with different information detail levels, can help to avoid an information overload.

This OIS functionality requires a news-model that is capable of forwarding OIS news to appropriate groups of employees depending on the actual model and data of a particular organisation, in order to increase the organisation members awareness about actual changes and news of their organisation.

4.10. The OIS Architecture: Service Platform and User Interface

The previous requirements imply an equal OIS supports for applications by integrated services and users by an information browsing interface. This requirement can be satisfied best by a client server architecture that distinguishes between an OIS server and OIS user interface. The OIS server realises the OIS model and offers services to other applications. The user interface should then be realised as an application on top of that service interface.

4.11. Summary

This section has identified basic issues that have to be considered when a model and system is developed for the representation of organisational structures and settings for the support of cooperative work and CSCW applications. Two specific models and systems which address this issue are investigated in the COMIC reports: [GMD 1-3] and [GMD 1-4]/[Prinz 93]. In particular the TOSCA system will be used for further eleboration of the concepts developed in this strand. For that purpose the system has been extended within COMIC by a model design tool that allows a flexible modelling of organisational information. This will be further used for an application of TOSCA for the ideas presented in chapter 3 and for experimental modelling of organisational views presented in chapter 2.

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[1] At GMD for example we have a monthly bulletin called "Verwaltungsmitteilungen".

5. Conclusion

It has been shown that the notion of Organisational Context in CSCW systems can be approached by regarding two levels of systems design: on the upper level an observation and analysis of the basic phenomena of interest in the work of real organisations is needed together with an identification of the crucial, cooperation enabling interrelations and influences between them. This has then been transformed into a set of requirements for the design of systems in order to achieve the desired support for collaboration in and across organisations.

6. References

[Aiello 84] Aiello L., Nardi D., Panti M. 1984. *A first Step towards the Office Expert System*, in Second ACM-SIGOA Conference on Office Information Systems, ed. C. A. Ellis, vol. 5, Toronto, Canada, June.

[Bannon, Schmidt 1991] L. Bannon, K. Schmidt. 1991. *CSCW: Four Charachters in Search of a Context*. In J. Bowers & S. Benford (Eds.) *Studies in Computer Supported Cooperative Work: Thory, Parctice and Design*. pp. 3-16. Ansterdam, North Holland.

[Benford Fahlen 92] S. Benford, L.Fahlen. *Aura, Focus and Awareness*. In *Proceedings of the 5th MultiG Workshop*. KTH, Stockholm 1992.

[Borenstein 92] Borenstein, Nathaniel. 1992. Computational Mail as Network Infrastructure for Computer-Supported Cooperative Work. In *CSCW ´92, Toronto, Canada*, 67-74. ACM.

[CCITT 92] CCITT. 1992. *Data Communications Network Directory, Recommendations X.500 − X.521*.

[deCindio 86] F. de Cindio, G. de Michelis, C. Simone, R. Vasallo, A. Zanaboni, *CHAOS as Coordination Technology*, Proc. of CSCW ´86, Austin Texas, pp. 325-342, 1986.

[Ellis 82] Ellis C. A., Bernal M. 1982. *Officetalk-D: An experimental office information system*. Proceedings of the first ACM SIGOA Conference.

[Fuchs 93] Fuchs, Ludwin. 1993. *LIVE − Videokonferenz auf der Sun SPARCstation*. GMD, Februar 1993.

[Grudin 90] Grudin, Jonathan 1990 *The Computer Reaches out: The Historical Continiuity of Interface Design* Proc. of CHI ´90, ACM Press, pp. 261-268.

[Hennessy 93] Hennessy, Pippa, Thomas Kreifelts, and Ute Ehrlich. 1993. Distributed work management: Activity coordination in the EuroCoOp project. *Computer Communications* 15 (8): 477-488.

[GMD-1-2] L. Fuchs 1993. *Review- How Organisational Context is Provided by CSCW Applications*. COMIC Working Paper.

[GMD-1-3] W. Prinz. 1993. *X.500 Support for the Representation of an Organisation*. COMIC Working Paper.

[GMD-1-4] W. Prinz. 1993. *TOSCA: Providing Organisational Information to CSCW Applications*. COMIC Working Paper.

[GMD-4-1] J. A. Mariani. 1993. *A Technological Perspective on Shared Objects*. COMIC Working Paper.

[GMD-4-2] J. A. Mariani, W. Prinz. 1993. *Requirements on Object Systems from a CSCW Perspective*. COMIC Working Paper.

[GMD-4-5] W. Prinz., J. A. Mariani, 1993. *Awareness about Co-Workers in a Collaborative Object System*. COMIC Working Paper.

[GMD-4-6] L. Fuchs, W. Prinz., 1993. *Awareness and Working Contexts* COMIC Working Paper.

[ISO 91] ISO/IEC JTC/SC21/WG7. 1991. *Basic Reference Model of Open Distributed Processing*. Parts 1-4, Working Documents.

[Kreifelts 84] T. Kreifelts, U. Licht, P. Seuffert, G. Woetzel. *DOMINO: a System for the Specification and Automation of Cooperative Office Procedures*. in B. Myrhaug and D. R. Wilson (eds). Proc. of EUROMICRO ´84. North Holland, Amsterdam. 1984. pp 33-41.

[Kreifelts 91] Kreifelts, Thomas, Elke Hinrichs, Karl-Heinz Klein, Peter Seuffert, and Gerd Woetzel. 1991. Experiences with the DOMINO Office Procedure System. In *Second European Conference on Computer-Supported Cooperative Work, Amsterdam, Netherlands*, ed. Liam Bannon, Mike Robinson, and Kjeld Schmidt, 117-130. Kluwer Academic Publishers.

[Kreifelts 93] Kreifelts, Thomas, Elke Hinrichs, and Gerd Woetzel. Sharing To-Do Lists with a Distributed Task Manager, To appear in Proc. of the 1993 ECSCW Conference, Milan.

[LANCS-4-2] T. Rodden. 1992. *COMICal Issues on a Shared Object Service*. COMIC Working Paper.

[Mariani, Prinz 93] J. A. Mariani, W. Prinz. *From Multi-User to Shared Object Systemss: Supporting Mutual Awareness in Collaborative Object Systems*. In proceedings of the GI Jahrestagung ´93, Dresden, Springer, 1993.

[Marmolin, Sundblad 92] Marmolin H., Sundblad Y., Tollmar K., Avatare A., Eriksson H. 1992. *Codesk — An interface to TheKnowledgeNet, Design and Implementation*. In *Proceedings of the 4th MultiG Workshop*, May 1992, Stockholm, Sweden.

[NOTT-1-1] A. Bullock. 1993. *Organisational Knowledge Browsers*. COMIC Working Paper.

[NOTT-4-1] S. Benford, A. Bullock. 1993. *Requirements of Interaction in Large Virtual Spaces*. COMIC Working Paper.

[NOTT-4-3] S. Benford et al. 1993. *From Rooms to Cyberspace: Models of Interaction in Large Virtual Computer Spaces*. COMIC Working Paper.

[NOTT-4-4] S. Benford et al. 1993, *Populated Information Terrains*. COMIC Working Paper.

[NOTT-4-5] S. Benford, L. Fahlen. 1993. *A Spatial Model of Interaction in Large Virtual Environments*. COMIC Working Paper.

[Press 92] L. Press, Systems for finding people, *Journal of Organizational Computing,* vol 2, no.3&4, pp. 303-314, 1992

[Prinz 90] W. Prinz. 1990. *Application of the X.500 Directory by Office Services*. R. Oldenburg Verlag.

[Prinz 92] Prinz, Wolfgang and Paola Pennelli. 1992. Relevance of the X.500 Directory to CSCW Applications. In *Groupware: Software for computer supported cooperative work*, ed. Dave Marca and Geoffrey Bock, 209-225. IEEE Computer Society Press.

[Prinz 93] W. Prinz. 1993. *TOSCA: Providing Organisational Information to CSCW Applications*. To appear in Proc. of the 1993 ECSCW Conference, Milan.

[Robinson 91] Robinson, Mike and Liam Bannon. 1991. Questioning Representations. In *ECSCW ´91, Amsterdam, Netherlands*, ed. Liam Bannon, Mike Robinson, and Kjeld Schmidt, 219-234. Kluwer.

[Schmidt 91] Schmidt, Kjeld. 1991. Riding a Tiger, or Computer Supported Cooperative Work. In *ECSCW ´91, Amsterdam, Netherlands*, ed. Liam Bannon, Mike Robinson, and Kjeld Schmidt, 1-16. Kluwer.

[Schmidt 92] Schmidt, Kjeld and Liam Bannon. 1992. Taking CSCW Seriously, Supporting Articulation Work. *Computer Supported Cooperative Work (CSCW), An International Journal* 1 (1-2): 7-40.

[Shephard 90] Shephard, Allan, Niels Mayer, and Allan Kuchinsky. 1990. STRUDL — An Extensible Electronic Conversation Toolkit. In *CSCW ´90, Los Angeles*, 93-104. ACM.

[Sietec 93] Sietec. 1993. *jointX publishing — Users Manual*. Sietec Systemtechnik GmbH & Co . OHG, 1993.

[Streitz 92] N. Streitz et al. 1992. *SEPIA: A Cooperative Hypermedia Authoring Environment*. in *Proc. of the 1992 Conference on Hypertext*. pp. 11-22. ACM Press, New York

[Suchman 87] Suchman, Lucy A. 1987. *Plans and situated actions. The problem of human-machine communication*. Cambridge: Cambridge University Press.

[Tsichritzis 85] Tsichritzis D., Gibbs S. F. 1985. *Etiquette Specification in Message Systems*, in *Office Automation*, ed. D. Tsichritzis, Springer.

[UPC-1-1] J. M. Marquès, L. Navarro, M. Sarmiento. 1993. *ODP Enterprise Models and Functions*. COMIC Working Paper.

[X.500] X.500. 1992. *The Directory*. Information Technology — Open Systems Interconnection, ed. CCITT and ISO /IEC 9594-1.

Understanding Organization Performatively

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This paper outlines and argues for a certain way of thinking about organizations may be of practical utility in CSCW and for research on the relation between technologies and organizations in general. This way of thinking — which is referred to as *a performative notion of organization* — draws on work in organization theory as well as some contributions to the sociology of science and technology. This paper will first contextualise its arguments in relation to the many and varied approaches to organization which can be found in organization theory and try to show how the orientation advocated departs from traditional theories. Following this, the notion will be illustrated in relation to some existing field studies. Finally, the implications of such a view might for COMIC will be sketched. In particular, an outline of a framework for studying organizational context will be given.

1. Introduction

This paper outlines and argues for a certain way of thinking about organizations may be of practical utility in CSCW and for research on the relation between technologies and organizations in general. This way of thinking — which is referred to as *a performative notion of organization* — draws on work in organization theory as well as some contributions to the sociology of science and technology. This paper will first contextualise its arguments in relation to the many and varied approaches to organization which can be found in organization theory and try to show how the orientation advocated departs from traditional theories. Following this, the notion will be illustrated in relation to some existing field studies. Finally, the implications of such a view might for COMIC will be sketched. In particular, an outline of a framework for studying organizational context will be given.

2. Concepts Of (Metaphors For) Organization

The organizational theory literature, as is hardly surprising, is replete with different concepts of organization, different ways of understanding and studying organizations, different ways of relating these concepts to practical issues concerning policy and management et cetera. In addressing the organizational theory literature, then, we are at once confronted with a multiplicity of contested theories, concepts and methods. How do we respond to this multiplicity? One response is to try and sift out all the different views, analyse them, appraise them and advocate one of them, some balanced combination or try to bring about a grand synthesis. In many re-

spects, this is the traditional way to do literature reviews and to assess existing work in a scholarly manner. Naturally, there is much work in this vein. However, organization theory — like many other contributions to the social sciences — also has what some would call a postmodern mood to it (see Power, 1990; Gergen, 1992; Blackler, 1992). Many contributors to the literature on organizations are now sceptical as to whether this kind of traditional scholarship is possible. Opting for a particular concept of organization and trying to fight off the hoard of alternative conceptualisations now seems to many to be an excessively daunting task. And as for trying to bring about a grand synthesis of all views, this looks like an even harder prospect, even if it were a wise one — and many would argue that trying to put all the pieces together in such a 'totalising' picture is not only intellectually dubious but politically authoritarian!

And yet... A sceptical mood of this sort, while tempting, can also strike one as defeatist — a way of opting out of dealing with hard and pressing problems (see Jameson, 1984). There is a painful dilemma here. Is there an oblique way to deal with such issues which — while not ignoring hard problems — does not address them with naivety? In the context of organization theory, is there a way of 'getting the measure' of the multiplicity of approaches to organization in which the multiplicity is neither trivialised nor found overwhelming?

This section draws heavily on Gareth Morgan's (1986) book *Images of Organization*. Morgan's basic move is to regard the various contributions to organization theory as *metaphors* for organization. That is, each approach picks out some features of organization, passes over or ignores others. Each approach can articulate, deal with and help solve some problems but will be silent on others. As it is sometimes put, each way of seeing is also a way of not seeing. For Morgan and those who follow him, no single metaphor can be held onto in the hope that it will be complete. Metaphors are necessarily partial and incomplete. Treating theories of organization as metaphors for organization makes us critical of any 'totalising' pretensions any single metaphor might have. However, Morgan is not defeatist. He argues that we should find ways of — as he puts it — *reading* organizations. Just as one might understand a text by locating, examining and interpreting its key metaphors, one can similarly address organizations. The practitioner can identify the metaphors which are at large in an organization point out their strengths and limitations, note what the metaphors can speak about and where they are silent and intervene or whatever accordingly.

While we draw on Morgan's (1986) approach, recent organization theory contains a number of other contributions with a similar orientation. In an earlier text, Burrell and Morgan (1979) displayed a range of different approaches to organization theory as did Clegg and Dunkerley (1980). For each of these authors, the diversity of organization theory was a phenomenon to be examined in its own right. Ackroyd (1992) argues that this re-orientation of organization theory can itself be understood organizationally. It has become clear to many organization theorists, when they appreciate the many contexts in which accounts of organization are used (by managers, by consultants, by academics and so forth) and the many audiences

who are addressed by these accounts (other managers, clients, students and so forth), that no single, stable paradigm can be expected to emerge. Much contemporary organization theory can be read as answering the question as to what should be done in the face of this dissolution and dispersal of the traditional paradigms.

Morgan's (1986) answer — the notion that organizations are like texts to be read — is, perhaps, one of the more underdeveloped and speculative themes of his book. To treat an organization as text is after all to employ another metaphor with its strengths, weaknesses and limitations. Why should we adopt this one rather than any of the others that Morgan explicates in his book? It's at this moment that Morgan's book can be made to 'undo itself'. If all metaphors are partial and incomplete, appreciating organizations as texts to be read 'artfully', must be no less partial and incomplete. However, as Morgan does not treat this possibility seriously, one is forced to believe that he is proposing 'organizations as texts' as a grand, meta-metaphor to organise all the others.

Ackroyd (1992, p.111) suspects that — for all their recognition of post-paradigm pluralism — Burrell, Morgan, Clegg, Dunkerley and others still wish to narrow down and control that pluralism by means of a fairly traditional academic dogmatism:

> Choice between theories, on this view, needs to be made by reference to criteria mainly external to the meaning of ideas specifically about organization. This view is substantially correct, but the number of possibilities is very wide and there is no obviously reliable guide to the way decisions should be made. The intellectual devices used to limit the range of meta-theoretical bases on which different theories might be built are different between authors, but the impulse is the same. This is to close down the range of choices to those few … legitimated by their own academic authority.

For the time being, however, let us follow Morgan's text to assist us in giving a brief exposition of a variety of approaches to organizations. We shall also present some assessments of the strengths and weaknesses of each metaphor before then addressing how we might go further. Indeed, the performative notion of organization which we shall end up examining is an attempt to resist the kind of 'self-undoing' that can be detected in Morgan's work and the 'traditional-dogmatic-theory-by-the-back-door' that Ackroyd (1992) charges much contemporary organization theory with.

This treatment of organization can also be compared with Jirotka, Gilbert and Luff's (1992) examination of different CSCW systems in relation to organizational theory. Their framework for addressing organization is similar to the one laid out below. This is largely because they share a common ancestor in Morgan's text. They use different versions of organization as a classifying device for different CSCW systems and, consistent with some of the remarks about organization theory just made, resist opting for any traditional account of organization. Rather, Jirotka et al. (1992) argue that a re-orientation of organization theory is required for innovative CSCW system design.

2.1. Organizations as Machines

Using machine metaphors to understand organizations is very commonplace. Such an often used notion as 'efficiency' has its origins in conceiving of an organization as in some way akin to a machine. The rise of automation (initially *factory* automation) has encouraged an approach to organizations which depicts them as machine-like. Organizations can be decomposable into functionally specified parts and sub-parts. In the (notorious?) scientific management approaches of Frederick Taylor (1911), the movements of humans are treated as akin to machine movements, and as analysable, measurable, decomposable and recombinable in mechanistic ways. On this view, management can become the art of quasi-mechanical design and control. Management works out — on 'scientific' principles — the organization of tasks and exerts control over their execution. Rationalising the 'division of labour' becomes a crucial management task.

Jirotka et al. (1992) argue that there are several CSCW systems (e.g., on their view, the COSMOS system, see Bowers and Churcher, 1989) which conceive of organizational life as structured in ways akin to a machine and which take the modelling of divisions of labour as their primary focus.

2.2. Organizations as Organisms

Conceiving of an organization as an organism has a number of effects. The organization can be seen to have quasi-biological 'needs' (cf. Maslow, 1943) which require 'satisfaction'. We think of the organization as existing in and in relation to an 'environment' where it can 'thrive', 'survive' or 'die'. Organization theorists following this metaphor can speak of different 'species' of organization and concern themselves with organizational 'fitness' to the environment. For example, does the organization have the 'requisite variety' for its environment that will enable it to adapt to external changes, crises or other developments? Burns and Stalker (1961) argue that different organizational forms would be more or less appropriate in different environments. In stable environments, bureaucratic hierarchies might well survive but in changing environments their failure to adapt may be disastrous (see also Kanter, 1983; Miller and Friesen, 1984). With the metaphor of organizations as organisms, biological-sounding questions like these can now be posed.

Accordingly to Jirotka et al. (1992), the influence of this metaphor for organization can be found in much CSCW work. In particular, the emphasis on the tailorability of systems to their particular environments (see Greenberg, 1991) is redolent of the adaptability of organizations and the recognition that different organizations, operating in different environments, may require different technological forms.

2.3. Organizations as Brains

Metaphorising the organization as a brain can bring to the fore the intellectual, problem solving or creative aspects of organizational life. Much of the force of this

metaphor, however, depends on how the brain is metaphorised in turn. Seeing the brain as an information processing device (cf. Simon, 1960) will enable the organization theorist to look at the flows of information in an organization and the problem solving activity which individuals engage in on the basis of this information. Seeing the brain as a differentiated organ with parts and interconnections brings to light the internal structure of an organization. Seeing the brain as a massively parallel distributed processing (PDP) device with many interconnections (on this metaphor for the brain, see Rumelhart and McClelland, 1985) may cause the theorist to look at how organizational information may 'gracefully degrade' being robust in the face of local failure. This metaphor drives much of the recent work on organizational memory and intelligence (e.g. Conklin, 1992) as well as attempts to theorise socially distributed cognition by analogy with PDP-based accounts of individual cognition (e.g., Hutchins, 1986). Finally, with this metaphor to hand, one can talk about 'organization learning' and anticipate that psychological and physiological theories of learning can be metaphorically extended to organizations.

2.4. Organizations as Cultures

For this metaphor, an organization is to be understood in terms of its 'ideas', norms', 'values', 'rituals', 'beliefs', 'superstitions' and 'traditions'. For organization as cultures, what is and is not real for an organization is 'socially constructed'. It is now commonplace to hear of such notions as 'corporate culture' or there being 'cultural barriers' to accepting organizational or technical change. Work pointing out the existence of informal channels of communication in addition to those depicted in organizational charts nurtured the notion of an 'informal organization' to be understood in cultural terms.

The 'discovery' of the informal organization led — in the 'Hawthorne Studies' of the 1920s and 1930s — to a profound criticism of the Taylorist approach to scientific management. How technology might be harmoniously integrated into the informal organization of workers was important to the Sociotechnical Systems approach of the Tavistock Institute of Human Relations in postwar Britain (see Rose, 1990) and to experiments in organizational democracy from Emery and Trist (1969) through to more recent work in Sweden and Denmark some of which is familiar within CSCW under the rubric of participatory design (e.g. Ehn, 1988).

2.5. Organizations as Political Systems

When organizations are apprehended as political entities, further ways of seeing organizations become possible and new phenomena become visible. We can speak of and try to identify and/or change sets of interests that opposed social groups may have. We can identify conflicts and power struggles. We can attempt to identify the different strategies used by different groups to secure or disrupt their or other's rights to rule. Or we can speak more mundanely of 'office politics' or 'hidden agendas'. All of these ways of talking about organizations are made possible through a set of political metaphors.

Perhaps most notable in versions of organization as political systems are the contributions of Marxist and neo-Marxist scholars. For example, in his work in the 1970s and early 1980s, Clegg (1979) (and also Clegg and Dunkerley, 1980) specifically argues against the organic notion of an organization with its supposed separation of organization from environment. For this writer organizations should be understood not as hermetically sealed from their environment (no matter how much that environment is supposed to influence the organization and vice versa) but in terms of the contradictory forces at large throughout capitalist society. Drawing on Marxist critiques of political economy, then, this account of organizations seeks to 'unpack' them in terms of questions of classes, class relations and interests and the differing relations that different social groups have to the means of production.

2.6. Organizations as Psychic Prisons

Within organizational theory, the terms and concepts of psychoanalysis have had a considerable influence. In addition to understanding organization in cultural terms, this is one of the main features of the work of the Tavistock Institute. On this view, organizations can be seen as being prone to the same kinds of psychopathologies that are supposed to plague human individuals. Organizations can enter into sado-masochistic relations with others. Organizations can be seen as having unconscious processes which may determine what they do inspite of explicit policy statements. Additionally, individuals within organizations may endure different kinds of pathological conditions as a result of their participation in organizational life. Or — on other views — maybe organizations emerge or exist because of the unconscious drives of those who participate in them. All these ways of thinking about organizations are made possible through metaphorical extensions of psychoanalytic and related discourse to organization theory, or — as in the case of the Tavistock Institute — an attempt to integrate an understanding of culture with individual psychology.

2.7. Organizations as Flux and Transformation

While Morgan (1986) gives a separate treatment to this metaphor system, his examples have much in common with systems we have already dealt with. All his examples involve the appreciation of the dynamics of organizational life. For example, thinking of organizations as self-(re)producing or self-organizing systems (e.g. Maturana and Varela, 1980) is one way to apprehend dynamics. Indeed, this approach has been influential for some writers in CSCW (see, e.g., Winograd and Flores, 1985; Medina-Mora et al., 1992) but, for present purposes, it is best to treat this as a further extension of organic, biological metaphors. Accordingly, hereafter, we shall not treat this metaphor system as separate from others mentioned already.

2.8. Organizations as Instruments of Domination

The same kind of comments apply here too. Morgan's treatment of organizations as instruments of domination dramatises and further extends the political metaphor.

3. The Metaphors At Their Limits

As remarked earlier, metaphors are partial and incomplete. In as much as any metaphor (or system of related metaphors) makes some issues visible and some things sayable, others things will remain in the background or may even be suppressed by a particular way of talking or theorising. It is important (both theoretically and practically) to identify these strengths and silences, these inclusions and exclusions. Again, what follows in this section draws on and develops Morgan's work.

3.1. Organizations as Machines

Morgan (1986, p.34/5) writes:

> The strengths [of this metaphor] can be stated very simply. For mechanistic approaches to organization work well: (a) when there is a straightforward task to perform; (b) when the environment is stable enough to ensure that the products produced will be appropriate ones; (c) when one wishes to produce exactly the same product time and again; (d) when precision is at a premium; and (e) when the human 'machine' parts are compliant and behave as they have been designed to do.…

> … mechanistic approaches to organization often have severe limitations. In particular they: (a) can create organizational forms that have great difficulty in adapting to changing circumstances; (b) can result in mindless and unquestioning bureaucracy; (c) can have unanticipated and undesirable consequences as the interests of those working in the organization take precedence over the goals the organization was designed to achieve; and (d) can have dehumanising effects on employees, especially those at the lower levels of the organizational hierarchy.

One has to be careful with Morgan's assessments here. For example, arguably, Morgan overstates the strengths of the mechanistic metaphor. It can certainly be claimed (cf. amongst others Bannon and Schmidt, 1991) that the mechanistic, scientific management approach fails to grasp accurately what goes on in even the most apparently regimented factory production process. Accordingly, it is probably best to not take Morgan as making empirical assertions, though his phrasing can be confusing (e.g. "mechanistic approaches to organization work well" when (a)-(e)). To show how organizations as machines operates *as metaphor*, I would rather understand Morgan's lists of strengths and limitations as features of the *metaphor system* which is generated by apprehending organizations as machines, rather than as empirical claims. Perhaps, 'strengths' (a)-(e) should be read as *conditions of plausibility* on the use of the metaphor system, the terms of these conditions also deriving from the system. *If* (a) to (e) seem to hold, *then* it is plausible to use the mechanistic metaphor. Conditions (a) to (e) identify circumstances which the mechanistic metaphor has something to say about. Similarly, limitations (a)-(d) are more of a summary of the objections which have been raised by organization theorists *operating within other metaphor systems*, a point which shall be returned to later.

Braverman (1974) published an important and powerful critique of 'scientific management' as it is often articulated in relation to this metaphor. On Braverman's account, Taylorism and allied approaches should be understood as ways of disci-

plining a potentially unruly workforce confronted with the brutality of factory production. 'Scientific management' should rather be understood ideologically — as a rationalisation for the control of a managerial class over production processes. Controversially, Braverman adds to this critique by drawing attention to the 'de-skilling' experienced by workers in the Taylorist factory. The embodied, traditional skill of craftsmen is 'externalised' by Taylorism and made the subject of management control and calculation, leaving workers to perform mundane and tedious tasks. The notion of 'de-skilling' is highly controversial and the picture of workers being overcome by management control-strategies often seems to underplay the scope there is for both the emergence of new skills with automation and for resistance on the part of the workforce (see Wood, 1982). From the point of view of our treatment of organization theory as metaphor, Braverman's (1974) contribution can be read as counterposing a version of organization as mechanistic structures with a version of organizations as arenas for political struggle. In other words, Braverman mobilises *another metaphor system* which has a place for understanding political struggle, class relations, ideologies and (humanist) accounts of skill to criticise Taylorism which addresses none of these (or at least not in the same way).

3.2. Organizations as Organisms

Taking organizations to be akin to organisms brings to the fore the relation between organizations and their context or environment, something which the mechanistic metaphor is more silent about. Identifying organizational 'needs' is a different focus from identifying operational goals as in the mechanistic metaphor. By distinguishing different 'species' of organization, the biological metaphors of this system enable one to give a more differentiated treatment to organizations — not all organizations will be treated in the same way. Organic metaphors enable one to articulate various ways in which organizational change can take place. Again, this is not something which is highlighted by the mechanistic metaphor. The emphasis on the environment can also lead to talk of 'organizational ecology' and an apprehension of inter-organizational relations with this metaphor. All of these emphases are made possible by the biological-organismic metaphor system.

However, critics of this way of apprehending organizations have pointed out limitations. For some critics, this metaphor encourages an illegitimate equation of the social with the biological. There is more to organizations than quasi-biological attributes. There are ideas, values, norms etc which require a sociological, psychological or political account. Depicting environments as 'selecting' appropriate organizational forms can also lead to an impression of the passivity of organizations. If they actively 'shape' their environment rather than merely 'adapting' to it, then a limit is reached with some of the more deterministic uses of biological metaphors. Assuming, emphasising or prescribing the 'functional unity' of the organization-organism as a fit biological entity can lead to an underestimation of processes of conflict within an organization or of the position of organizations within a general economic and political system (cf. Clegg and Dunkerley, 1980).

3.3. Organizations as Brains

We can chart the emphases and the silences of this metaphor system too. As with the biological metaphors just discussed, organizational change can be addressed using this system. However, here change is depicted in terms of intellectual processes such as organizational learning or planning. A construal of organizations which makes intellectual or cognitive processes primary, may also encourage the scrutiny of the rationalities behind such otherwise mechanistic processes as goal setting and target achievement. As many contemporary theories of brain processes and cognitive abilities in the cognitive sciences employ computational metaphors (the brain/mind as a computer), conceiving of organizations as brains can allow the theorist to speak in a unified discourse about the human and the technical components of organizations which use computing technology. For example, the tradition of cybernetics (Wiener, 1961; Ashby, 1952; Beer, 1959) has also been influential in understanding organizations in informational terms. Indeed, cybernetics has a general understanding of notions such as control, feedback, information and so forth which, for many authors, have promised a unified way of talking about organizational, technological, individual and social phenomena.

However, critics of this form of organizational theory have pointed out limitations. Again, this metaphor system does not encourage one to examine seriously questions of power and conflict within an organization. An emphasis on the problem solving aspects of organizations can lead to an over-intellectualisation of organizational life and a neglect of irrationalities. In the CSCW literature, Bannon (1991) has pointed out that the rationalised and comforting stories told about technologies for supporting 'community and organizational memory' are somewhat at odds with his experiences of their use, where conflicts, delicate responsibilities and dilemmas of power come to the fore.

3.4. Organizations as Cultures

Metaphorising organizations as cultures can be a way of pointing to the symbolic significance of much of organizational life and its dependence on systems of shared meaning. The ritual-like aspects of organizations which can find little rational legitimation in more intellectualistic approaches can be grasped culturally. The focus on shared meanings, values and norms can also enrich accounts of organizational change. Organization change is not merely a matter of introducing new technology, operating procedures or management structures, it also (or instead) involves introducing or instilling a new culture.

As before, there are a number of criticisms of this metaphor system. Once again, organization theorists who emphasise the conflictual nature of organizations find this suppressed in this version and in the socio-technical systems perspective (Brown, 1967; Rose, 1988) Additionally, treating organizations as cultures has made possible the emergence of a new kind of organizational theorist: one who can interpret organizational culture, identify healthy cultures and point out cultural defi-

ciencies. However, in Morgan's (1986, p.138) terms, these "corporate cultural gurus" can be objected to on the grounds that they provide further means for "developing the art of management into a process of ideological control" by prescribing 'good' value systems, beliefs and rituals. There is also a tendency in some of the writings on 'corporate culture' to treat it as a separate, semi-autonomous realm which can be treated as a further, distinct variable in organizational analysis. In other words, there can be a tendency to *reify* culture in this literature, to treat it as a separable thing. Ironically, at the extreme, this can lead to an instrumental or mechanistic approach to organizational culture which can sometimes just be 'bolted on' to traditional mechanistic approaches, as if to soften the blow of the machine metaphor with some cultural sweetening.

3.5. Organizations as Political Systems

Conceiving of organizations as political systems can help us attend to the political dimensions of all aspects of organizational life. Organizational goals, values, structure, job design, leadership and problem solving styles (etc.) can all be demonstrated to have a political dimension. That is, all these organizational phenomena can be related to questions of power, interest and social relations in the workplace. Additionally, political metaphors for organization help "explode the myth of organizational rationality" (Morgan, 1986, p.195). Once we understand the politics of/in organizations, we begin to ask: whose rationality? whose measurements of efficiency? who sets the goals? who benefits? The emphasis on internal struggles and differences of interest within an organization is also a valuable corrective to the idea of organizations as functionally integrated systems as well as to any attempt to over-intellectualise or rationalise organizations. Thinking of organizations politically might also be a way of connecting an understanding of organization with questions of government and social order in general (cf. Clegg and Dunkerley, 1980).

However, part of the problem with this method of organizational analysis is — in a sense — also its virtue: the ubiquitous applicability of the political metaphor. It is almost always possible to recast any organizational phenomenon as having a political nature or significance. If this way of talking is given a reductionist slant ("organizations are *nothing but* political systems"), organization members' failures to see this often *have to be* explained in terms of how they are hoodwinked by ideology (the theorist has no other option!). Conceiving of organizations as political systems often affiliates with depictions of members as alternately conspiring or covertly manipulative on the one hand and completely duped on the other. None of this is to deny the importance of apprehending the politics of organizations, nor even to deny that members are sometimes manipulative, sometimes duped. Rather, it is — as before — to warn against the over-extension of a particular metaphor, so that its limited terms overly constrain our accounts. Besides to conceive of organizations as political systems alone is inadequately specific. Just as one can ask: whose interests? who benefits? one can ask: whose politics? An analysis of an or-

ganization in political terms by a liberal pluralist will probably not resemble an analysis by a classical Marxist.

3.6. Organizations as Psychic Prisons

Like cultural metaphors, relating organizations to fundamental psychological issues can be a way of insisting on the *human* (as opposed to the mechanistic) aspects of organization. The kind of humans who are portrayed in this metaphor are ones with hidden motives, drives and needs who are influenced by unconscious processes and patterns of control which allude their conscious awareness but ensnare them nevertheless. A metaphor system of this sort may make us usefully sceptical about the expressed aims or nature of an organization causing us to "dig below the surface" (Morgan, 1986, p.228). This metaphor system also further contributes to the demise of any over-rationalised understanding of organizations. Aggression, greed, fear, hate and sexual desire may now all have to be reckoned with. Relating organizations to psychodynamic processes is another way of emphasising the constitutive role of power relations in organizational life. Indeed, for some advocates of these approaches to organizations, a psychodynamic elucidation of power relations adds detail to a political account for it discusses how these relations are *experienced*. Finally, these psychodynamic approaches and metaphors may enable us to identify another source and aspect of resistance to organizational change and innovation.

Critics of the use of psychoanalytic theory in understanding organizations have pointed to several limitations of this source for metaphors. Such approaches often have a tendency to be overly psychologistic. That is, they seek out deep psychological explanations whereas perhaps more plausible explanations are available in sociological, political or other terms. For example, emphasising unconscious processes may cause us to miss occasions where control and obedience may be secured by more blunt calculative means. Emphasising the 'prison-like' nature of unconscious influence and dependence can also lead to theories which are either excessively pessimistic or (paradoxically) overly utopian in their fantasies about what it would be like to 'released' from psychic prison. Both excessive pessimism and utopianism are symptoms of an approach which is inadequately grounded in concrete possibilities for organizational change as we might find them in organizations now rather than in some hoped for psychological liberation.

4. Some Reflections And Reorientations

Having followed and developed Morgan's text and given an outline of the different kinds of metaphors for organization we can identify, together with their strengths and limitations, let us take stock of the argument so far and suggest some ways in which we can go on by reorienting our relation to these metaphors.

4.1. Metaphors at War

… to use another metaphor! We have tried to identify strengths and limitations in each of the metaphor systems discussed. However, it is important to qualify the status of these strengths and limitations. Any metaphor, as remarked already, will highlight some features of the object under investigation while relegating others to the background. Criticising a metaphor system is often a matter of pointing out what has been relegated to the background and insisting that it should be brought to the foreground. For example, in a study of the metaphor systems at work in political and media discourses leading up to the Gulf War, Lakoff (1991) identified a system which personifies politics and international relations, where — say — Saddam Hussein was taken to stand for Iraq, and war was depicted as a fight between Saddam Hussein and George Bush. According to Lakoff, this system hides the complexities of politics and international relations as well as hiding the bloodiness of war. In this way, Lakoff is able to criticise personification and war-as-a-fight metaphors by pointing out what they exclude.

In a similar manner, in our appraisal of the metaphor systems which can be found in organization theory, we have reviewed how critics of each system point out exclusions, silences and limitations. There is a problem though with this method of analysis: what is excluded from a metaphor system is an indefinitely extensible list. One can *always* think up something which has not been mentioned! So, what is it that justifies insisting that the exclusions which are noted are the ones that matter rather than the indefinitely many that could be brought into the foreground?

A tempting answer to this is that an exclusion becomes notable and hence a *limitation* of the metaphor system under examination if there are terms for that exclusion in *some other metaphor system*. Thus, we see above the mechanistic metaphor being criticised for its inflexibility in changing circumstances where change and development are precisely some of those phenomena which the organic metaphor system is set up to account for. Similarly, we see the organization as brains metaphor being criticised for its rationalising tendencies when accounting for irrationality is precisely the domain for the psychic prison metaphor system. Finally, emphasis on the functional unity of 'organic' organizations hides contradiction and conflict within an organization according to the political metaphor system. And so on.

The point is, then, that the limitations of a metaphor become visible when we encounter the strengths of another one. This gives the metaphors for organization a curious inter-dependence. The boundaries of applicability of a metaphor are encountered only when it bumps up against another one, its terms, its strengths, the forms of knowledge it offers for organizational life. This provides us with further arguments for why it is ill-advised (theoretically or practically) to opt for just one metaphor, just one theory of organization, and hope that it will fit all the kinds of circumstances we are likely to encounter.

4.2. Cannibalising Disciplines

It also important to note how the metaphors for organization we have examined have each argued for the use of a particular form of knowledge (be it politics, economics or whatever) to understand organizations. That is, thinking about organizations often involves the metaphorical extension of research, theory or models from one discipline into another context. For example, if you take organizations as big brains, you can begin to look for parallels with psychology or cognitive science. If you take organizations as cultures, you can then try and translate anthropological or sociological theory into organizational theory. If you look to mechanistic metaphors, you can gain inspiration from engineering. The organism metaphor system sustains parallels with biology, political metaphors with political science, and psychoanalytic metaphors with obviously psychoanalysis but also with various other contributions to psychology and psychotherapy.

In all of these ways, metaphorising organizations enables one to import to the study of organizations some ready-made theory, models, findings, analogies as and when the knowledge from the cannibalised discipline seems to fit. When it no longer fits, that is, when the limits of a particular metaphor system are encountered, we have a number of choices. We can give up 'importing' knowledge from economics, psychology, political theory or whatever, and perhaps, instead, investigate actual organizations in all their detail. Or we can *make* the recalcitrant parts of the cannibalised discipline fit by extending the metaphor yet further in the name of theoretical creativity. If we take this course, we might start looking for: organizational 'lubricant' (to 'oil' the organization as machine's parts), organizational 'genes' (to maintain the organization's form over generations) and so forth. Whatever. The point is that each metaphor for organization we have encountered has related to it *a form of knowledge* (be it biology, psychoanalysis or cognitive science) which it is going to look to for inspiration, for the terms of organizational analysis, for appropriate research methodologies, et cetera.

4.3. The Critical Features

In a study of theories of the nature, origins and development of society and social interaction, Latour and Strum (1986) considered various contributions including those of Freud, Dawkin, Girard, Hobbes, Leakey, Marx and Rousseau. While these accounts of society are very different the one from the others, Latour and Strum suggest that it is possible to systematise the arguments a little by concentrating on the different critical questions which each account has some answer to. Latour and Strum argue that, on examination, the debates turn about a comparatively small number of items:

a. the *units* in terms of which society is defined (family, genes, classes, kin, individuals, cities)

b. the *qualities* these units are endowed with (foresight, social skills, greed, blind force, selfishness)

c.   the *form* the relations between units take (exchange, calculation, parasitism, exploitation, asymmetry)

d.   the *currency* with which the relations are calculated (money, number of offspring, energy, pleasure and pain, power)

e.   the *time* delay or interval within which these calculations take place (a day, a year, a generation, a million years)

f.   the degree of *reciprocity* deemed acceptable (one to one barter, potlatch, personal balance, market or generalised exchange).

Let us suggest that exactly analogous points can be made about the debates concerning the nature of organizations that we have studied so far[1]. That is, that different versions of what organizations are can be derived by answering Latour and Strum's "questionnaire" in reference to the metaphor systems we have presented. In this way, the features (a) to (f) can provide us with a framework for understanding different kinds of organization theory and, for COMIC purposes, different senses which can be given to the phrase 'organizational context'. However, in view of the discussion in the previous section, let us add one more item:

g.   the form of *knowledge* deemed useful or appropriate (economics, politics, cognitive science, psychoanalysis, biology, anthropology).

Let us illustrate these suggestions by analysing — albeit crudely — some of the metaphors of organization we have examined in terms of this list.

Mechanistic metaphors tend to distinguish between management, workforce and productive machinery (units), the former being endowed with 'scientific management skills' and an overall knowledge of the production process, the latter with the ability to perform routine manual tasks as itemised in a job specification once they have had their embodied skills wrested from them and externalised through scientific management (qualities). Management perform calculations over the movements of the workers' bodies and those of the machines so as to control the production process (form of relations). These calculations may be measured in 'clock time' and the overall production process assessed for its 'efficiency' (currency). Efficiency and financial calculations are likely to relate to the rhythms of the business year and measurements of the motion of machines/workers will relate to time intervals such as 'turn around time', 'time to complete' and 'the shift' (time delay). The exchange between different units is in terms provided by employment contracts within corporate capitalism — exchange of labour for wage et cetera (reciprocity). Engineering,

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[1] A footnote concerning Latour's general orientation to social theory. That Latour and Strum's questions about society should 'scale down' to questions about organisation would not be surprising in the broader context of Latour's work (e.g. 1987). Latour has resolutely avoided introducing different theoretical terms to study different kinds of entity. He prefers general, 'degree-zero' concepts such as 'actor' and 'network' and 'association' to study entities irrespective of their 'size' or 'geometry' (see also Callon, 1992) or material form. Human individuals, animals, machines, groups, organisations, societies etc. can all be seen as actors or networks of associated actors. This approach has the advantage of resisting many of the deeply held dualisms hich have dogged work in the social sciences - between human and non-human, between subject and object, between the micro and the macro. Whether it has any further, more substantive advantages is currently highly controversial. However, we do not need to get into these controversies to profit from the framework we are suggesting or from the performative notion of organisation which we are about to develop.

economics, time-and-motion psychology and 'scientific management' itself inform the application of this metaphor (form of knowledge).

Organic metaphors may also distinguish between different management and workforce groupings internal to the organization but new units appear when the organization itself is distinguished from its environment. Qualities and relations are derived by biological analogy, e.g. competition for scarce resources, 'fitness', 'survivability'. Calculations will be in terms of costs and benefits to survival or 'reproduction'. When this metaphor is used to discuss developmental changes or evolutionary processes in the organization, the relevant time interval may be decades or even centuries. Reciprocity may be discussed in terms of further biological notions such as 'co-evolution'. Biology and certain forms of cybernetics become the form of knowledge which will instruct us as to the nature of organizations.

5. Towards A Performative Notion Of Organization

If it is granted that analysis of different accounts of organization can be given in terms of critical features such as the units, qualities, relations, currency, time interval, form of reciprocity and form of knowledge involved, the question now becomes what are the consequences of such an analysis? Should we now attempt a grand synthesis reconciling or finding a place for all possible selections and advance that as our organizational theory? There is an alternative. Latour (1986, p. 270/271) in his work on 'society' draws different conclusions — conclusions we can follow in studying organizations[1]:

> When these questions are considered, a new order emerges from the continuous debates about what it is that holds us all together [as a society or in an organization]. The order obtained is a function of the options selected from the above 'questionnaire' and the composition of society [or organization] that results accordingly differs radically. Any modification, no matter how small or how scientific, to each of the answers might have enormous consequences.… [To] trace the division of labour between men and women a few thousand years earlier (or later) entails a complete change in what women can and cannot do today. Establish the drives of social actors on the basis of natural instead of divine laws, and the legitimation of all the powers in society changes signs. [Or: Establish the drives of organizational actors on the basis of psychoanalytic instead of information processing laws, and the legitimation of all the powers in an organization changes signs.]
>
>   The origins of society [or organizational life] are no longer behind us, and the task is not the discovery of the 'real' units, the 'real' qualities, the 'real' currency, and the 'real' time-delay that make up society [or organizations]. The task before us is rather to use the screams and furies of the entire range of groups dissatisfied with the genealogy of their positions, because each of these fierce debates — whether in the political or the scientific arena — are deciding on the composition of society [or organizations] *now*, before our very eyes.

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[1][Square bracketed text added by the author.]

The different versions of organizations or 'organizational context' which might be generated from Latour and Strum's list are not therefore just commentaries on an independently existing reality which our definitions merely describe or point to ostensively. Rather, in a significant sense, *we perform the organizational by defining it*. In these very debates about the nature of organizational life, we are producing it. As Latour (1986, p. 273) puts it:

> The question: 'What links us together [in a common organization]?' is not answerable in principle, but in practice, every time someone raises it a new association is made that does indeed link us together. Society [Organization] is not the referent of an ostensive definition discovered by social scientists [organization theorists] despite the ignorance of their informants. Rather it is performed through everyone's efforts to define it.

By referring to a "performative definition" of organization, we are giving a twist to a fundamental concept in speech act theory (Austin, 1962). Our use of language in defining the social/organizational does not take the form of a ghostly presence *outside* of organizational life. Rather an organization comes into being in the way that it does *precisely through* the associations actors make as they recruit others to their definition of it. There is a minimal sense in which this notion can be grasped quite easily. If any one of us is to offer a version of organizational, there has to be an audience for our claims. In attempting to find/assemble an audience, we are already constructing links between actors, for we are — at minimum — relating actors-as-addressees to ourselves-as-addressors. Each time an organization member identifies units, endows them with qualities, posits their relations and the rest a little bit of organizing is being done.

We are suggesting then that we should not regard the metaphors of organization that we have examined as mere descriptions or commentaries on organizational life. Whether used by practicioners, theorists or organization members, the metaphors have a performative significance. Such metaphors are *internal* to organization life. They help to produce it in whatever form it has. This view is consistent with, indeed involves, the observation that the images of organizations analysed above are all accounts of organizations which *participants* (members) may use as part of their doing of organizational life (as also noted by Morgan (1986), Jirotka et al. (1992) and most notably by Bittner (1965)). Thus, if we understand accounts of organization performatively, we have a new topic for investigation: how organization members define their organization, how they identify units endow them with properties and relations and so forth. Such a topic for investigation is not a mere curiosity. For — on the performative understanding — it is through such operations that organizing is done, that organizations are produced.

Taking the defining practices of organization members as an empirical topic also addresses the criticism that Ackroyd (1992) levels against those (like Burrell and Morgan, Clegg and Dunkerley) who seek to intellectually arbitrate over a pluralism of accounts of organization. Burrell and the rest as depicted by Ackroyd can now be seen as *no different in principle from organization members themselves* for *all sides (organization theorists and members included) are attempting to make sense of organizations and to convince others of the worth of their accounts*. The empiri-

cal topic for investigation that the current argument is opening up is precisely those accounting practices.

The next section draws on two pieces of empirical work to illustrate the utility of the performative notion and elucidate its sense.

6. Some Empirical Arguments For The Performative Notion

6.1. A Field Study of the Implementation of a CSCW Network

Under this heading, we shall discuss some fieldwork which has been conducted in an organization within the United Kingdom's central government. This organization, which we shall call 'CGO', is responsible for developing the standards, procurement policies and specifications of good practice which central government organizations should observe with respect to government computing. Amongst CGO's various branches, the Future Technology Branch (FTB) is most concerned with exploring new computing developments and research in computer science and allied trades. Anticipating that it may be of relevance to central government computing, FTB has conducted a number of studies of CSCW, employing a series of consultants over the last four years who have between them written a review monograph on the subject and explored how CSCW may impact upon more established methods of systems analysis and design. Over the last 24 months, FTB have themselves installed a network of computers which runs a variety of applications of the sort discussed in CSCW. It is this network, the issues involved in its construction and maintenance and in the use of the applications present and how all of these matters are experienced in CGO which has been the subject of the fieldwork.

(A longer account of this work can be found in Bowers and Rodden (1993). What follows here concerns the aspects of the fieldwork relevant to the development of a performative understanding of organization.)

Throughout the study of the CGO's CSCW network, a wide variation in the ways organization members talk about and treat their work, the network and the organization itself has been noted. For example, the network is often discussed in a technical discourse in terms, say, of the processing and storage capacities of the machines and how their communication protocols relate to those observed in other networks in the organization. However, we also hear the network formulated as an economic object ("CGO have invested a lot of money in this network; we have to demonstrate a return"), a political entity ("CSCW and a lot of networking hype are all about greater workplace democracy but this organization isn't really like that"), a source of individual empowerment ("using the network I should be able to communicate much more effectively with other people; I could deal with problems immediately and not have to wait for someone's next free slot in their diary"), an object with potential organizational implications ("if this network were to be success-

ful, lateral communication across the whole of CGO would improve; the left hand would know what the right was doing!"), a personal matter connected with the project manager's own individual interests and ambitions ("it is after all Dan's baby"), etc. etc. In short many forms of knowledge are recruited to understand the network and its relation to CGO.

Depending on whether the network is conceived technically, economically, politically, organizationally, or in personal terms, different units are named (e.g. operating systems, budgets, trade unions, project teams, Des) and different (and problematic) qualities and relations are identified (e.g. inter-operability, costs, working conditions agreements, project management issues, Des' lengthy working hours and high motivation). The network has raised a whole set of radically variable concerns. Indeed, especially in the early stages of the CSCW network project at CGO, it was unclear which, if any, of these concerns was paramount.

What kind of 'organizational context', then, was assumed by the CGO workers in their orientation to the CSCW network? In these early stages of the project, 'any and all' seems like the correct answer from a performative point of view. Many different units, qualities, relations etc. were 'in play'.

However, one of the senior managers participating in the network project, Jon, came to regard this variability — the mass of different ways different organization members had for dealing with and talking about the network and its role in CGO — as indicating a confusion about the aims of the CSCW networking project. That is, Jon problematised the variability itself. To address this and offer a solution, Jon suggested a distinction should be observed between "the operational" and "the experimental". The former category is explicated by Jon as referring to the technical aspects of the CSCW network, how the network relates to others in the organization and how it should be managed so as to ensure consistency between software version numbers and such like. According to Jon, it is this alone that Dan, the project manager, should concern himself with, assisted by one of the project's consultants. In contrast, the experimental aspects of the network are formulated by Jon as concerned with "the impacts of the network on teamwork". Indeed, the non-existence (according to Jon) of teamwork in FTB and in CGO more generally is often taken by him as one of the major problems that the organization faces. For Jon, the experimental aspects of the network are closely tied to quantitative evaluation: the impacts of the network on teamwork are to be assessed by comparing "performance indicators". Furthermore, it should be the main task of another one of the project's consultants to refine appropriate performance indicators and make the measurements.

In this way, Jon is offering a strategy for sorting out the variability, distinguishing between the important and the unimportant, while defining roles for Dan and the consultants which they are invited to fill. Much of Jon's activity in the more recent phases of the project involves attempts to rally the team members around this distinction so that they can see themselves and their duties in this common picture of what the project is all about. For example, the consultants to the project have been asked to deliver documents reviewing the different kinds of performance indi-

cators that are available and implement studies of the network using the appropriate ones. These requests have been cemented through the terms of the consultants' contracts.

How might a performative notion of organization help us understand CGO and the CSCW network that has been implemented there? It is clear that many versions of what CGO is like *as an organization* are abroad in CGO. CGO is an organization which has an over-emphasis on individual work at the expense of teamwork, internally duplicates projects, is not a democracy, operates on a consensus basis, is a typical Civil Service organization, is rigidly hierarchical, has been made leaner and more responsible to client-demand, is more market-oriented than before, has a culture of experimentation, organises its work on the basis of written documents et cetera, et cetera. There are many, not necessarily mutually consistent accounts of the nature of CGO as an organization at large within CGO. Should we — as workers in the field — side with any particular one of them, treating the others as systematic errors? Or should we — as students of organization theory — say they're all wrong as in fact organizations are big brains? We suggest that neither strategy — with their attendant accusations of error or mystification on the part of our informants — is appropriate.

Rather, we have tried to follow how the participants themselves sort this multiplicity out. Jon's distinction between the experimental and the operational — together with its offered roles — is an instance of this management of multiplicity. Again, here the performative notion enables us to see a dimension of the organizing of organizational life. Jon's depiction of CGO as an organization where everyone does their own thing without enough teamworking *involves* the definition of 'roles' for Dan and the consultants. These 'roles' do not have an advance existence in any organizational 'script'. Rather they are produced by Jon as part of his version of what CGO should be like. The definition of roles and the incitement of suitable actors to fill them has been referred to as 'enrolment' by Latour (e.g. 1987) and Callon (e.g. 1986). Whether Jon succeeds in enroling everyone along the lines we've described is an open and further empirical question. He may win out, he may not. The multiplicity of versions of organization that we heard initially may be funnelled through the empirical/operational distinction with Dan and the consultants acting accordingly. Or the empirical/operational distinction may come to be seen as just another attempt to organise organizational life on a par with the others. That this is an empirical issue (and not one to be resolved by adopting the 'correct' organizational theory) becomes clear on the performative account.

6.2. Teamwork in an NHS Child Development Centre

The following sequence is drawn from a study of informal talk in team-work practice in a multi-disciplinary Child Development Centre (CDC) within the British National Health Service. (See Middleton (forthcoming) for a fuller description of this study and Bowers and Middleton (1991) for a discussion of these data in relation to notions of 'distributed cognition'.)

The setting: Sister's office which is used as a general meeting room. Sister (S) and one of the Unit Physiotherapists (UPT) are discussing a problematic case. CPT refers to Community Physiotherapist, a Physiotherapist who works within the community but who has a base within the CDC. DPT refers to the District Physiotherapist, the person in overall charge of physiotherapy within both the community and the CDC. The following is a simplified transcription of some of their talk.

a.   .....teacher at um at school and she had a child that was cerebral palsied and she was wanting more physio she took the child off to get a private physio involved and Jane [PTC] said well if another physio's involved then I can't be because

PTU: yes yes

b.   we both probably will be doing different things saying different things she has not the team approach and I don't think that it should be done and.... and I think that you should involve Anne [DPT] certainly Jane [PTC] did and and I think Jane [PTC] was saying exactly what you're saying about this case *exactly* what you're saying and I feel um you ought to go through it with Jane [PTC]

PTU: she did actually talk to Anne [DPT] about it

c.   she is a very dynamic lady and um it it's extremely difficult I think Jane [PTC] had quite a few sleepless nights over it

PTU: um

d.   but uh she was sticking in exactly the same way as you were and I I think if you have a chat with her and a chat with Anne [DPT] I am quite sure that uh

PTU: yeh

e.   ok

In this extract, an equivalence between cases is argued for on the basis of (i) both cases involving private as well as NHS treatment and (ii) the identity of Jane's (PTC's) account and the current one (PTU's). This equivalence forms the basis of action: PTU should contact PTC (involved in the earlier case) and DPT (consulted before). The formulation of who has (PTC, DPT) and who has not the 'team approach' (the other physio) further justifies the course of action. In this extract, what it is to be a "team" is used as one of many resources to argue for a particular course of action in relation to this problematic case. "(T)he team approach " is identified as a distinctive feature of this organization's practice which the Sister uses to illustrate a potential distinction between the individualization of private practice and the collective nature of their team state practice. Being part of a team is deployed as a discursive resource in the argument over the direction of future practice in this problematic particular case. In this example, the Sister presents a series of arguments concerning what might be an appropriate course of action in a particular case *at the same time as* a version of what constitutes organizational life and team practice is constructed.

Importantly, the Sister, in identifying some actors who do and some who do not have the team approach, and enjoining PTU to liaise with someone who does, is doing more than *merely* describing or commenting on the organization. She is recommending courses of action and associations between actors which would bring into existence a new organizational form. Again, the Sister's deployment of a ver-

sion of organizational life emphasising teamwork should be understood performatively — as doing organizational life itself.

7.   Concluding Remarks And Speculations

This paper has presented a review of a number of different accounts of organizations which can be found in the organization theory literature (based on Morgan's (1986) exposition). Instead of siding with any particular version, we have pointed out the critical features over which these different versions differ. We have also observed that producing versions of organizational life is a concern for organization members and not just for organization theorists. Accordingly, we have suggested that different accounts of organization should be understood performatively as implicated in organizing organizational life rather than as some comment on an externally and independently existing thing, 'the organization'. We have illustrated this view with respect to two empirical cases.

What implications might such a view have for COMIC and future work? Let us point to a number of possibilities.

Our arguments suggest that we should not assume just one particular view of organizations in designing CSCW systems. CSCW systems of the sort considered in COMIC need to support multiple views of organizations. Organizational pluralism seems to us to be the appropriate stance for COMIC. Accordingly, in further work on organizations in COMIC a number of approaches are to be developed. For example, the work on TOSCA at GMD primarily embodies a structural view of organizations and explores possibilities for its computer based support. The contributions of Milan on the analysis of work processes adds a sensitivity to the dynamism of organizations and explores communications networks within organizations to assess the sustainable complexity of work processes. This approach is clearly influenced by a number of the versions of organizations we have discussed (organizations as information processing devices, as self-organizing systems and so forth). The activity theory orientation pursued in work at Oulu clearly attempts to integrate various accounts of work organization through a certain concept of activity. Task-based views of work and organizational life are addressed alongside cultural conceptions. Additionally, activity theory has long promised the integration of individual with social perspective on work and interaction. These are just three of the approaches towards work and organizations to be developed in COMIC. Clearly, they trade on quite different notions of organization. At this stage, such pluralism should be regarded as a strategic methodological advantage.

However, the position developed in this document does not stop with organizational pluralism. Indeed, whether pluralism is intelligible or otherwise for understanding a particular setting, on the performative view, turns out to be an empirical question. While pluralism may have certain methodological advantages, it is not — for us — a substantive view. Accordingly, we would like to make progress in future work in spelling out the specificities of the performative view we advocate both

in terms of the organizational theories under development elsewhere in COMIC and in terms of specific technologies which might support a performative approach to organization. The 'critical features questionnaire' (units, qualities, form, currency, time, reciprocity, knowledge) may enable us to develop a framework for understanding organizations and organizational context in future work in COMIC.

Furthermore, we are exploring the similarity between the items (units and the rest) on the one hand and object-oriented concepts on the other. This is a preliminary to investigating whether object-oriented notions are appropriate for modelling multiple views of organization in support technologies (the views being sets of selections from the 'questionnaire'). For example, we intend to explore the viability of generic 'organization building tools' which enable users to specify units, endow them with qualities, relations and the rest. A set of such tools may support the integration of the technologies discussed above (TOSCA, WorkFlow systems and the rest). Clearly, these are speculative remarks but at this stage, speculation based on notions which — we have argued — have empirical and conceptual utility seems justified.

8. References

Ackroyd, S. (1992). Paradigms lost: Paradise regained? In M. Reed and M. Hughes (eds.) *Rethinking organization: New directions in organization theory and analysis*. London: Sage.

Ashby, W. R. (1952). *Design for a brain*. New York: John Wiley.

Bannon, L. (1991). Community technology? *Systemica,* 8, 23-42.

Bannon, L. and Schmidt, K. (1991). CSCW: Four characters in search of a context. In J. M. Bowers and S. D. Benford (eds.) *Studies in computer supported cooperative work: Theory, practice and design*. North Holland: Elsevier.

Beer, S. (1959). *Cybernetics and management*. New York: John Wiley.

Bittner, E. (1965). The concept of organization. *Social research,* 32, 239-255.

Blackler, F. (1992). Formative contexts and activity systems: Postmodern approaches to the management of change. In M. Reed and M. Hughes (eds.) *Rethinking organization: New directions in organization theory and analysis*. London: Sage.

Bowers, J. M. & Middleton, D. J. (1993). *Distributed organisational cognition: An innovative idea?* Paper presented at the Joint Workshop on the Management of Intellectual Resources, Universitée Marne-la-Vallée, Paris, France.

Bowers, J. M. and Churcher, J. (1989). Local and global structuring of computer mediated communication: Developing linguistic perspectives on CSCW in COSMOS. *Office: Technology and people,* 4, 197-227.

Braverman, H. (1974). *Labour and monopoly capitalism: The degradation of work in the twentieth century*. New York: Monthly Review Press.

Brown, R. (1967). Review of research and consultancy in industrial enterprises: A review of the contribution of the Tavistock Institute of Human Relations to the development of Industrial Sociology. *Sociology,* 1, 33-60.

Burns, T. and Stalker, G. M. (1961). *The management of innovation*. London: Tavistock.

Burrell, W. G. and Morgan, G. (1979). *Sociological paradigms and organisational analysis: Elements of a sociology of corporate life*. London: Heinemann.

Callon, M. (1986). Some elements of a sociology of translation: domestication of the scallops and the fishermen of St. Brieuc Bay. In J. Law (ed.) *Power, Action and Belief: A new sociology of knowledge?* Sociological Review monograph 32. London: Routledge and Kegan Paul.

Callon, M. (1992). Techno-economic networks and irreversibility. In J. Law (ed.) *A sociology of monsters: Essays in technology, power and domination.* Sociological Review Monograph. London: Routledge.

Clegg, S. (1979). *The theory of power and organisations.* London: Routledge.

Clegg, S. and Dunkerley, D. (1980). *Organisations, class and control.* London: Routledge.

Conklin, J. (1992). Capturing organizational memory. In D. Coleman (ed.) *Groupware '92.* New York: Morgan Kauffman.

Ehn, P. (1988). *Work oriented design of computer artifacts.* Stockholm: Arbitslevcentrum.

Emery, F. E. and Trist, E. (1969). *Form and content in industrial democracy.* London: Tavistock.

Gergen, K. (1992). Organization theory in postmodern era. In M. Reed and M. Hughes (eds.) *Rethinking organization: New directions in organization theory and analysis.* London: Sage.

Greenberg, S. (1991). Personalisable groupware: Accommodating individual roles and group differences. In L. Bannon, M. Robinson and K. Schmidt (eds.) *ECSCW'91: The Second European Conference on Computer Supported Cooperative Work.* Dordrecht: Kluwer.

Hutchins, E. (1986). *The social organization of distributed cognition.* University of San Diego. Mimeo.

Jameson, F. (1984). Postmodernism, or the cultural logic of late capitalism. *New Left Review,* 146, 53-93.

Jirotka, M. Gilbert, G. N. and Luff, P. (1992). On the social organisation of organisations, *Computer Supported Cooperative Work,* 1, 95-118.

Kanter, R. M. (1983). *The change masters.* New York: Simon and Schuster.

Lakoff, G. (1991). *Metaphors of war.* Article distributed by electronic mail, February, 1991.

Latour, B. (1986). The Powers of Association. In J. Law (ed.) *Power, Action and Belief: A New Sociology of Knowledge?* Sociological Review Monograph 32. London: Routledge and Kegan Paul.

Latour, B. (1987). *Science in Action: How to Follow Scientists and Engineers Through Society.* Milton Keynes: Open University Press.

Latour, B. and Strum, S. (1985). Human Social Origins: Oh Please Tell Us Another Origin Story. *Journal of Biological and Social Structure.*

Medina-Mora, R., Winograd, T., Flores, R. and Flores, F. (1992). The action workflow approach to workflow management technology. In J. Turner and R. Kraut (eds.) *CSCW '92: Sharing perspectives (Proceedings of the conference on computer supported cooperative work).* New York: ACM Press.

Middleton, D. J. (forthcoming). Talking work: Argument, common knowledge and improvization in team work. In Y. Engeström and D. Middleton (eds.) *Communication and cognition at work.* Cambridge: CUP.

Miller, D. and Friesen, P. H. (1984). *Organizations: A quantum view.* Englewood Cliff: Prentice Hall.

Power, M. (1990). Modernism, postmodernism and organization. In J. Hassard and D. Pym (eds.) *The theory and philosophy of organization: Critical issues and new perspectives.* London: Routledge.

Rose, M. (1988). *Industrial behaviour (2nd edition).* London: Penguin.

Rose, N. (1990). *Governing the soul: The shaping of the private self.* London: Routledge.

Rumelhart, D., McClelland, J. and others (1986). *Parallel distributed processing: Explorations in the microstructure of cognition.* (2 vols) Cambridge, MA: MIT Press.

Simon, H. (1960). *The new science of management decision.* New York: Harper and Row.

Taylor, F. W. (1911). *Principles of scientific management*. New York: Harper and Row.

Wiener, N. (1961). *Cybernetics*. Cambridge: MIT Press.

Winograd, T. and Flores, F. (1986). *Understanding computers and cognition: A new foundation for design*. Norwood, NJ: Ablex.

Wood, S. (ed., 1982). *The degradation of work? Skill, deskilling and the labour process*. London: Hutchinson.

How to put cooperative work in context: Analysis and design requirements

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Work is a situated activity. Being effective in work activities requires awareness of the Organizational context (OC) where it is situated.

In this paper we discuss three issues related to the above claim:

· awareness requires both transparency and visibility of the OC. Moreover it requires that the representation of the OC, through which visibility and transparency are achieved, has some learning capabilities;

· lack of awareness is a major factor affecting the transaction costs of work activities;

· any Computer Support to Cooperative Work needs to embody an OC representation.

These three issues are discussed from the point of view of the work process model the authors are developing.

The work process model gives precise guidelines to distinguish within the OC of a work process three different types of knowledge (namely the outer, inner and individual OC) and to outline how they can be represented.

A short section is dedicated to how the OC adaptor TOSCA can used as a basis for the representation of the OC of a work process.

1. Introduction

This paper tries to respond to the design and requirement issues coming from the need to put cooperative work in context. The purpose of the paper is to explain both what we consider Organizational Context (OC), and how it can be (partially) represented and used.

Work is a situated activity [Suchman 1987], [Lave, Wenger 1991], [Jordan 1992], [Stucky 1993]. In particular it is situated into a context that "includes anything relevant and necessary to achieve the goals of an organization" [Sarmiento et al. COMIC-UPC 1-2]. The OC is a complex and dynamic entity that reflects the complex and dynamic nature of cooperative ensembles, as they are "large, often transient, with membership not stable and with patterns of interaction that change dynamically to face the requirements and the constraints of the situations" [Schmidt, Bannon 1992]. The OC of a cooperative ensemble is subject to changes and undergoes changes with different speed and different visibility: while the "cooperative work arrangement" [Schmidt COMIC-RISOE 1-3] is a transient formation, that 'continuously' changes, generally under the eyes of the interested persons, the "work organization" and the "formal organization" change 'discretely'

and their changes very often are unobservable to many persons who may become interested in them.

The effectiveness of any person within a work process depends upon his or her ability to maintain himself or herself aware of its OC (cooperative work arrangement, formal and work organization) and its changes. In light ofchanging nature, two attributes characterize the awareness of the OC: visibility and transparency. The structure of the OC (rules, role distribution, communication protocols, etc.) is the outcome of its history. It can be rather obscure both for the newcomer, who does not know anything about it, and for the experienced member of the group, since he or she may not have registered its changes. But while the newcomer needs to see the structure of the organizational unit he or she has become a member of in order to learn it, the experienced member generally acts, or at least wants to act, as if the structure of the organizational unit he or she is a member of were transparent to him or her.

We refer to the *visibility* attribute as the attribute that makes the OC visible to a worker whenever he or she needs new ways of acting in the OC. It's the way to act exploiting the complexity of the OC.

We refer to the *transparency* one as the attribute that characterizes (or should characterize) the OC during the normal exploitation of the work, that is when the OC is 'ready at hand' to the workers and they don't need to care about its structure. It's the way to act disregarding the complexity of the OC.

An information system representing the OC can be very useful to support both visibility (making its information accessible to its users) and transparency (allowing the support system to use the information it contains to give effective answers to its users) if it has some learning capabilities. Various scholars in the organization and management sciences have characterized the change dynamics of the OC of a cooperative ensemble in terms of its organizational learning capability [Argyris, Schoen 1978], [Senge 1992]: a good OC representation system should also have it, i.e. it should have some mechanisms automatically updating the representation and granting its consistency w.r.t. the OC. We refer to the *learning* as the capacity to maintain the representation consistent with the represented OC.

A CSCW environment is therefore able to support awareness as much as it supports transparency, visibility and learning of the OC. It is much more effective in responding to the above requirements as it provides:

- a model of the OC. Using the model, the workers acquire visibility about the organizational components of the cooperative ensemble; (it provides the visibility);
- an integration of the model with the electronic support systems used in the work practices; (it provides the transparency);
- the mechanisms allowing the model to learn the changes and to maintain itself consistent with the OC; (it provides the learning).

Setting aside the learning capability, that has been afforded only by some prototypes and systems [Conklin 1992], [De Cindio et al. 1986, 1988], [Divitini et al.

1993], we can use the transparency and visibility attributes can be used to classify some CSCW systems (most of them reviewed within [Fuchs COMIC-GMD 1.2], [Benford COMIC-NOTT-1-1]) from the point of view of the support they offer to awareness of the OC.

Looking at them from the viewpoint of the two attributes of visibility and transparency (see Figure 1), we can observe three categories.

The first one includes systems like Officetalk-D [Ellis, Bernal 1982], DOMINO [Kreifelts, Woetzel 1987], [Kreifelts et al. 1991] and WooRKS. [Ader, Srivaths 1992] They are all office support systems built around a workflow management system. The transparency of the OC is supported basically by the automatic scheduling of the tasks and by mechanisms of exception handling, through which the system helps in finding with whom to interact to solve the problems. It should be noted that WooRKS, as it provides also a model of the hierarchical structure of units and roles inside the OC, supports more visibility than the first two systems. Their similarity lies in the fact that they all use a work model by means of which the user can act disregarding the complexity of the OC.

The second one includes systems like Grace [Benford et aL. 1992], the ISO Group Communication standards [ISO-XCG 1991], [ISO-XACC 1991], EIS [Hennessy et al. 1992] and TOSCA [Prinz 1993, COMIC-GMD 1-4]. They provide the user with a broad range of object classes useful to model appropriate representations of the organizational objects and the relationships among them. They are similar as the users can use them to "navigate" the complexity of the OC in order to discover the required index to the resources needed; furthermore they provide the applications with interfaces to the OC classes represented.

The third one includes systems like WooRKS+UTUCS [Agostini et al. 1993], [De Michelis, Grasso 1993] and the Task Manager + TOSCA [Prinz COMIC-GMD 1-4], where the knowledge base representing the OC is used to support the work processes. In these systems a model of the work process is used to support the work process while a model of the resources is used as a knowledge base both to support the processes with transparency and to provide visibility on the OC, either when required from the newcomers or to solve breakdowns.

In any case, all these systems give only a partial answer to the Organizational Context representation problem, as their support of visibility, transparency and learning has severe limitations. It seems to us that all of them did not face the problem in sufficiently general terms. They constitute, anyhow, a good basis for proposing a more complete and effective OC representation.

We think that, to overcome the limits of existing systems, it is necessary to build the OC representation upon a model of cooperative work, suitable not only for describing and analyzing work arrangements but also for evaluating the benefits the support systems may offer in terms of costs. In other words we need to characterize the work metaphor [Bowers COMIC-MAN 1-] underlying the OC representation. In this paper we discuss in some depth the work process model proposed in [De Michelis 1993] and we show how it provides a good basis for characterizing the constituents of an OC representation. The work process model is also

used to discuss the benefits that awareness of the OC can give in terms of reduction of transaction costs.

While the visibility of the OC is analyzed in some detail also at the level of the representation, the issues concerning transparency and learning of the OC are only outlined. Lastly the possibility of using the "OC adaptor" TOSCA [Prinz 1993, COMIC-GMD-1-4], [Sarmiento et al. COMIC-UPC-1-2] is discussed.
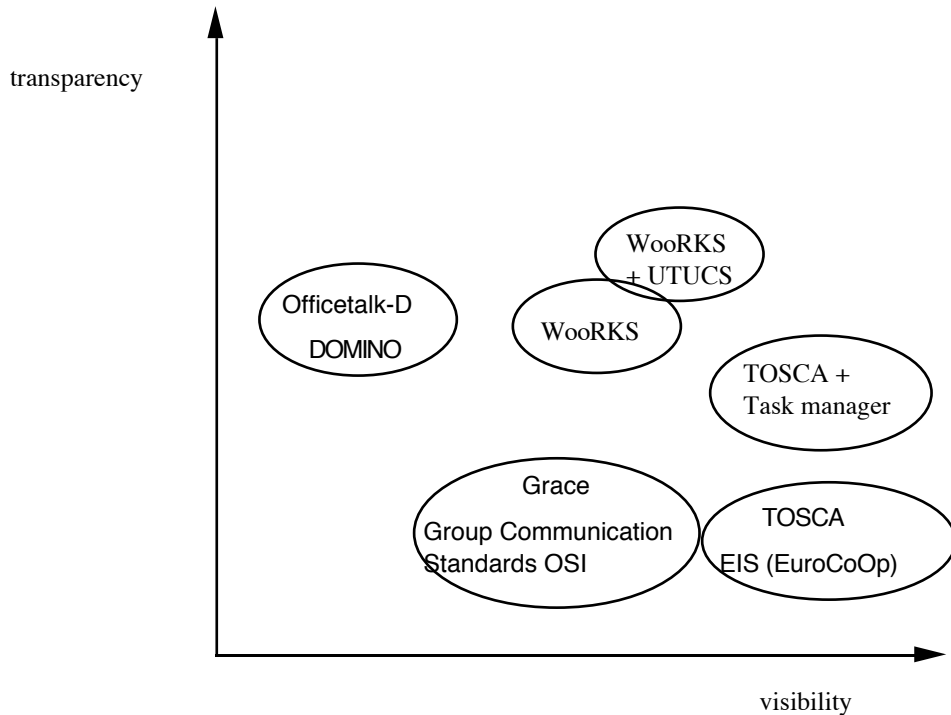
Figure 1 — Visibility and transparency of some CSCW systems

2. The organizational context of work processes

As we have claimed in the Introduction, most observers agree that work is a situated activity, and that awareness of its (organizational) context is a very important capability of effective workers, in any situation. To analyze the context of work it is important to understand the nature of work itself, what make up its basic components, how organizational units are related to it, etc.

It is not the aim of this paper to discuss in detail these issues: one of us has sketched the main features of our approach in a very recent paper [De Michelis 1993], to which we refer the interested reader. It is therefore sufficient to recall in short the main features of what we consider the work process approach, so that we can discuss the concept of OC in relation to it.

In our approach work, as a human activity, is viewed as the pragmatical dimension of human life. With this image of work in mind, if we look at organizations such as firms and public institutions, we can completely characterize

their behaviour through the work processes their members are involved in; meanwhile, by work process we mean the relation between human beings embedding the flow of actions giving rise to the expected outcome. The meaning of any action is strictly dependent on the customer/performer contract defining it.

In accordance with Fernando Flores and his co-workers [Keen 1991], [Medina-Mora et al. 1992], a work process is a four phase cycle starting with a customer generating the request for an action, continuing with a performer agreeing with the customer to do the required action and then completing it, and finishing when the customer declares his/her satisfaction (the Action Work Flow®; see Figure 2, here below), recreating the conditions for restarting the cycle.
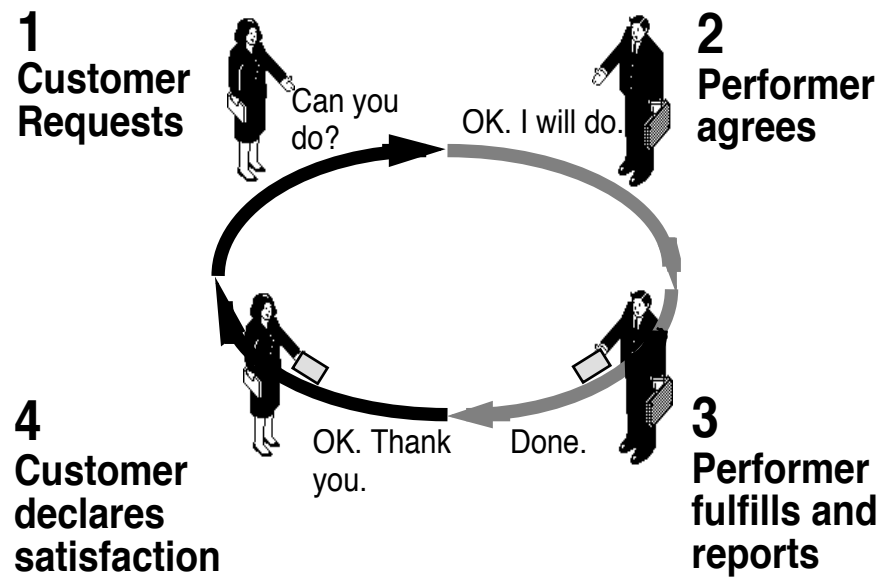
Figure 2 — The Action Work Flow®, (Source: ATI)

Sometimes the customer/performer cycle is simplified through the contraction of two of its phases. An example of a contracted cycle is the business process of mail Marketing, where the requests the Buyer makes in the catalogue are by definition accepted as contracts by the Seller (see Figure 3).

R

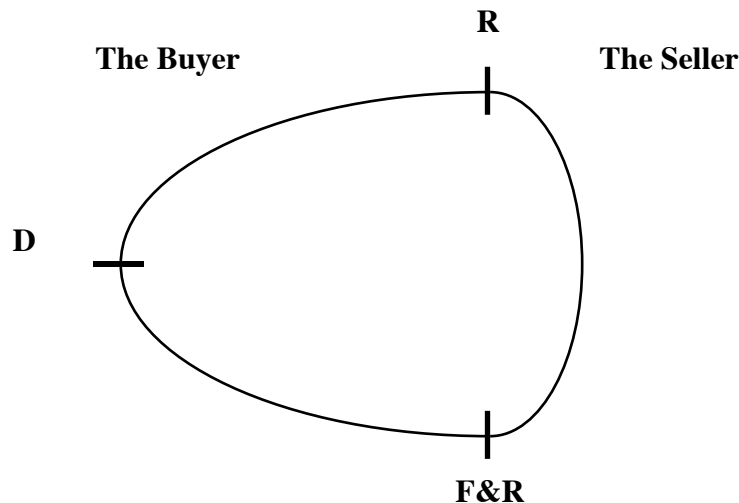**The Buyer**   **The Seller**

D

F&R

Figure 3 — A simplified customer performer cycle

The customer/performer cycle represents the basic form of a work process. But only simple work processes (involving just one person as the customer and just one person as the performer on one action) reduce themselves to one customer performer cycle. When a work process is not simple the performer as well as the customer, when necessary, opens within it other work (sub-)processes with other performers, becoming their customer, to get the help (in terms of human, informational, technical or material resources) necessary for the completion of any of its phases. The analysis and description of all the planned work sub-processes that are open within a work process and of the way the latter are interconnected by means of its "cycle of (customer/perfomer) cycles" image (for the cycle of cycles we pay tribute to the work of Fernando Flores and co-workers, who developed a well supported methodology to design chains of action workflows [Medina Mora et al. 1992], and to the experiences of Buni Zeller and others at RSO in supporting work processes with workflow management systems [Schael, Zeller 1991, 1993]) is an important tool for understanding the complexity of its interactions. The customer/performer cycle gives a relational picture of a work process: it shows it as a relation.

Analyzing its behaviour through the cycle of cycles model we can understand the relations linking the members of its community of practices, but does not fit some more traditional ways to observe work processes. We often speak about a work process from the viewpoint of the actions performed within it (of its action flow): action flows can either be designed during the negotiation phase (and modified during the execution phase, when necessary), as project plans, or be predefined in a standard way as procedures.

Any person participating in the cooperation network of a work process plays within it a role that is characterized by the sub-processes to which he or she can participate; by the tasks he or she has to accomplish within the procedures that are activated within it; and/or by the actions he or she has to complete within the projects in which he or she participates, characterizing its recognized abilities and

responsibilities within that work process. The role of a member of a cooperation network changes during the development of a work process, as an effect of the occurrence of changes within the sub-processes he or she participates in.

The cooperation network of a work process is not (generally) a unit of the organization to which the performer belongs even if very frequently firms and public Institutions try to shape their organizational units on their work processes in order to unify control over organizational structures and the control on the work processes, it is impossible to constrain the cooperation network of a work process within the boundaries of a predefined organization without reducing its effectiveness with respect to possible breakdowns or duplications of the resources needed to perform them.

The relation between work processes and organizational structures is more subtle than a simple embedding: at the macro-organizational level any work process needs a supervising authority controlling and maintaining it (that acts therefore as a (secondary) customer with respect to it), while at the micro-organizational level the rational distribution of human resources among work processes can be accomplished by embodying them into organizational units. The performers of a work process generally do not belong to the structure headed by the person having responsibility over it (who therefore acts as customer for their performances) while the members of an organizational unit generally perform actions within different work processes. Therefore the head of that organizational unit is a (secondary) performer within a customer/performer relation with all the people responsible for the work processes on which his/her collaborators play a role. The definition of organizational structures within the organization involved in a work process makes its customer/performer cycle more complex than the simple one proposed in Figure 2, for it introduces into it multiple customers and/or multiple performers.

The principal performer together with all the persons with whom he or she can cooperate within a work process constitute its cooperation network. The roles played by the members of a community of practices within its customer/performer cycles allow us to characterize the forms of cooperation into which they enter. There are four main forms of cooperation: collaboration, coordination, co-decision with equal roles, and co-decision with distinct roles (for a deeper discussion of the four forms of cooperation see [De Michelis 1990, 1993], [De Michelis et al. 1992]). Let us sketch them here below.

Collaboration occurs when two or more people work together in order to achieve a single common goal: no distinction can be made between what is done by any single participant. Collaboration is carried on by customers and performers within a customer/performer cycle.

Coordination occurs when two or more people work together to perform different sub-tasks that are part of a more general task: each single participant has therefore his or her own task, but all tasks are mutually related. Coordination is carried on by people as customers and performers in cycles at different levels: e. g. a customer must coordinate him or herself with the performers of the subcycles initiated by his or her performer.

Co-decision with equal roles occurs when two or more people participate in a decision process, where all of them share full responsibility for the decision to be taken. Co-decision with equal roles is carried on by persons who are customers of the same performer (with one single satisfaction condition).

Co-decision with distinct roles occurs when two or more persons participate in a decision process, where each one of them has his or her own responsibility on a particular issue related to the whole decision to be taken. The managers of the different functions of a firm defining its annual budget participate in a co-decision with distinct roles. Co-decision with distinct roles is carried on by persons who are all performers for the same customer (having one condition of satisfaction, embodying all the actions all the performers perform).

If we look at work from the viewpoint outlined above we can draw two conclusions:

1) work is performed within work processes, and therefore its OC is the context of the work processes within which it is performed;

2) The OC of a work process is made up of all the features characterizing it listed above: its cycle of cycles model as well as its flow of actions, its cooperation network as well as the macro- and micro-organizational structures of the organizations in which its performers participate, the history of completed and ongoing work processes as well as the skills of the persons participating in them, etc. It is important to observe that different actors of a work process (its customer or in principal performer, or any of the other members of its cooperation network) represent the OC in a different manner, as their positions within the work process each define a particular point of view.

If we try to represent the OC of a work process, from the viewpoint of its principal performer, we observe that the knowledge we have to collect can be classified into three categories:

- the knowledge about what has happened outside the work process, as the definition of organizational structures, of the work process form, etc.: this type of knowledge has a relevant overlapping with what Schmidt calls 'work organization' and 'formal organization' [Schmidt COMIC-Risoe 1-3];

- the knowledge about what has happened within the work process itself, during its history, as the state reached by a work process, in regard to who did what within it, etc.: this type of knowledge has a relevant overlapping with what Schmidt calls 'cooperative work arrangement';

- the knowledge about what is strictly personal to each participant in the work process, as his/her experience, ability, skills, etc: this type of knowledge does not fit into Schmidt categories.

We can call these three types of information on the OC of work processes respectively: *outer*, *inner* and *individual* OC. The reason why distinguishing the three types of information characterizing the OC of a work process is of particular interest is that, while it is possible to automate the inner OC learning as a function of the work process support, learning the outer OC requires a service updating the

information characterizing it, when necessary, and learning the individual OC requires someone (an organizational unit) observing, analyzing and evaluating the behaviour of the persons participating in the work process.

We will come back to the learning problem, after that we have given more details about the three types of information characterizing the OC.

2.1. The outer OC

As we have pointed out above, by outer OC we mean the information characterizing what influences a work process during its life, but is not generated within its life: everything that characterizes a work process independently from its history, e.g. before it starts, belongs to its outer OC. It provides indexes to information useful for performing the process [Schmidt COMIC 1-3].

The Institutions

Every work process involves legal entities both at the customer and at the performer level. We define them Institutions. Examples are corporations, firms, or public Institutions. The Institutions involved within a work process are part of its outer OC. The Institutions can be represented by information on their organizational structure, on their legal representatives, the addresses of their main offices, etc.

The Market

The Market (constituted by all its potential customers), to which the performances of a work process are offered, is decided outside the work process by its supervisor, and therefore is part of its outer OC. The Market of a work process can be represented by information characterizing its members(from the social, legal, geographical, ... points of view) .

The Supervisor

The supervisor is the person who is responsible for the performances of a work process. The person supervising a work process is decided outside the work process (by the top management of the Institution to which the perfomer belongs) and therefore is part of its outer work process. The supervisor of a work process can be characterized by his/her name, his/her address, his/her position within the organizational chart, his/her other duties, etc.

The cooperation network

The performer together with all the persons with whom he or she can cooperate within a work process constitute its cooperation network. The cooperation network is created through all the instances of a work process that have been performed or are ongoing. Therefore it is part of its outer OC. The cooperation network of a work process can be characterized by the names of its participants, their addresses, their roles within the work process itself, their other duties, ...

The form of the work process

The rules defining the roles of the participants in a work process, the customer/performer relations that are defined within it as well as its flow of actions, etc., in brief its form, are defined outside the work process itself under the responsibility of its supervisor. Therefore they are part of its outer OC. The form of a work process can be represented by a cycle of cycles model, indicating, for each cycle, its customers and its performers, together with, whenever possible, the procedure embedded within it.

The relations with other processes

The relations of a work process with other work processes induced by the macro- and micro-organizational structures of the Institutions involved in it are also part of the outer OC of the work process. The representation of the relations between work processes depends upon the way by which the organizational structure of the involved Institutions is represented.

2.2. The inner OC

By inner OC of a work process we mean the information characterizing its history. While the outer OC is made up of structures, categories, models, etc., the inner OC consists in events and in what characterizes those events: actors, states, past, ...

While awareness of the outer OC means being an experienced member of an Institution, awareness of the inner OC means being a committed member of a cooperation network.

The principal customer

The principal customer of a work process is the person (representing or not an Institution) who performs the request within it. The principal customer is the initiator of the work process, and becomes such only by the event of deciding to have a condition to be satisfied. Therefore he or she is part of the inner OC. The principal customer of a work process can be characterized by his or her name, his/her address, the Institution to which he or she belongs, his or her position within it, the previous work processes where he or she acted as principal customer, the things (actions and/or conversations) he or she has already done within the work process etc.

The current state of the work process

In any moment a work process (if not simplified) is in one of its four phases: e.g. in the phase concluding with the request, or in the subsequent phase concluding with the agreement. Within that phase it is possible that sub-processes have been opened, and they are also in one of their four phases. The phases reached by the work process and by its opened sub-processes characterize its state. The current state of a work process can be characterized by indicating in its cycle of cycles

model the active phases together with principal customers of all opened sub-processes.

The current state of the flow of actions

If within a work process a procedure has been initiated or a project plan has been established and initiated, then it is important to know what has been already done and what needs to be done in order to perform the requested action. The current state of a flow of actions can be characterized indicating in its model the line separating the already performed actions from those which are under execution.

The history

All the already performed actions and inter-actions, the already completed sub-processes, of a work process, in summary its history, provide all that leads to the current state of the process. Breakdowns make every work process unique: also if we model it taking into account all the possible variants we may foresee in its evolution, exceptional breakdowns may occur. In our approach we prefer to have simple models of work processes, in order to support people is understanding. But as a consequence we need to record all the events characterizing its history. The history of a work process can be characterized by a hypertextual structure linking together its previous and current states (as well as those of its flows of actions) with the documents, the conversations, ... performed at them.

The actors involved

The actors already involved in a work process are the already active part of its cooperation network, are relevant as are the actors of the events of its history. The actors involved in a work process can be characterized by their names, their addresses, the actions and conversations they have performed and are performing, …

2. 3.   The individual OC

The outer and inner OCs are not sufficient for fully characterizing the conditions in which a work process is performed: in order to understand what we must do next we need to know something about the persons that are (on the customer as well as on the performer level) active in it. The individual OC characterizes what is strictly personal to each participant in the work process, such as his or her experience, ability, skills, tool support, etc. The information outlined above allows us to understand how much awareness the participants may reach if well supported, and the limits they not can overcome. Short and clear curricula of the participants together with the inventories of their working spaces offer a good representation of the individual OC.

2.4. The outer OC of a real work process: the Credit Procedure

The work process taken into consideration is the process through which a customer request for a new credit is managed within an Italian Bank (more details about the Bank and its Credit Procedures can be found in [Agostini et al. 1993] and [Schael, Zeller 1993]).

The customer, who interacts with the agency director who is responsible for the whole procedure, may be a private person or a legal representative of an Institution. Relevant data (both anagraphical and financial) and mandatory documents involved in the procedure are different in the two cases.

After a preliminary informal investigation of which the director is in charge, a formal request document has to be signed by the customer. The document must contain information about requested amount, duration of the credit, and, when requested, guarantees.

Furthermore, the customer has to give detailed information about his/her financial position. The agency director looks in the customers' database in order to see whether the customer is already known and to check his or her financial position with respect to the Bank. After this first investigation, the branch director activates several secondary processes with the customer, with the branch secretariat and with the central credit office of the Bank in order to decide whether he or she is in favour of giving the credit or not. The customer's total assets and the risk associated to the requested credit provide the customer's current situation. If the branch director supports the credit request he or she will sign it. If the credit request is under 50.000.000 Lit. and the interest rate is higher than 17.5%, the signature is sufficient to make operative the credit after its registration in the "book of credits". Otherwise other bodies of the Bank have to sign the form. The customer gets an official letter about the resolution concerning his or her request, after it has been signed by the resolution body and all technical necessities have been fulfilled. The customer has to send a signed copy of this letter back to the Bank in order to state his or her acceptance of the credit and the related conditions.

Here below we give some hints about the outer OC of the Credit Procedure.

The Institutions

The Bank is the main Institution involved in the procedure on the performer side, while a physical person or a firm (whether they are they already customers of the Bank or not) are involved on the customer side. Less important roles are played by other Institutions, as the Bank of Italy and CERVED, who act as simple information providers.

The Bank involved in this case study is a limited liability cooperative that was established almost 120 years ago. Its headquarters are in a medium size town in northern Italy. The Bank was founded and initially developed as a Bank local of scope whose main purpose was to achieve widespread penetration in its home province.

The Bank's regional character changed with time. It is a peculiar characteristic of this Bank to constantly foster the expansion and diversification of its operating structure on diverse Markets, thus achieving economies of scale. At the same time, a balance is always kept between the need for expansion and the necessity to consolidate the acquired Market share. Subsequent to the local presence, the Bank opened branches in various adjacent sub-regions, reaching a total number of 56 branches. Here below (Figure 4) the organizational chart of the Bankis is depicted .
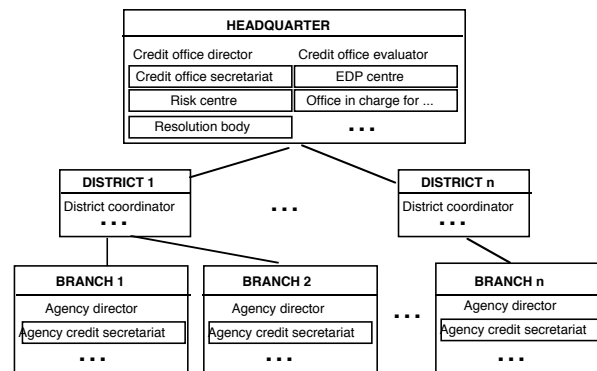
Figure 4 — The organizational chart of the Bank

The Market

The Market consists of the persons and Institutions who are already customers of the Bank, and of all potential customers, both persons and Institutions. In this procedure the Market is not restricted to a target predefined by the Bank, as it doesn't use a special policy to contact it.

The supervisor

The agency director is the initiator of the Credit Procedure, but the credit office director is the person who is responsible for the performances of procedure. He or she is responsible for all the credit activities. The credit office director delegates the deliberation competence to the credit office director for loans <= 50.000.000 and interest rate >=17,5, while for loans >= 80.000.000 and interest rate >=14,5 he or she needs some deliberations on the part of top management.

The cooperation network

In the following a brief description of the organizational roles belonging to the cooperation network is provided:
- **agency director —** He or she is responsible for the agency's overall performance and for commercial development. According to the organizational model of the Bank, he or she is the initiator of the Credit Procedure. In line with current rules of the Bank, his/her role is characterized by autonomy and full responsibility in initiating a loan request procedure;

his/her deliberation competence is limited to loans <= 50.000.000 Lit and Interest rate >= 17.5%;

- **agency credit secretariat** — The persons of this office support the agency director in preparing the credit dossier, i.e the bureaucratic documentation needed;

- **district coordinator** — He or she has responsibility over the Bank budget for credit operations in his or her area of competence. He or she is informed on all credit proposals in order to explore new business opportunities. His/her deliberation competence is limited to loans <= 80.000.000 Lit and interest rate >= 14.5%;

- **credit office director** — He or she is an experienced manager, usually reaching that position after a career in the agencies. He or she usually also has some experience as a credit evaluator; the responsibility of the director is to supervise credit activities in general. His/her deliberation competence is limited to loans <= 200.000.000 Lit. and interest rate >= 14.5%;

- **credit office evaluator** — He or she deals with the risk assessment of the customer, taking no formal decision. He or she is in charge of gathering random information and forecasting Market evolution of the customer's company. He or she is responsible for the formal check on the Credit Procedure and on the proposed conditions;

- **credit office secretariat** — It is mainly concerned in the formal recording of official decisions; it is responsible for data gathering and filling-in of complex standard forms;

- **risk centre** — This office is responsible for the administration of data inside the information system. It is in charge of enhancing of the rate of data exchange between the various organizational units;

- **top management** — Its role is that of a resolution body. Its deliberation competence is extended to loans > 200.000.000 Lit. and interest rate <14.5%. The vice director is in charge of deliberations about loans <= 300.000.000 Lit. with a rate of interest <= 14,5%; the general director has deliberation competence limited to loans <= 600.000.000 Lit. and any interest rate; the full committee of general directors decides on credits <= 1.500.000.000 Lit;

- **EDP centre** — This office is responsible for storing data in the information system;

- **office in charge of perfecting the practice** — It is responsible for the completion of the practice and its subsequent registration when there are guarantees involved. It is the competent office for stocks, mortgages or foreign affairs.

The form of the work process

The form of the Credit Procedure is depicted in the following pictures, where customer/performer relations (Figure 5) and flow of actions (Figure 6) are

identified. It should be noted that only the flow of actions of a part of the procedure is described.
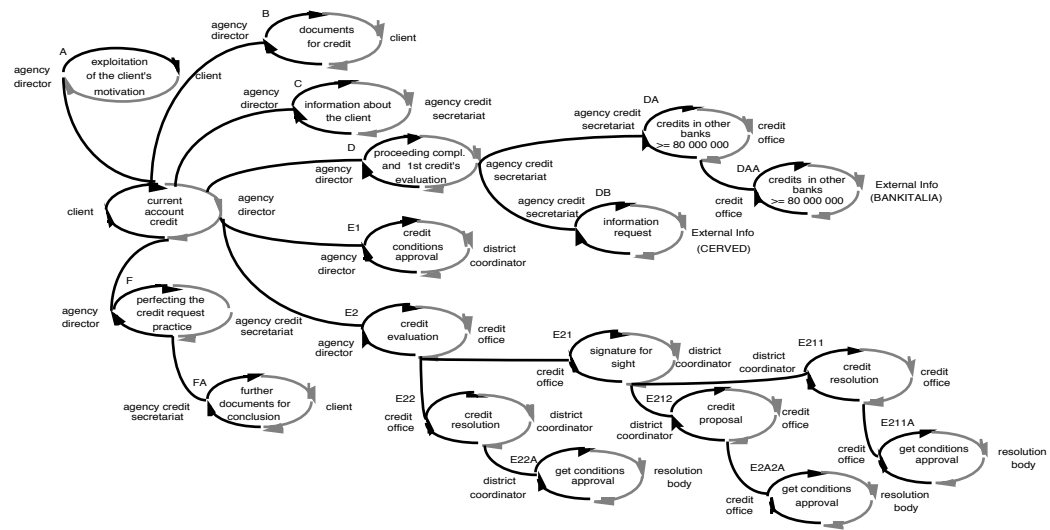

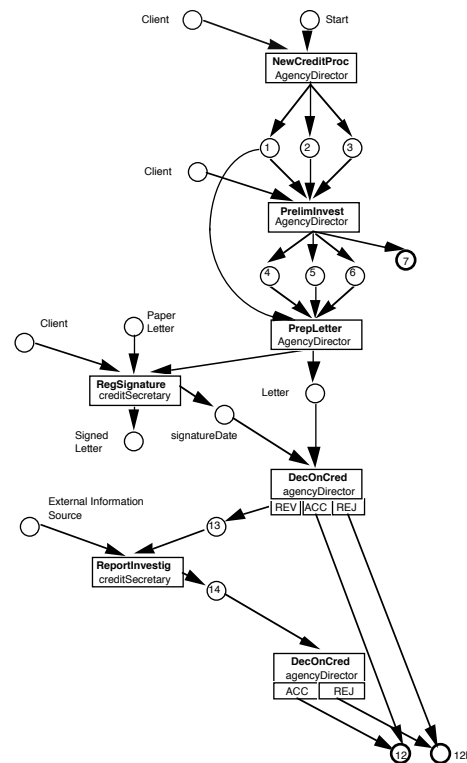Figure 5 — Customer/performer relations of the Credit Procedure

Figure 6 — A partial model of the flow of actions

Relations with other processes

The main relations with other processes are those instantiated by the 'information about credit' sub-process, where the agency credit secretariat acquires information about the account of the customer, and by the 'perfecting the credit request practice' sub-process where the agency credit secretariat modifies the account conditions of the customer.

2.5. The inner OC of a real work process: the Credit Procedure

The inner OC is strictly dependent on the actual instance of the work process and its history determines the information that characterizes it. So a real case of inner OC can be explained making reference to an example [Agostini et al. 1993].

Let's imagine a realistic sequence of conversations and actions activated by the customer Roberto Bianchi, representing the advertising agency INPUT Image Project that needs a credit to update its sw/hw equipment. The first meeting between the customer and the agency director, Mr. Guglielmo Rossi, is located in the proposal phase and is devoted to the exploitation of the customer's motivations. Request for the necessary documents also falls in this phase. An agreement phase follows, where the agency director requests the agency credit secretary, Miss Anna Neri, to see if INPUT Image Project is already known to the Bank and to check its financial position. Let's imagine being at the end of this phase: Mr. Rossi is in charge of the activity on the preliminary credit investigation, and among the other tasks he has to check the list of documents which Mr. Bianchi has delivered.

It should be noted that during the process there are many situations where an exception may arise, and so a communicative activity devoted to resolving it may be started. In our case the customer has supplied the wrong documents in place of the requested ones and Mr. Rossi is not sure about the legal correctness of this substitution and wants to have some more information. This exceptional case requires a new conversation, not depicted in Figure 5, with someone that can help in solving the breakdown (in this case she may be the secretary).

Here below we give some hints about the inner OC of the Credit Procedure.

The principal customer

The principal customer is Mr. Roberto Bianchi, representing the firm INPUT Image Project srl. They are already known to the Bank and its database contains the legal data of the firm and the history of its relationship with the Bank.

The current state of the work process

The (sub-)processes under execution, their active phases and customers are:

main loop	agreement	Mr. Bianchi
documents for credit	declaration of satisfaction	Mr. Rossi

Figure 7, here below, shows in a graphical way both the already perfomed sub-processes and the sub-processes under execution (with an indication of their current states).
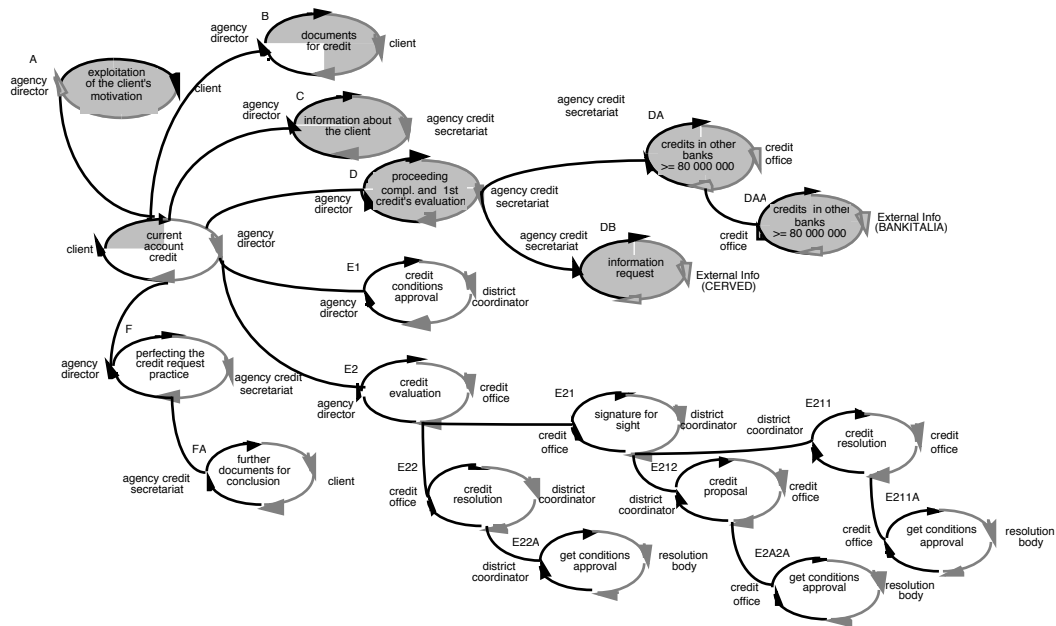

Figure 7 — The current state of the Credit Procedure of the INPUT Image Project

The current state of the flow of actions

The activity under execution is PrelimCreditInvest; it is the subject of a conversation between Mr. Rossi and Miss Neri, as the documents produced by the customer are to be checked.

The tokens in the Petri Net of Figure 8 show the current state of the flow of actions in a graphical form.
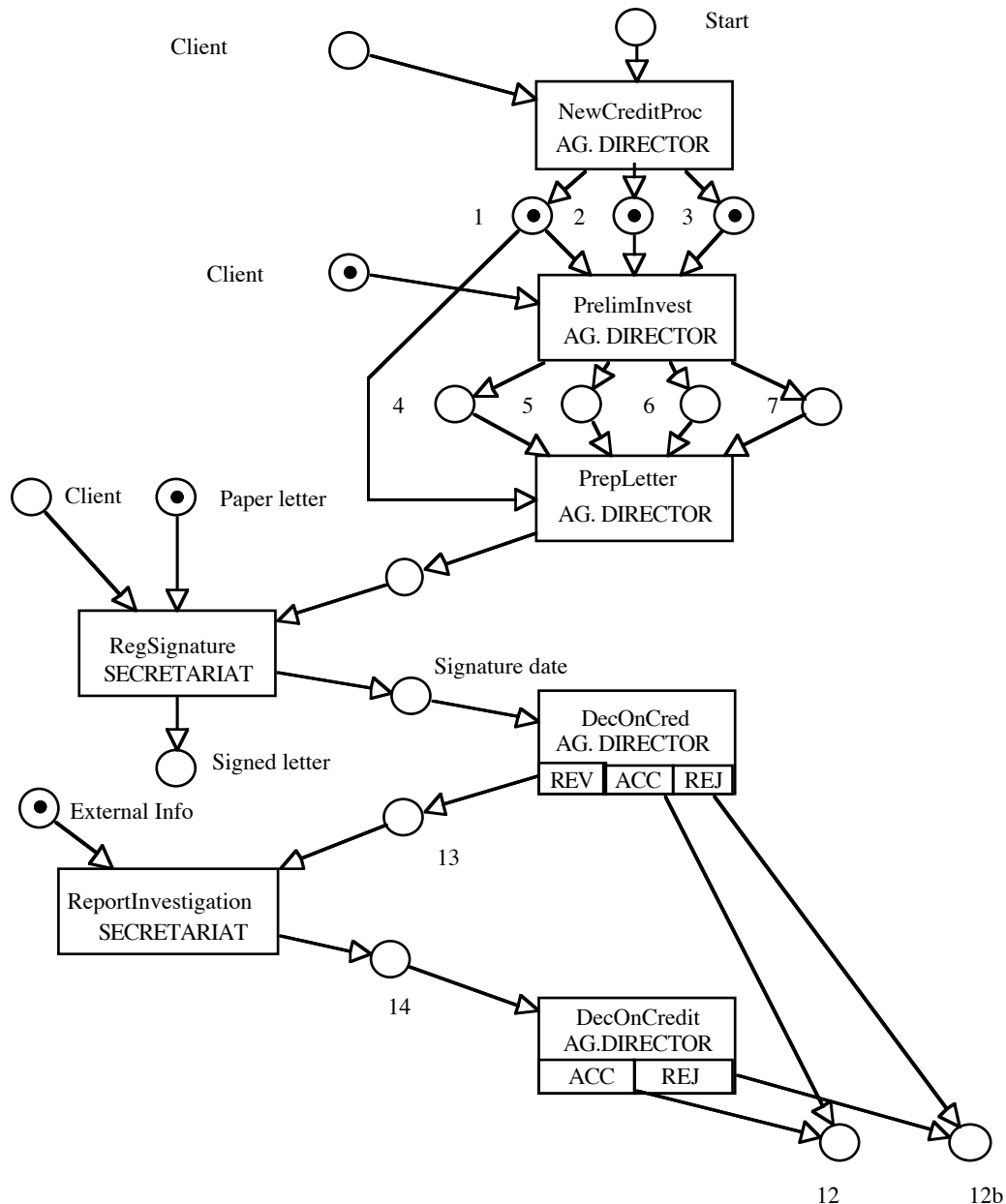
The history

The history is fully identified by the already perfomed sub-processes and by the already executed phases of the sub-processes under execution.

In our example the main process is still under execution: in particular, its first phase has been succesfully completed, while the agreement phase is still under execution as only the 'proceeding compl. and 1st credit evaluation' and the 'information about the customer' sub-processes have been successfully completed, while 'documents for credits' is still under execution.

The flow of actions has reached the triggering of the activity PrelimCredit Invest. The following activities and the following forms have been produced.

```
ACTIVITY action_1: Meetcustomer
```

```
    ROLE Manager OF CONTEXT Branch
    INPUT
      Start FROM OUTER_WORLD
    OUTPUT
      meetingDate
  END_ACTIVITY
  ACTIVITY action_2: NewCreditProcedure
    ROLE Manager OF CONTEXT Branch
    INPUT
      meetingDate FROM action_1
    OUTPUT
      form1 -- requested credit amount and type
      form2 -- customer's identification on the                    --
      anagraphical database
      form3 -- comment on new Credit Procedure      END_ACTIVITY
  ACTIVITY action_3: Meetcustomer
  ROLE Manager OF CONTEXT Branch
    INPUT
      FROM NewCredit Procedure
    OUTPUT
      meetingDate END_ACTIVITY
```

The activity PrelimCreditInvest is not completed, because form7 is the subject of an open conversation with Miss Neri.

```
ACTIVITY action_4: PrelimCreditInvest
    ROLE Manager OF CONTEXT Branch
    INPUT
      meetingDate FROM action_3
      form1 FROM action_2
      form2 FROM action_2
      form3 FROM action_2
    OUTPUT
      form4 -- customer's exposition to the                -- Bank/risk
profile
      form5 -- customer's updated anagraphical              -- data
      form6 -- customer's motivations
      form7 -- list of necessary and                -- c o l-
lected/missing documents
  END_ACTIVITY
```

The history representation associates to each state all those conversations opened within it to solve exceptional situations. In this case only the open conversation between Mr. Rossi and Miss Neri is associated with the current state.

The actors involved

The actors involved in the process are:

Roberto Bianchi	legal representative of the INPUT Image Project
Guglielmo Rossi	agency director
Anna Neri	secretary

3. Representing the OC of a work process by TOSCA

The aim of TOSCA is to provide both cooperation support systems and users with organizational information. Two basic object types are defined for the representation of organizational objects and organizational relationships. Based on these basic object types a comprehensive set of subtypes for the specific representation of organizational information is provided by the system.

Therefore TOSCA can be used to define the appropriate objects and relationships for a CSCW environment, both to retrieve useful organizational information about a process, and to provide a system with the objects for a computer support of the process.

Starting from the characteristics of TOSCA that make it an OCadaptor [Sarmiento UPC-1-2], we can show how they could be used to model the OC of a work process as we have outlined in the previous sections. Some examples show how the basic classes provided by TOSCA can be enriched to embody the categories of our model (Figure 9).
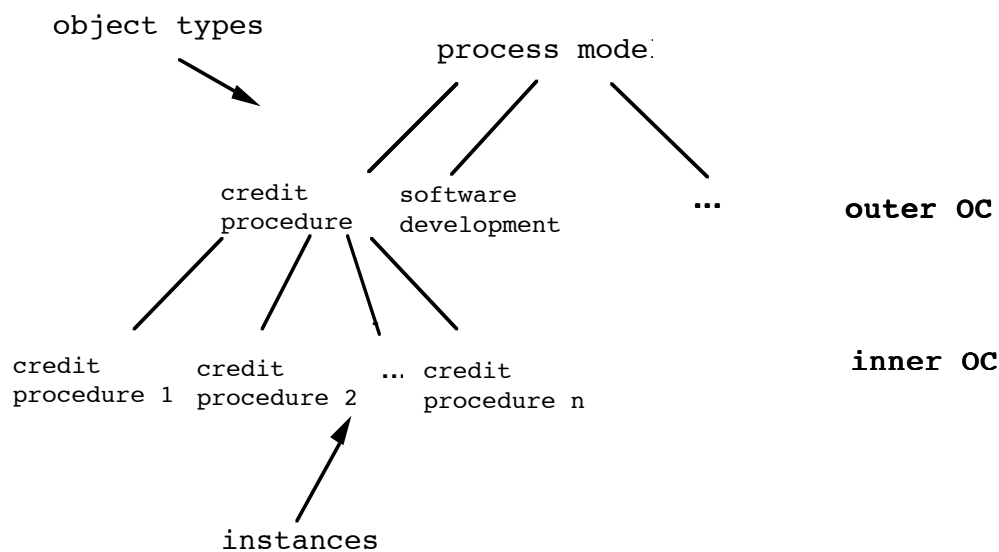

Figure 9 -Extending TOSCA to capture the work process model

In accordance with our model, the 'process' class is the basic object class to be added to the set provided by TOSCA.

Here below the 'process' class, as well as 'procedure' one and the four relationships 'proposal', 'agreement', 'performance' and 'satisfaction' are described as examples of use of the system.

```
class process --organizational object type
attributes
        --mandatory
        customer: actor
        customerRole: roleRelation
        performer: actor
```

```
            performerRole: roleRelation
            conditionsOfSatisfaction: time (& ??)
            supervisor: actor
            supervisorRole: roleRelation
            flowOfAction: procedure
relationships
            --mandatory
            proposal
            --optional
            agreement
            performance
            satisfaction
class proposal inherits from relationship
attributes
      relation identifiers:
            {is composed by, belongs to}
      value set attributes:
            {source: process, destination: SET OF processes}
class agreement inherits from relationship
attributes
      relation identifiers:
            {is composed by, belongs to}
      value set attributes:
            {source: process, destination: SET OF processes}
class performance inherits from relationship
attributes
      relation identifiers:
            {is composed by, belongs to}
      value set attributes:
            {source: process, destination: SET OF processes}
class satisfaction inherits from relationship
attributes
      relation identifiers:
            {is composed by, belongs to}
      value set attributes:
            {source: process, destination: SET OF processes}

class procedure --organizational object type
attributes
            --mandatory
            flow: netOfActivities
```

Using the enriched set of basic classes of TOSCA, the user can define the appropriate subtypes desciribing specific work processes (see Figure 9). Each subtype is defined by means of a set of default values for the attributes customer, performer, supervisor, flowOfAction. Links between the sub-processes are defined using the relationships (proposal, agreement, performance, satisfaction).

- The roles of the customer and the performer are links to the organizational structure; the Institutions involved in the process are also linked.

- Each sub-process is linked by relationships (proposal, agreement, performance and satisfaction) to the others. The actors of the cooperation network are defined by roles in each sub-process.

- The form of the work process is defined by the use of the phase relationship (agreement, performance and satisfaction).

- The flow of actions is defined, when needed, by the 'procedure' object (a net of activities).

A subclass of the 'process' type defines the outer OC. An instance of this subclass is created during the execution of the process, defining the inner OC.

- The principal customer and performer are identified by the specific actors playing those roles.
- The roles of the involved actors map into specific instances of actors.
- The current state and the history are completely described by the value of the attributes and relationships of the 'process' object.

Summarizing:

- The user is provided with a general model of work process that can be used to represent the outer knowledge about it.
- The outer representation can be exported in order to be linked to an application, generating, modifying and updating the representation of the inner OC.

4. Awareness and transaction costs

The model of work process on which our treatment of the OC is based, emphasizes the following aspect of human work: work is complex, as its distinctive features (customer/performer relation, cooperation network, action flow, cooperation forms, organizational structures, etc.) cannot be captured by a single point of view. In other words we can say that the complexity of a work process is the image of the combination of the multiplicity (the number of persons in its cooperation network, the number of persons with which each of them communicates, the number of conversations between any couple of persons, ...) and of the autonomy (of the persons in its cooperation network, of the persons with which any person of its cooperation network interacts, of the persons participating in other work processes ...) it exhibits.

Why is the complexity of a work process relevant? Because it can be the cause either of the impossibility of performing it to the satisfaction of the customer (the requested action is not performed within the fixed time constraints, with adequate quality attributes, ...) or of the distance between the value of the resources spent to perform it and the value the customer attributes to it.

The complexity of a work process is therefore the main cause of the transaction costs [Williamson 1975, 1985] an organization must afford to do its business, and analyzing the former can be a good starting point for evaluating the latter ones.

Moreover, the complexity of a work process is the principal obstacle to its participants' awareness of the OC: if a work process is simple (few participants, with limited possibility of exhibiting their autonomy, because breakdowns are rare) they can easily maintain themselves aware of its OC, while if it is complex (a great number of participants, with a lot of other things to do, exhibiting frequently their autonomy in facing breakdowns) awareness becomes a problem as they can forget, get confused about, or not know something relevant with respect to their responsibility within it.

The impact of the complexity of a work process on transaction costs is strictly related to participants' awareness: the lack of awareness has in fact a relevant impact on transaction costs. To analyze this relation in a deeper form let us recall which are the principal factors affecting transaction costs [De Michelis 1993] .

The transaction costs of a business process constitute, with its transformation (production) costs, the main element of its economic value. If we take into account the work process model we have discussed in the previous section, we can try to give a more detailed characterization of its transaction costs, defining the factors affecting them and, if necessary, their weight. Let us discuss here below some of these factors. The list is not exhaustive, but it has been compiled in order to give a rich account of their nature.

1. *Internal factors*: the transaction costs of a work process depend on:

- the number of members of its cooperation network (a larger number of participants implies in fact a higher cost of any assessment of the actions to do),

- the number of the interactions — collaborations within sub-processes, coordinations, co-decisions with equal and distinct roles — it embodies (a larger number of interactions implies in fact a higher cost of the management of the whole process),

- …

2. *External factors*: the transaction costs of a work process depend on:

- the number of other work processes in which any of its participants participates also (if a large number of participants has other commitments in other work processes, then the complexity of those work processes reflects on the work process under consideration),

- the number of newcomers to it (newcomers require some effort to become participants of the cooperation network),

- the number of participants leaving it (a participant of a cooperation network is an intelligent source of knowledge within it, and if he or she leaves it the cooperation network loses that source),

- …

3. *Individual factors*: the transaction costs of a work process depend on the threshold of sustainable complexity of its participants. Any person in any moment of his/her life has the capability to manage in a smooth way a certain number of inter-actions of different type or, in other words, to participate effectively in a certain number of work-processes: if and when he or she tries to increase that number, he or she becomes always more ineffective not only in the new processes into which he or she enters but also in all the work processes he or she was already participating in. Ineffectiveness grows exponentially when the maximal number of processes is passed. For any person, the above recalled maximal number depends on the threshold of complexity he or she is able to sustain.

As easily understood, individual factors are strongly connected to awareness. The threshold of sustainable complexity needs therefore a deeper discussion.

4.1. The threshold of sustainable complexity

While the other factors of the transaction costs of a work process depend on the design of the work process itself, and can be afforded only modifying it (either on the customer side, modifying the services offered, or on the performer side standardizing or destandardizing some parts of it — on this issue we will dedicate a different paper), the last factor plays a different role: on the one hand, the threshold of sustainable complexity is relevant only when a significant number of members of a cooperative network have reached it; on the other, in this case it behaves as an inverse multiplicative factor of the transaction costs: the higher the threshold, the lower the costs. Enhancing the threshold of sustainable complexity of the members of a cooperation network means, therefore, reducing globally the transaction costs of the related work process. It is in fact evident that if a person is able to cope effectively with a larger number of interactions without generating breakdowns within them (either forgetting to do some required action, or forgetting the matter of an interaction, or confusing two different interactions, etc.), the transaction costs of the work process in which he or she is involved will be smaller, as he or she will not impact it with the breakdowns he or she is provoking. Let us illustrate further the above point: until a person is able to cope with his/her interactions within a work process without needing help, he or she will not produce any new cost: whereas, when he or she reaches the point of no longer being able to handle them without the help either of his customers or some other persons, he or she will be individually a cost factor of the process itself.

On what does the threshold of sustainable complexity of a participant to a work process depend? Why is a person forgetting to do some required action, or forgetting the matter of an interaction, or confusing two different interactions, etc.?

The answer can be given as follows: the threshold of sustainable complexity of a person defines his/her awareness capability, i.e. it bounds his/her capability of being aware of the OC of the work processes within which he or she is involved. Human beings are not unlimited processors: their performances are bounded by some attributes qualifying them.

The awareness capability of a person depends, on the one hand, on some generic attributes qualifying his/her performances; on the other, on the way he or she is supported with respect to the visibility/transparency of the OC of the work processes within which he or she is active.

The above mentioned generic attributes are of two types: skills and tool supports.

The awareness capability of any person heavily depends on his/her culture: if he or she has a good education, if he or she is literate, then he or she will be able to maintain him or herself aware within a larger number of (more complex) work processes; instead, a person of a low cultural level, unable to express himself or herself with exactness, will generally be unable to participate in various work processes without getting confused.

The awareness capability depends also on the tools he or she can use to interact with his/her partners: fast and reliable transportation means, efficient communication media, good addressing mechanisms, efficient storages for the information and for the documents generated within the work process are some examples of tools that are needed to maintain awareness within multiple work processes, because they reduce the cost of acting within them.

The two above factors are not independent: the ability to use tools is part of the culture of a person (using sophisticated communication media is a skill we attain through learning and practice), whereas with good tools we can become capable of doing things for which we have not any special skill (with a word processor we are able to create high-quality documents that we were not able to create only with a typewriter).

The impact of tools on the awareness capability depends finally also on the way we dispose of them: if they are always at our disposal, whenever we need them and wherever we are, then they are maximally effective in allowing us to concentrate on the process in question, while, if to use them we need to move, if they require a modification of our work setting to be used, etc., then they balance the complexity they absorb with the one they create, weakening their positive impact on our performances.

Therefore, what is relevant with respect to enhancing the threshold of sustainable complexity is not only the set of tools we are provided with, but also how the latter are integrated within our work space.

The skills and tool supports discussed above define a standard of quality of a modern professional: they do not face the issue of awareness in its very essence. In order to really enhance the awareness capability of a person, beyond what any well equipped person can do by him or herself, i. e. in order to increase the threshold of sustainable complexity beyond the limits we already know, it is necessary to support effectively the transparency and/or visibility of the OC of work processes.

If we can react to the events occurring within a work process making implicit reference to that part of its OC recalled in the event itself (minimal example: if we can answer a message through a reply function; maximal example: if we can send a message to the person responsible for XXX, without knowing anything about him or her), then any action we do has for us a minimal cost, and we are protected from the errors we can make, and therefore from the breakdowns we may provoke. As an example, WooRKS+UTUCS [De Michelis, Grasso 1993], [Agostini et al. 1993] provides its users with the possibility to use role names within the procedures as addresses of messages, so that they can give an identity to whoever has performed an action.

Moreover, if we can access directly any information about the OC of a work process (minimal example: if we can get clear information about the state reached by the process; maximal example: if we can know if there is a person with a given ability within the cooperation network of the process, and who he or she is and how we can reach him or her), then we are able to cope with any breakdown we encounter within it, with our and other minimal costs. As an example, TOSCA

[Prinz 1993, COMIC-GMD 1-4] provides its users with the possibility of evaluating (on the model) how much time is needed to complete a procedure (e.g. the investment procedure) so that they can make realistic and affordable plans.

The learning capability of the system representing the organizational context has an indirect impact on the threshold of sustainable complexity: when some information about the OC is not automatically updated, it is possible that it becomes (at least temporarily) obsolete, and this fact can either induce us into error, or require that we verify its reliability. As an example CHAOS [De Cindio et al. 1986, 1988], [Divitini et al. 1993] automatically updates the organizational model of the group of its users, so that they can always direct their messages to the people playing the right role within the process.

5. Conclusion

In this paper we have outlined an approach to the representation of the OC of cooperative work and we have discussed why it should, and how it can, be integrated within a CSCW environment.

It is our conviction that, since a lack of awareness of the OC of the work processes is one of the most important factors impacting transaction costs negatively, Computer Support to Cooperative Work needs an OC representation system as one of its main components.

The Groupware Systems currently on the market are therefore, even if useful, only faint images of what a Computer Support to Cooperative Work should be.

It is time to think of new systems integrating the services Groupware Systems offer their users toward an OC representation. Our research moves in this direction.

Acknowledgments

References

AA.VV., *Proceedings of the Computer Supported Cooperative Work Conference 1986*, MCC Austin, 1986.

AA.VV., *Proceedings of the 2nd Computer Supported Cooperative Work Conference 1988,* ACM New York NY, 1988.

AA.VV., *Proceedings of the 3rd Computer Supported Cooperative Work Conference 1990,* ACM New York NY, 1990.

AA.VV., *Proceedings of ECSCW'91*, Kluver Dordrecht, 1991

AA.VV., *Proceedings of the 4th Computer Supported Cooperative Work Conference 1992,* ACM New York NY, 1992.

AA. VV., *Proccedings of ECSCW'93*, Kluwer Dordrecht, 1993

Ader M., Srivaths K., *WooRKS Programmers' Guide*, TR ITHACA Bull 92.U4#23.3.0, Bull Paris, 1992

Agostini A., De Michelis G., Patriarca S., Tinini R., *A prototype of an Integrated Coordination Support*, 'Computer Supported Cooperative Work (CSCW) an International Journal', 1993 (to appear)

Agostini A., De Michelis G., Grasso M. A., Patriarca S., Reengineering a business process with an innovative Workflow Management System: a Case Study, in *Proc. COOCS'93*, ACM New York NY, 1993

Argyris C., Schoen D. A., *Organizational Learning: a Theory of Action Perspective*, Addison Welsley Reading MA, 1978

Benford S., Smith H., Shepherd A., Bullock A., Howidy H., *An Information Sharing Approach to CSCW: the GRACE Project*, 'Computer Communications' 15-8, 1992

Bowers J., Benford S. (eds.), *Studies in Computer Supported Cooperative Work*, North Holland Amsterdam, 1991

Conklin J;, Capturing Organizational Memory, in D. Coleman (ed.), *Proc. of Groupware '92*, Morgan Kaufmann New York NY, 1992

De Cindio F., De Michelis G., Simone C., Vassallo R., Zanaboni A., CHAOS as a Coordination Technology, in [AA VV 86]

De Cindio F., Simone C., Vassallo R., Zanaboni A., CHAOS a knowledge-based system for conversing within offices, in H. Lamersdorf (ed.), *Office Knowledge: Representation, Management and Utilization*, North Holland Amsterdam, 1988

De Michelis G., *Computer Support for Cooperative Work*, Butler Cox Foundation London, 1990

De Michelis, G. Computer Support for Cooperative Work: Computers between Users and Social Complexity, in *Organizational Learning and Technological Change,* Springer Verlag, 1993 (to appear).

De Michelis G., Donzelli P., Schael T., Zeller B., Computer support for cooperative work in Space Science Activities, in G. Vanderveer, M. J. Tauber, S. Bagnara, M.Antalovits (editors), *Human-Computer interaction: Tasks and Organization*, CUD Roma, 1992

De Michelis G., Grasso M. A., *Conversations and routines*, 'Structured Programming', 14 1993

Divitini M., Omodei Sale' G., Pozzoli A., Simone C., Supporting the dynamics od knowledge sharing within organizations, in *Proc. COOCS'93*, ACM New York NY, 1993

Ellis C. E., Bernal M., Officetalk-D: an experiemntal information system, in *Proc. of the 1st ACM SIGOA*, ACM New York NY, 1982

Ellis C. E., Gibbs S. J., Rein G. L., *Groupware: some issues and experiences*, 'Comm. ACM' 34.1, 1991

Hennessy P., Kreifelts T., Ehrlich U., *Distributed Work Management: Activity Coordination within the EuroCoOp Project*, 'Computer communications' 15-8, 1992

ISO/CCITT, *Group communication Working Document X.gc (version 8),* Output from the joint ISO/IEC/CCITT meeting at Ottawa, 1991 (avaliable from the authors)

ISO/CCITT, *Asynchronous Computer Conferencing Working document X.acc (version 8)*, Output from the joint ISO/IEC/CCITT meeting at Ottawa, 1991 (avaliable from the authors)

Jordan B., New Research Methods for Looking at Productivity in Knowledge-Intensive Organizations, in *Proc. of the Conference on Productivity in Knowledge-Intensive Organizations,* Grand Rapids MI, 1992

Keen P. G. W., *Shaping the Future: Business Design through Information Technology*, Harvard Business School Press Boston MA, 1991

Kreifelts T., Woetzel G., Distribution and Exception Handling in an Office Procedure System, in G. Bracchi, D. Tzichritzis (eds.), *Office Systems: Methods and Tools*, North Holland Amsterdam, 1987

Kreifelts T., Hinrichs E., Klein K. H., Seuffert P., Woetzel G., Experiences with the DOMINO Office Procedure System, in [AA VV 91]

Lave J., Wenger E., *Situated Learning: Legitimate Peripheral Participation*, Cambridge University Press Cambridge, 1991

Medina-Mora R., Winograd T., Flores F., Flores R., Workflow management technology: examples, implementations, and new directions, in [AA VV 1992]

Moran T. P., Anderson R. J., The workaday world as a paradigm for CSCW Design, in [AA VV 1990]

Prinz W., TOSCA: Providing organisational information to CSCW applications, in [AA VV 1993]

Schael T., Zeller B., Design Principles for Cooperative Office Support Systems for Distributed Process Management, in A. Verrjin Stuart et al. (eds.), *Support Functionality in the Office Environment,* North Holland Amsterdam,1991

Schael T., Zeller B., Workflow Management Systems for Financial Services, in *Proc. COOCS'93*, ACM New York NY, 1993

Schmidt K., Bannon L., *Taking CSCW seriously,* 'Computer Supported Cooperative Work (CSCW) an International Journal' 1.1-2, 1992

Senge P., *The Fifth Discipline: the art and practice of the learning organization*, Doubleday Currency 1991

Stucky S., Technology in Support of Organizational learning, in *Organizational Learning and Technological Change*. Springer Verlag, 1993 (to appear).

Suchman L. A., *Plans and Situated Actions*, Cambridge University Press New York NY, 1987

Williamson O. E., *Markets and Hierarchies*, Free Press New York NY, 1975

Williamson O. E., *The Economic Institutions of Capitalism*, Free Press New York NY, 1985

COMIC Reports

Benford S., *Review of existing systems and models*, COMIC-NOTT 1-1

Bowers J., *Understanding Organisations performatively*, COMIC-MAN 1-

Fuchs L., *Review: How organizational context is provided by CSCW applications*, COMIC-GMD 1-2

Prinz W., *TOSCA Providing organizational information in CSCW applications*, COMIC-GMD 1-4

Sarmiento M., Navarro L., Marquès J. M., *From Small to Large Scale*, COMIC-UPC 1-3

Schmidt K., *Organizational Context in Context. Position paper*, COMIC-Risoe 1-3

Notes on systems supporting "organizational context" — an activity theory viewpoint

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From the viewpoint of a working subject the structural elements of a particular working activity define an organizational context "in the small". These elements (tools, object of work, process, outcome, community, rules, division of labour) are situational and local instances of the corresponding structural features of the larger organizational body or bodies where the particular working activity is embedded — "organizational context in the large". Organizational context "in the small" is derived and constructed from OC "in the large" and this situationalization is one of the key features to be considered when building systems which try to make organizational context more visible and comprehensible. Because all elements have their own development history, another important feature is the support of historical viewpoint on organizational context and its development.

The third essential feature is expansiveness: because the participants of an activity are also all the time constructing the activity by making changes in the elements, the potential support systems should allow this and support it.

The list of elements gives some hint of potential support types and corresponding systems.

Introduction

The initial research orientation within strand 1 has been to find which kind of information on organizations would be useful to "put" into CSCW systems and how this information should be conceptualised and codified. The needed information on organizations has been termed as "organizational context". This term has not been very operational, however, because the concept of organization is so fuzzy and open to different interpretations. It seems not fruitful to try to derive a "general" definition of an "organizational context" from different organizational theories and use that as a guide in designing CSCW systems. Instead, a more promising starting point is to take a more restricted view: start from some practical situation and relate the "organizational context" to that by asking what kind of information would be useful in that particular situation.

One obvious starting point is then work done in organizations: we can limit our interest on organizations to those features that are relevant to a particular work during a work process and then try to use different conceptualizations of work for to redefine "organizational context" for our purposes. The aim of this paper is to make one attempt along just this venue of thought: it uses the structure of "work activity" from Activity Theory to redefine the "organizational context" and then studies po-

tential implications. The hypothetical work situation behind the elaboration is a newcomer "learning the ropes".

Background: some attempts to define the "co-operative work" in CSCW research

Group work and teamwork

What is the 'co-operative work' to be supported by computers? The most usual answer has been 'work of a group', like "CSCW has emerged as an identifiable research field focused on the role of the computer in group work" (Greif 1988, p. 5), "One definition for it might be 'software for a group'. Another is 'computer-supported co-operative work.'" (Tazelaar 1988) or "CSCW looks at how groups work and seeks to discover how technology (especially computers) can help them work." (Ellis et al. 1991). Although this may intuitively sound acceptable, it is based on a quite naive view at groups: "In most cases the term 'group' is used in this connection without any clarification as it had some clear, widely accepted meaning. Unfortunately, (...) this is not the case." (Lyytinen 1990, p. 6, footnote.) Johansen (1988) uses – instead of group – a term 'business team', which is less ambiguous than the former, and he even justifies the use of the term by referring the on-going development of business work[1]. However, he does not elaborate the concept towards a more analytical conceptual tool.

Other attempts

Besides these 'intuitive' efforts there have been some other attempts, mostly based on some distinguishable external features of the work to be supported (e.g. Sørgaard 1987) or 'design metaphors' (like tool, shared material, communication medium etc.). However, the difficulties in defining the term "CSCW" or the corresponding research field has been notified by many recent authors, like Bannon et al (1988), Bannon & Schmidt (1991), Lyytinen (1990) and Suchman (1989). The term has been found to be vague, redundant and not able to differentiate from traditional systems, even erroneous. On the other hand, some onerous attempts to overcome these defences, like Sørgaard (1987), have been evaluated to be too restrictive e.g. by Bannon et al. (1988) and Lyytinen (1990).

Sørgaard's work is worth of a closer examination, because the author — inspired by a perspective of more democracy in the working life — really takes pains in delineating a special kind of work according to the nature of the task. Sørgaard suggests that CSCW has following attributes: co-operative work has a shared goal, it is non-competitive, not hierarchically organised and relatively autonomous. Despite his effort, the result remains a bit elusive: "Pure co-operative work is hard

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[1] I agree with Johansen that there is a change going on in work organization and new, earlier execptional work organization forms are now becoming more and more common. Like Johansen, I have also suggested in (Kuutti 1989) that the rise of CSCW may be connected with that development. The elaboration of that theme is beyond the scope of this paper, however.

to find. Co-operative work can be an aspect in many organizations ... " (Sørgaard 1987, p.721).

Bannon & Schmidt (1991) have made a radical departure from the use of the external features of co-operative work or design metaphors as starting points of the definition. They present their view shortly as follows: "Co-operative work is constituted by *work processes that are related as to content*, that is, processes pertaining to the production of a particular product or service". (pp. 5-6)[1].

Lyytinen (1990) uses the structuration theory as developed by Giddens in analysing work and the role of CSCW applications. The structuration theory apparently gives a firm foothold and the paper is rich of interesting avenues for further exploration. Structuration theory sees – according to Lyytinen – work process as a social structure, constructed continuously by 'human agents' and possessing a detailed internal structure. He puts a special emphasis on the formation process of social structures in interactions and thus on the role of CSCW applications both as a medium and an outcome in the formation of the work process. Lyytinen's definition of 'co-operative work' comes close to that of Bannon and Schmidt presented before.

Suchman (1989, 1991) suggests that the using of the term CSCW implies more a shift in the perspective of designers than actual change in technology. She emphasises a couple of fundamental aspects of work: practice is always fundamentally social and it is always mediated by artefacts.

Tentative synthesis

I believe that it is possible to find a 'lowest common denominator' for different definitions expressed above and still maintain an acceptable delineation of the research field. If we define CSCW as *the work by multiple active subjects sharing a common object and supported by information technology* , we obviously can cover a great part of the recent research and still be able to draw acceptable clear boundaries around the object of it.

The key element is naturally the definition of 'active subjects' or 'human agency' in Giddens' terminology: "Agency refers to human being's capability of doing things and to volitional character of their action i.e. that any individual could at any phase in a given sequence of conduct act differently" (Lyytinen 1990, p. 10). This existence of multiple active subjects gives us a mean to delineate CSCW from both "traditional information systems", where predetermination of work sequences of multiple users by the system has been the normal case, and personal applications

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[1] In the last incarnation of their paper in CSCW Journal Schmidt and Bannon (1992) continue from this initial definition and restrict the work to be supported being "articulation work", something which is needed for to manage the "real" work. While this definition seems to be correct what comes to production of material "things" and is a conceptual step forward in that particular environment, I believe that in general it is too restrictive. If we for example consider the COMIC project as an environment, it does not sound very reasonable to exclude the generation of new research results outside the scope of potential CSCW applications – but that's exactly what the articulation principle supposes. Thus I prefer this older definition.

that support only a single user[1]. On the other hand, a common *object of work* is clearly different from a shared goal (criticised to be too restrictive) or shared material (criticised to be too loose). Negotiators may have opposite goals, but they have a common object, a problem space. Database users may share material, but the objects of their work need not have anything common. Also the community that shares a common object of work can usually be delineated in practice, whatever the contributions of different participants of that community may be.

Implications to organizational analysis

This definition has a couple of important consequences, if we want to use it as a starting point when developing CSCW systems for an organization.

1) What is the relationship between the just defined units and formal organizational structure? In other words: to which extent the members of an organizational unit really share a common object of work and possess actorship in their work? Ideally, an organizational unit might have been formed around a common object of work, and during the last years there has been plenty of organizational consultants and researchers pointing that adding more actorship to work is the right way to go towards future organizations. In practice, however, it is very difficult to find an example case — perhaps a newly formed a small project group would qualify. The older and the larger organizational units grow, the more different objects and vested interest step in, and the more hierarchically and strictly managed is the work organization, the more difficult is to find actorship and common objects, especially along the formal lines of organization. Instead of that, research has revealed that the way in which work actually gets done in practice has often not much to do with the organizational structures and rules. Thus, to grasp the essential in organizational analysis, it is necessary to find such analytical tools that are not dependent on borders and boundaries within an organization or even between different organizations.

2) Active subjects will need a special treatment in analysis, if we want to take the "active" quality seriously in the account. "Active" work subjects do not only "do", but they think and decide what to do, and this thinking and deciding does not happen in a vacuum but in a social context. If we want to design systems for active subjects of work, we must learn what they do, but also what they think they do. Here no simple ideal of a "rational man" will not suffice, because — again — organizational research has clearly shown how little plain rationality can explain about organizational behaviour. Thus we need such concepts for analysis which help us in connecting social and organizational context with cognition and thinking.

Now my prime idea has been that the concept of activity from Activity Theory nicely corresponds with both of these demands. On the one hand, it delineates chunks of work in organizations useful in defining and legitimating the whole con-

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[1] There are situations, where we have an active actor using a "traditional system", like in data base searches. In these occasions their work situation is normally considered using strictly individual viewpoint only, however.

cept of CSCW: a CSCW application is a computer system supporting an activity. This delineates it nicely on the one hand from personal systems supporting only individual actions and on the other hand from traditional information systems, which albeit usually support many activities do not differentiate between them during the analysis or design phase and finally base the design on individual "information needs". IS systems let just undifferentiated activities "tap" into information resources. On the other hand, one of the main tenets in the Activity Theory is to provide a link between cultural-historical context and thinking and thus it should be useful for just such analysis where relations between organizational contexts and people's conceptions are been studied. To my knowledge the first among "real" organizational researchers recognising this has been F. Blackler (1992), but the field is still largely uncultivated. Despite the importance of this dimension any elaboration of it beyond some superficial references is, however, left outside of this version of this paper .

The concept of activity

Broadly defined, Activity Theory is a philosophical framework for studying different forms of human praxis as developmental processes, both individual and social levels interlinked at the same time. How can such ambitious goal be achieved or even addressed? I would like to highlight a few of the key ideas of Activity Theory:

Activities as basic units of analysis.

The behavioural and social sciences have always suffered from a dichotomy between individual and social. If one uses a social system as a unit of analysis, there are problems in maintaining the human agency. If individual actions are studied, there are problems in maintaining the contextuality. The concept of a 'social system' in general without any additional determinants is somewhat loose and incoherent for to be operational in analysing work, for example. When people are members in a work group, a department and the sport club of the firm, which one is the "real" social system — or none of them, or all? The solution offered by Activity Theory is that there is a possibility to delineate a unit — a minimal meaningful context for individual actions — that must form the basic unit of analysis. This unit — that defines also a social system but includes more than that — is called an activity. The delineation of activities is based on the identification of shared object of activity: each separate object shared by several peoples defines one activity. The concept of activity is elaborated further in the next section.

History and development.

Activity Theory claims that activities and their dynamics cannot be really understood without seriously analysing the historical development which has led to their present stage. Activities and their elements are under continuous development and this development is not linear or straightforward but uneven and discontinuous.

Only through a historical analysis can the forces acting behind the development be uncovered, and without knowing these there can be only blind attempts to guide the development.

Mediation.

A very strong idea is that the relations within an activity are not direct ones but are mediated by various artefacts such as instruments, signs, procedures, machines, methods, laws, forms of work organization, accepted practices etc. These artefacts and constructs have been created and transformed by humans during the development of an activity itself and carry with them a particular culture — historical remains from that development. Because of the nature of artefacts and constructs, they should be never treated as 'given' although they easily tend to disappear from the consciousness of participating people. "The idea is that humans can control their own behaviour — not "from the inside", on the basis of biological urges, but "from the outside", using and creating artefacts. This perspective is not only optimistic concerning human self-determination. It is an invitation to serious study of artefacts as integral and inseparable components of human functioning."(Engeström 1990, p. 12.).

The structure of an activity

As was mentioned earlier, the basic idea is that there exists a "fundamental type" of context, which is called an activity. It is meaningless to study essentially human qualities using a smaller object of research, because without that basic context one cannot grasp the essence of the phenomenon. Activities in which humans participate are the basic units of development and human life and thus form the base of the study of all contextuality. Activities — an individual usually participates several at the same time — have the following properties:

- An activity has *an object* and activities can be separated according to their objects. The transformation of the object towards some desired state or direction motivates the existence of an activity.
- An activity is a *collective phenomenon.*
- An activity has an active *subject*, who understands the motive of the activity. This subject can be individual or collective. Not all participants involved in an activity necessarily understand the motive of the activity in which they are participating or even recognise the existence of such one. In this case they are not active subjects of the activity.
- An activity *transforms environment.*
- An activity is a *historically developing* phenomenon.
- *Contradictions* are the force behind the development of an activity.
- An activity is realised through conscious and purposeful *actions* by participants.
- The relationships within activity are *culturally mediated.*

Y. Engeström (1987) has made an attempt to structurize the concept of activity as defined by A. N. Leontjev (1978) by establishing a simple model of the concept of activity and culturally meditated relationships within it. He starts from elementary building blocks of activities called *actions*:
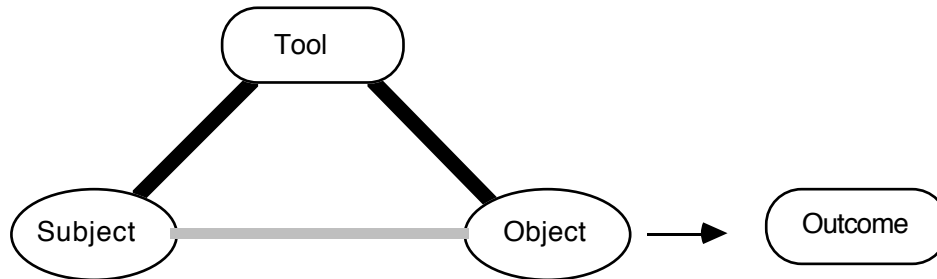

Figure 1: Structure of an individual, mediated action

Cultural mediation is carried out by introducing a third, intermediate term which carries with it the cultural heritage of the situation. Thus the (reciprocal) relationship between the *subject* and the *object* of activity is mediated by a *tool* into which the historical development of the relationship between subject and object thus far is condensed. The tool is at the same time both enabling and limiting: it empowers the subject in the transformation process with the experience crystallised to it but it also restricts the interaction to be from the perspective of that particular tool or instrument only — other potential features of object remain "invisible" to subject. This kind of actions alone is too simple to fulfil the needs of a consideration of the systemic relations between an individual and his environment in an activity, however, and thus a third main component, namely *community* (those who share the same object) has to be added. Two new relationships are then formed: subject-community and community-object. Both of them are also mediated and thus we have the following structure:
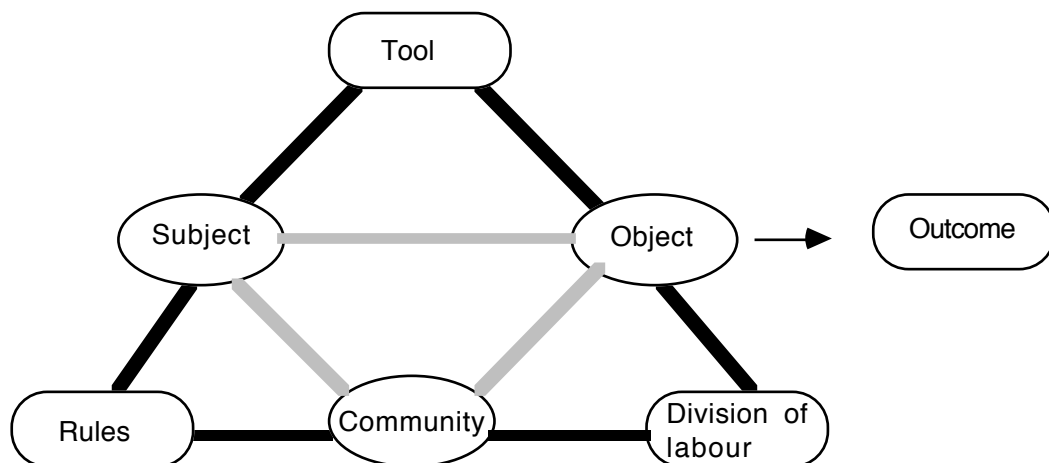

Figure 2: Basic structure of an activity

This systemic model — which according to Engeström's hypothesis is the simplest possible in terms of a unit of analysis— contains three mutual relationships between subject, object and community. (An activity is a systemic whole in the sense that there is a relation between all parts. Some those relations are not drawn in the picture because of the sake of clarity.) The relationship between subject and object is mediated by tools, that between subject and community is mediated by *rules* — formal and informal rules, norms, habits which regulate a person's behaviour as a member in some community. The relation between object and community is mediated by the *division of labour* — both horizontal and vertical: how is the community organised related to the object of activity, including power relations. Each of the mediating terms is a construct: it is historically formed and open to further development. In fact, during the existence of an activity the corresponding mediating members are continuously reconstructed. This development is, however, not a smooth and linear one, but uneven and discontinuous, driven by different contradictions.

Persons are generally participating several parallel activities in work, home and social life. For example, a IS development project for, say, a departmental application can apparently be described as an activity. It has a collective subject — the development group — that uses a development methodology as a tool to transform an object — the work practice to be improved. There is a community that shares the object: at least the manager of the department and those workers, whose work will be affected. There is a set of explicit and implicit rules controlling the relationship between the subject and the community: administrative procedures, accepted work practices, union laws, etc. There is also a certain division of labour in transforming the object: what the development group is expected to do, what is the role of departmental manager, the role of workers, etc.

At the same time there is another activity, where the subject is the leader of the development project, his or her tools are project management tools and the object is the development project itself to become successfully completed. The community consists of the members of the project group. Again, there is a certain — but different — set of rules and division of labour.

We can imagine a third connected activity, where the subject is the departmental manager, who is using the whole project as a tool in changing the power structure of the organization for his or her own benefits. The community is his or her peer managers and upper administration, and again some set of rules and division of labour can be found.

So, in real life situations there exist always an interconnected web of activities, which can be separated according to their objects. The participation in interconnected activities having very different motives can cause tensions and distortions (e. g. the position of the departmental manager in the example).

Besides the connections through people participating in multiple activities, activities can form also lateral and hierarchical networks: for example, an outcome of one activity may be the necessary element for other one, or an activity may be the object of another activity, etc.

Activities in organizational analysis (in general)

Because an activity delineates one part of work processes in an organization, it can be obviously used in analysing organizations. An organization can be seen as an interconnected web of networks and hierarchies of activities. Thus far the concept of activity has been used in practical analysis only for to study local and situational work organization at "group" level (examples of this can be found in the COMIC report Oulu-2-2 (Saarelma 1993) and thus they are not replicated here).There are no principal obstacles, however, why the analysis could not be expanded to cover also larger parts of organizations. Virkkunen (1990) has been using the concept of activity in his study on management, but this area is still practically unexplored, and many questions are totally open.

For example, some researchers are putting more emphasis on long-term and stable activities (e.g. "activity systems" by Engeström) while others see the concept of activity useful also when dealing with short-term and emergent formations. It is not clear if it is more practical to try to use the same concept for both cases or should a new term and concept be defined for another one. Unexplored is also the question on what would be the appropriate unit to locate a "work culture" — set of beliefs, manners and norms concerning the work. It could be connected to an activity where "rule"-artefact can be and is used to describe exactly this feature. On the other hand, many times an organizational unit — say, a department — will develop an internal culture, and when activities will span over organizational boundaries, their "rule"-artefacts would contain not one but many conflicting sets of beliefs, manners and norms. Is it useful to try to stretch the concept of activity cover both culture-formative and conflicting-cultures situations or should some additional concept be borrowed from some suitable branch of organization theory?

One might also suspect that because of multitude of parallel and nested activities in practical work organizations any attempt to describe a larger part of them at the same time would lead to a somewhat messy description.

Different types of possible connections between activities

Activities can be connected together and form webs and hierarchies in several ways. Here are some of them (=those that are immediately obvious for me, this is not an enumeration of possibilities), namely "contextual", "hierarchical" and "chain" connections.

Activity in the context of other activities

Baron Münchhausen was able to raise himself (and the horse, too) up from a swamp by lifting himself strongly from his own hair, but there are no activities which could do the same: the normal situation is that either the whole activity or at least different elements of it are created by other activities. In organizations it is also very usual that some of those element-producing activities are active all the time and not only during the initial start. These activities can be provisionally called

"contextual" activities to the central activity. At least those producing different arte-facts — tools, rules, work organization — are usually identifiable. There may be several activities contributing to each class of these artefacts: for example, official rule-setting and unofficial practice-formation. The following figure describes this type of relations.
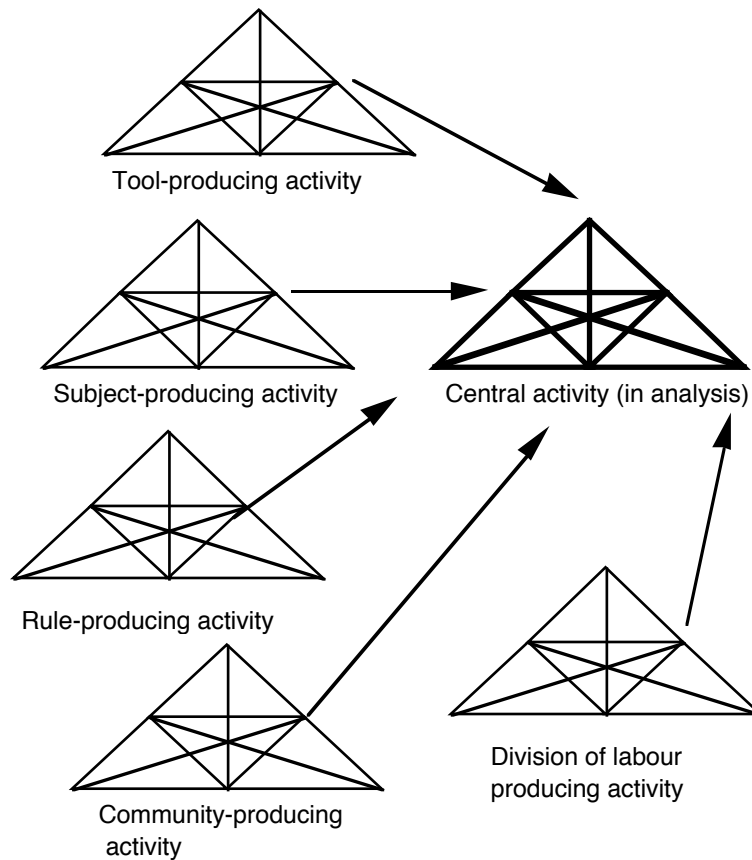

Hierarchy of activities

Activities can be nested hierarchically. Especially the object of an activity can be and many times also is another activity. For example, management can be described as an activity (peer managers as the community in that activity) which has several whole activities as its object.
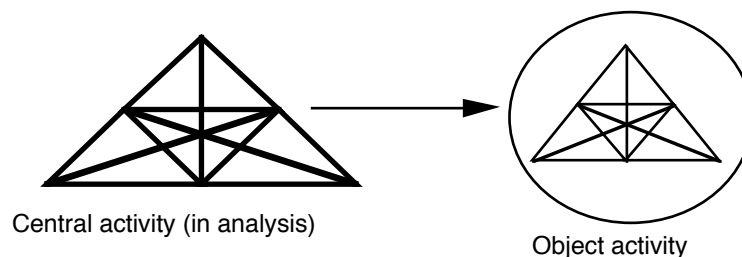
Production chains

It is in principle possible to form production chains using activities: the outcome of one activity will become the object of the other and so on. As far as I know, no-

body has yet actually used this type of thinking in a real analysis (although there are some ideas into this direction in Saarelma &Kokkinen-Jussila 1993), so this is pure speculation: there may be some hidden and destructive problems. But in general I can't now see any reason why it couldn't be done.


Object-producing activity

Central activity (in analysis)

Object-using activity
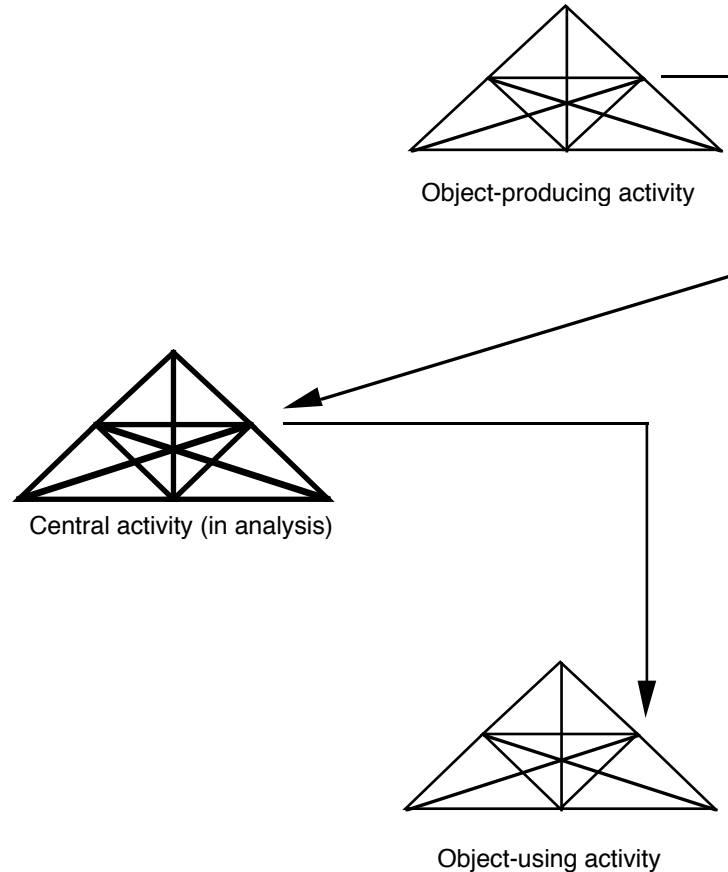
Work activities as strand 1 "organizational context"

The concept of activity suggests one possible structurization for a work practice. What would it mean if we would assume that work activity is a proper conceptuali-sation of "organizational context"? The structure of activity would give a primary classification for necessary topics of information and the theoretical background would tell us something on the nature of that information. Three necessary features must be specially mentioned here: situationality, historicity and constructivity.

The structure of "organizational context"

From the viewpoint of a working subject the structural elements of a particular working activity define an organizational context "in the small". These elements (tools, object of work, process, outcome, community, rules, division of labour) are situational and local instances of the corresponding structural features of the larger

organizational body or bodies where the particular working activity is embedded — "organizational context in the large". So we can make a definition that an "organizational context" of a work situation consists of elements of the corresponding work activity — the features and parts of the "host" organization that are relevant to that work practice described as an activity. The following figure tries to illustrate this.

"ORGANIZATIONAL CONTEXT"
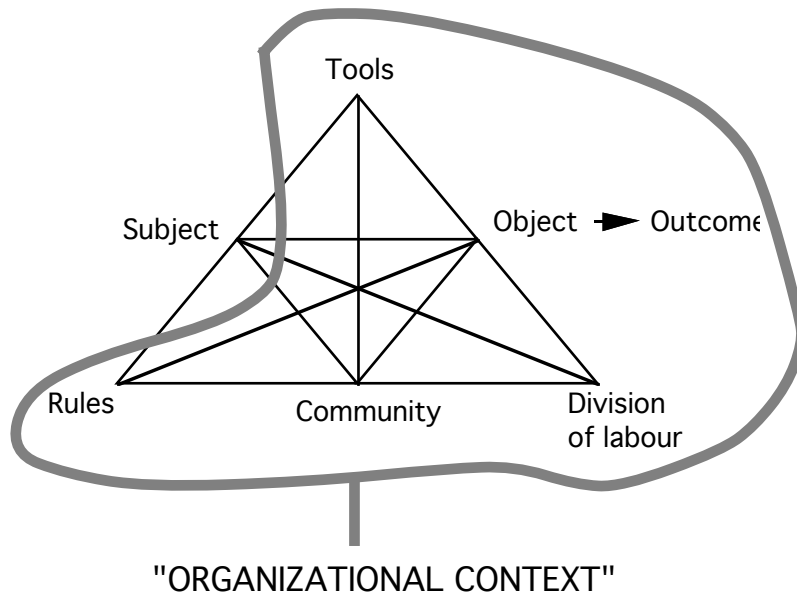
From the viewpoint of activity theory, lumping all these elements under the same heading is not fully correct, because there is a certain difference between the "upper" and "lower" parts of the triangle. From that viewpoint it would be more correct to name the "upper" part as e.g. "core of the work practice" and leave "organisational context" mean only the "lower" part, as in the next figure, where the two sets of features are identified:

- "Core" — the object of actions, result to be achieved and tools available.
- "Organisational context" — the work community participating the process, rules, norms and beliefs regulating the community and the "who, what and how" — working organisation of labour along both hierarchical and horizontal dimensions.

"CORE OF WORK'

Tools

Subject   Object → Outcome

Rules   Community   Division
of labour

"ORGANIZATIONAL CONTEXT"
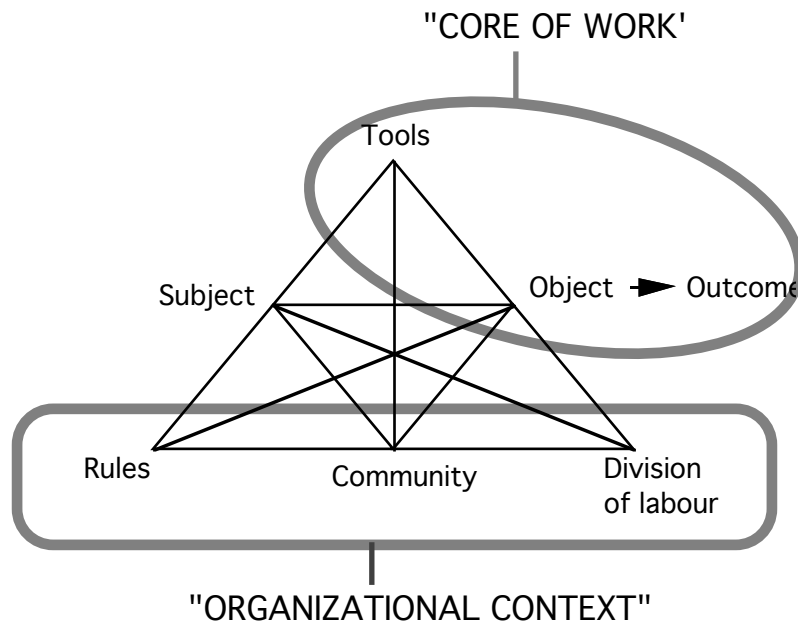
Although the latter definition of "organisational context" seems to be theoretically more sound, from the viewpoint of CSCW systems it is not yet clear what would be the benefit of that distinction. In this phase of study it may be reasonable to avoid premature commitments and use the broader definition as far as it seems to be useful. So we can talk about CSCW systems that support the "organisational context" by making it more visible, comprehensible and accessible. According to our definition, these systems would contain subsets of the whole body of organisational information, subsets that would be relevant to particular working situations. The separation between subsets would be based on the boundaries between corresponding work activities and they could contain information on all structural elements of an activity: tools, object, outcome, rules, community and organisation of work.

Situationality

One of the obvious questions in embedding organisational information in CSCW systems is the relevancy of the information. In large organisations there will be enormous amounts of potential information, of which only a tiny part will ever be relevant to a particular user in a particular work situation. If the amount of available information is not selectively restricted — "situationalized" — it will overflood the poor user. But what are the criteria how this situationalization can be done?

Activity Theory suggests that different work activities participated by a person are the natural units that should be used in situationalization. A work activity does not contain the whole organisation, but *per definitum* only those elements and features of organisation that are relevant for that particular work practice — selected and formed during the historical development of that work practice in that organisation.

Historicity

The historical development of different elements in an activity is one of the key issues activity theory is emphasising. In many occasions the recent state of affairs is difficult to understand without a reference to the historical development that has produced it (e.g. different "sediments" in the set of working rules due to successive changes in legislation). It is not far-fetched to think that this "sense of history" would be possible and beneficial to be supported by a system.

Construcivity

Activity theory sees workers not only as performers in a predetermined setting but also as active constructors of the whole activity. Even when the elements of an activity in a work situation are nominally "given" and "freezed", activity theory hypothesises that there is a reconstruction going on all the time: people do adapt their activity to the changing situations by making changes in elements. One of the objections against the idea of embedding organisational information into a system that has been levelled in strand 1 discussions has been that such information might reify some particular viewpoints and existing structures. This is a real danger and a potential threat for the flexibility of work organisations. Thus the systems should not support only the learning of the existing situation, but also the constructing a new one. This "expansive" dimension has been stated and to some extent elaborated in (Kuutti 1991) and (Kuutti & Arvonen 1992).

Some ideas on support systems

Which kind of systems will result if these ideas are utilised? If we look at the "lower part" of the activity triangle, we can make following initial projections:

	Active	**Expansive**
Rules	"Official rulebook", standards, norms	+ "unofficial rulebook", expanded and renegotiated along the course of work
Community	Visible network of people participating the activity: "phonebook"	+ support for expanding the existing network or creating a new one
Division of labour	Visible description of command hierarchies and responsibilities what comes to the creation of the outcome	+ support for renegotiating the old contracts and control areas

Also the "upper" part of activity triangle can be supported. We can separate the object into three subparts — object, outcome and the transformation process — as the following figure suggests:

	Active	**Expansive**
Tools	"Toolbox + help" - what are the tools available? - how they are used?	+ creation of new tools
Object	- what parts does the object consist of? - what are the relations between parts?	+ change or expansion in the object
Process	- what are the necessary steps in transforming the object into outcome? - how do differerent tools relate to different steps? - what is the status of the process now?	+ change in the process
Outcome	- why is this outcome useful? - what are the values guiding the activity?	+ change in outcome or values

Already now there exists many programs where one feature or another has been supported at least to some extent. However, it is difficult to find examples where all

potential areas would have given support in the same program. And the support for situationality, historicity or constructivity has not got much emphasis, if at all. In that sense it seems that activity theory can give us some constructive advice in directing our efforts in developing demonstrator systems. Meanwhile, one part of theoretical efforts could be directed in finding where do these pieces of organisational information come from — to which extent they are imposed like organisational standards and to which extent they are reproduced on-site? And how they can be identified and collected into systems? The prototype systems might be used as testbenchs for reflection.

References

Bannon, L. & Schmidt, K. (1991) CSCW: Four Characters in Search of a Context. In J. M. Bowers & S.D. Benford (eds.) *Studies in Computer Supported Cooperative Work*. North-Holland/Elsevier, Amsterdam.

Bannon, L., Bjørn-Andersen, N. & Due-Thomsen, B. (1988) Computer support for cooperative work: an apparaisal and critique. In Bullinger, H. J. (ed.) *EURINFO 88*, Nort-Holland, Amsterdam.

Blackler, F. (1992) Formative Contexts and Activity Systems: Postmodern Approaches to the Management of Change. In Reed, M. & Hughes, M. (eds.) *Rethinking Organization. New Directions in Organization Theory and Analysis*. Sage Publications, London.

Ellis, C. A. & Gibbs, S.J. & Rein, G.L. (1991) Groupware; some issues and experiences. *Communications of ACM*, vol. 34, n:o 1 (Jan 1991), pp. 38-58.

Engeström, Y., (1987). *Learning by expanding*. Orienta-konsultit, Helsinki.

Engeström, Y. (1990) Activity theory and individual and social transformation. Opening address at the 2nd Intl. Congress for Research on Activity Theory. Lahti, Finland, May 21-25, 1990.

Greif, I (Ed.) (1988) *Computer-Supported Cooperative Work: A Book of Readings*, Morgen Kaufman, San Mateo, California.

Johansen, R. (1988) *Groupware: Computer Support for Business Teams*. The Free Press, New York.

Kuutti, K. (1989) The Impact of Work Development on Information Systems. In *Scandinavian Research in Information Systems*, vol. 1 no 1, pp. 165-176.

Kuutti, K. (1991) The Concept of Activity as a Basic Unit for CSCW Research. In Bannon, L. J., M. Robinson & K. Schmidt (eds.) *Proceedings of the 2nd ECSCW*. Kluwer Academical, Amsterdam, pp. 249-264.

Kuutti, K. & Arvonen, T. (1992) Identifying CSCW Applications by Means of Activity Theory Concepts: A Case Example. In *Sharing Perspectives — Proceedings of the CSCW'92 Conference*, ACM Press, New York.

Leontjev, A.N. (1978) *Activity, Consciousness, and Personality*. Prentice Hall, Englewood Cliffs.

Lyytinen, K. (1990) *Computer-Supported Cooperative Work — issues and challenges. A structurational analysis*. Manuscript. Univ. of Jyväskylä, Dept. Computer Science.

Saarelma, O. (1993) New work — new instruments. A report on information system development process in a health care center. Report COMIC-Oulu-2-2, Univ. Oulu, Dept. Inf. Proc. Science.

Saarelma, O. & Kokkinen-Jussila, M. (1993) Terveyskeskuksen yhteistoimintaverkkojen analysointi. (Analyzing cooperative networks in a health care center) In Simoila, Harlamov, Launis, Engeström, Saarelma & Kokkinen-Jussila : Mallit, kontaktit, tiimit ja verkot — välineitä terveyskeskustyön analysointiin. (Models, contacts, teams and networks — tools for analyzing work in health care centers) *Report No. 80, Center for Social and Health Care Development* (STAKES), Helsinki. (In Finnish).

Schmidt, K. & Bannon, L. (1992) Taking CSCW Seriously. Supporting Articulation Work. *Computer Supported Cooperative Work* ,Vol. 1 No.1-2, pp. 7-40.

Suchman, L. (1989) Notes on computer support for cooperative work. Working paper WP-12, Univ. Jyväskylä, Dept. Computer Science.

Suchman, L. (1991) Understanding Practice: Video as a Medium for Reflection and Design. In J. Greenbaum & M. Kyng (eds.) *Design at Work*: *Cooperative Design of Computer Systems*, Lawrence Erlbaum , Hillsdale NJ.

Sørgaard, P. (1987) A cooperative work perspective on use and development of computer artifacts. In Järvinen, P. (ed.) *The Report of the 10th IRIS seminar*. Acta Universitatis Tamperensis ser B vol 27, University of Tampere.

Tazelaar, J. M. (1988) Editorial for the section "In depth: Groupware", *BYTE*, Dec 1988, p. 242.

Virkkunen, J. (1990) Johtamisen rationalisointi vai kehityksen hallinta (The Rationalization of Management or The Mastery of Development) Julkishallinnon kouluttajat, Helsinki. (In Finnish).

The Organization of Cooperative Work

Beyond the 'Leviathan' Conception of Organization

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The paper examines the relationship between cooperative work and the wider organizational context. The purpose of the exploration is not to contribute to organizational theory in general, but to critique the transaction cost approach to organizational theory *from the point of view of cooperative work* .

The paper posits that the formal conception of organization – organization conceived of in terms of 'common ownership' – is inadequate as a conceptual foundation for embedding CSCW systems in a wider organizational context. The design of CSCW systems for real-world application must move beyond the bounds of organizational forms conceived of in terms of 'common ownership'.

1. The problem

> From organization as "islands of conscious power in this ocean of unconscious cooperation like lumps of butter coagulating in a pail of buttermilk"
> (Coase, 1937, p. 388)

> To organization as "more like a marriage than a one-night stand, but there is no marriage license, no common household, no pooling of assets."
> (Powell, 1989, p. 301).

The current comprehensive transformation of the political economy of modern industrial society is engendering a new regime of demands and constraints on the realm of work. The business environment of modern manufacturing, for instance, is becoming rigorously demanding as enterprises are faced with increasingly global competition, contracting product life cycles, radical product diversification, and the need to pamper customers — with the concomitant transformation of the organization of production towards order-driven production bordering on custom-tailoring, insignificant or completely eradicated inventories and buffer stocks, shortened lead times, dwindling batch sizes approximating batches of one, concurrent processing of multiple different products and orders, and so forth (Ohmae,

1985; Gunn, 1987; Best, 1990). The transformation does not merely affect manufacturing and other industries directly affected by that transformation. The demands of an educated and critical populace (and the needs of the manufacturing industries and other industries), compel administrative agencies, health and service organizations, and so forth to drastically improve their innovative capability, operational flexibility, and product quality. Accordingly, modern work organizations must be able to adapt rapidly and diligently to changes in environmental conditions and demands and the same time be able to coordinate and integrate their distributed activities in a efficient and effective way. Altogether, this requires horizontal and direct coordination and integration of activities across functions and professional boundaries within the organization or within a network of organizations, witness the different but related campaigns of Flexible Manufacturing, Concurrent Engineering, Total Quality Control, Design for Manufacturability and so on.

In other words, modern work organizations require support from advanced information systems that can facilitate the horizontal coordination of distributed decision making. Simultaneously, the proliferation of powerful workstations in cooperative work settings and their interconnection in comprehensive high-capacity networks provide the technological foundation to meet this need. Such developments are illustrated in the area of Computer Integrated Manufacturing (CIM) by the efforts to integrate formerly separated functions such as design and process planning, marketing and production planning, etc., and by the similar efforts in areas such as Office Information Systems (OIS), Computer Aided Design (CAD), Computer Aided Software Engineering (CASE) to facilitate and enhance the exchange of information across organizational and professional boundaries.

These developments inaugurate a fundamental shift in the approach to the design of computer systems. In the design of conventional computer-based systems for work settings the core issues have been to develop effective computational models of pertinent structures and processes in the field of work (data flows, conceptual schemes, knowledge representations) and adequate modes of presenting and accessing these structures and processes as represented in computer systems (user interface, functionality). Surely, normally computer systems were used in organizational settings and were even often used by multiple users as in the case of systems that are part of the organizational infrastructure (e.g., database systems). Nevertheless, the issue of how multiple users work together and coordinate and mesh their individual activities — 'through' the system or 'around' it — was not addressed directly and systematically, as a design issue in its own right. So far as the underlying model of the structures and processes in the field of work was 'valid', it was assumed that the articulation of the distributed activities was of no import or that it was managed somehow by whoever it might concern. It was certainly not a problem for the designer or the analyst. With CSCW, however, the very issue of how multiple users work together and coordinate and integrate their individual activities has become the focal issue (Schmidt and Bannon, 1992).

Now, cooperative work is not a separate work domain. Rather, CSCW addresses a set of crucial design issues across different application domains such as MIS, OIS, CIM, CASE, etc. Thus, a central problem in CSCW systems design is to provide an appropriate 'interface' to the wider organizational context as represented by domain-specific information systems such as MIS, OIS, CIM, and CASE systems.

Moreover, cooperative work in real-world settings is far more than team work, project work, group sessions and so forth. Cooperative work involves a wide range of loosely interdependent activities and, hence, loosely interacting actors, and there is no clear demarcation between the intensive interaction in team work and the more loose and protracted interaction in wider cooperative arrangements.

With this in mind, the objective of the present paper is to examine the issue of the relationship between cooperative work and the wider organizational context. The purpose of the exploration is not to contribute to organizational theory in general, but to critique organizational theory, in particular the influential Transaction Cost approach, *from the point of view of cooperative work* .

So, what is the interface between cooperative work arrangements and their organizational setting?

2. The Leviathan approach to organizational theory

> "during the time men live without a common
> Power to keep them all in awe, they are in that
> condition which is called Warre; and such a
> Warre, as is of every man, against every man"
> (Hobbes, 1651, Chap. XIII, p. 185)

Karl Weick probably holds the record for extreme agnostic positions in organizational theory:

> "The word organization is a noun and it is also a myth. If one looks for an organization one will not find it. What will be found is that there are events, linked together, that transpire within concrete walls and these sequences, their pathways, their timing, are the forms we erroneously make into substances when we talk about an organization." (Weick, 1974, p. 358).

This position definitely has an air of smartness. But does it bring us anywhere? Organizations certainly do not exist in any tangible sense or in other ways that are amenable to naive observation. But neither do most of the objects of scientific investigation: elementary particles, DNA, hurricanes, black holes, turntaking protocols, social meaning, cognition, kinship, money, and so on.

In his deconstruction of the notion of organization, Weick is guilty of a category mistake. He is overly general. The problem is, rather, that the specific notion of 'the organization' as a unit of ownership with well-defined boundaries and with central coordination and regulation of activities — is becoming a myth or rather an

extreme and rare case. It is not 'organization' per se that is a myth, it is a specific historical form of organization that is waning and thus becoming a myth.

At the roots of this notion of organization lies the notion of economic behavior in organizational forms as opposed to economic behavior in the market.[1] Why do some economic activities occur as interactions within firms and other corporate units? Why do not all economic activities occur on the open market? This issue has attracted continued attention for several decades as has given rise to the prevailing paradigm in organizational theory.

While a few contributions to the theory of the business firm analyze important aspects of cooperative work and the organization of cooperative work (especially the seminal work by Barnard (1938)), they all investigate cooperative work and organizational interactions *from the point of view of the firm* — not from the point of view of cooperative work. The reason being that the central issue in this movement within organizational theory is the *relationship between organization and market*. Why is the Invisible Hand of market-mediated coordination replaced by the Visible Hand of direct administrative coordination?

The problem that haunts the different authors in this movement is to reconcile the radical presuppositions of neo-classical political economy with the manifest existence of firms encompassing multiple actors engaged in different activities. In order to analyze this problem, an influential tenet within this movement focuses on the multitude of 'transactions' in economic activity and how they are accomplished.

2.1. Commons

The Transaction Cost school may be said to originate with the work of Commons on the economic origins of 'collective action'.

The analysis by Commons is based on the proposition that "conflict of interest" is universal and fundamental to political economy. He is in this respect building on Hume and Malthus who, according to Commons, "made scarcity the basis of coöperation, fellow feeling, justice, and property" (Commons, 1934, p. 6):

> "I start, like economists, with scarcity, as universal for all economic activity. Then I proceed, as did Hume and Malthus, to show that out of scarcity derives not only conflict, but also the collective action that sets up order on account of mutual dependence." (Commons, 1934, p. 6).

According to Commons, then, economic activity involves not only ubiquitous and rampant conflict of interest but also — given the mutual dependence of the conflicting interests — the endeavor to bring "order out of the conflict of interests" through the collective action of various institutions (Commons, 1934, p. 4).

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[1]   Ouchi has created much confusion in the transaction cost school by defining an organization "as any stable pattern of transactions" (Ouchi, 1980, p 132) — only to contradict this definition on the very same page by stating: "In this definition, a market is as much an organization as is a bureaucracy or a clan." (p. 132) Typically, however, the patterns of transactions in markets are not particularly stable; to the contrary, they are typically volatile and transient. And if the pattern of transactions is not stable then, according to Ouchi's own definition, there is no organization, market or no market. What he intends to say is that organization and market are two alternative governance structures.

Consequently, Commons' conceives of organization as a "collective action" established through "coöperation", that is, through the institutional subjection of individual self-interests to the putative common good.

The firm and other forms of "collective action" is thus a governance structure emerging to curb the centrifugal forces of individual self-interests. Commons' notion of organization is thus closely related to the Hobbesian Leviathan that is called for to prevent

> "that miserable condition of Warre, which is necessarily consequent […] to the naturall Passions of men, when there is no visible Power to keep them in awe, and tye them by feare of Punishment to the performance of their Covenants" (Hobbes, 1651, Chap. XVII, p. 223).

Thus, in a language strongly reminiscent of Hobbes', Commons expounds his concept of "coöperation":

> "coöperation does not arise from a *presupposed* harmony of interests, as the older economists believed. It arises from the necessity of *creating a new harmony* of interests — or at least order, if harmony is impossible — out of the conflict of interests among the hoped-for coöperators. It is the negotiational psychology of persuasion, coercion, or duress. The greatest American piece of actual coöperation, latterly under ill repute [anno 1934], is the holding companies which suppress conflicts, if persuasion proves inadequate. A more universal coöperation, suppressing conflict in behalf of order, is proposed by Communism, Fascism, or Nazism. These have found their own ways of submerging conflicts of interest. Hence, harmony is not a presupposition of economists — it is a consequence of collective action designed to maintain rules that shall govern the conflicts." (Commons, 1934, pp. 6 f.)

The most influential contribution by Commons, however, is his introduction of *the transaction* as the 'unit of analysis': "I made the transaction the ultimate unit of economic investigation, a unit of transfer of legal control." (Commons, 1934, p. 4).

For Commons, transactions occur between actors defined in terms of ownership. That is, transactions occurs when goods are transferred across boundaries of private property:

> "Transactions […] are not the 'exchange' of commodities,' in the physical sense of 'delivery,' they are the alienation and acquisition, between individuals, of the right of future ownership of physical things, as determined by collective working rules of society. The transfer of these rights must therefore be negotiated between the parties concerned, according to the working rules of society, before labor can produce, or consumers can consume, or commodities be physically delivered to other persons." (Commons, 1934, p. 58).

That is, a transaction can be seen as an interface between conflicting interests . Consequently, the notion of transaction is imbued with this sentiment:

> "I make conflict of interest predominant in transactions. But I conclude that this cannot be allowed to be the only principle, because there are also mutual dependence and the maintenance of order by collective action." (Commons, 1934, p. 6)

In these two sentences, Commons stated the core of the program of the subsequent Transaction Cost movement: Conflict of interest is predominant in transactions; because of the mutual dependence of the warring parties, however, order must be established and maintained by collective action in the form of organization.

2.2. Coase

What Commons did not explain or even address was the obvious question: Why are some transactions carried out within organizations while others are carried out beyond the auspices of organization?

This question was addressed and — to some extent — solved by Coase, another pioneer of the transaction cost approach to the theory of the firm. Coase retains the dichotomy of market and firm. Thus, quoting D. H. Robertson's colorful description, he conceives of firms as "islands of conscious power in this ocean of unconscious cooperation like lumps of butter coagulating in a pail of buttermilk" (Coase, 1937, p. 388). Or in his own words:

> "Outside the firm, price movements direct production, which is coordinated through a series of exchange transactions on the market. Within a firm, these market transactions are eliminated and in place of the complicated market structure with exchange transactions is substituted the entrepreneur-coordinator, who directs production. It is clear that these are alternative methods for co-ordinating production." (Coase, 1937, p. 388).

Coase's innovation was to explicitly conceive of markets and firms as alternative "governance structures" and to explain the proportions of market and firm coordination by measuring the administrative costs of each in the same unit, namely transaction costs. Both modes of economic coordination carry costs of administering a transaction: the costs of discovering relevant prices and of negotiating, implementing, and enforcing a contract in the market, versus the managerial costs of organizing transactions in the firm. "The main reason why it is profitable to establish a firm would seem to be that there is a cost of using the price mechanism" (Coase, 1937, p. 390). Firms exist where the cost of conducting a transaction within the firm is less than the cost of conducting the same transaction in the market: "a firm will tend to expand until the costs of organising an extra transaction within the firm become equal to the costs of carrying out the same transaction by means of an exchange on the open market" (Coase, 1937, p. 395).

According to Coase, all economic activity requires transactions defined as an act whereby "resources are allocated" between the different "factors of production" (Coase, 1937, pp. 389, 391).

In redefining transactions this way, and thus conceiving of "transaction[s] within the firm" (Coase, 1937, p. 395), Coase transcends the simplistic notion of Commons that transactions only occurred at the boundary of entities of common ownership. By enabling us to conceive of markets and hierarchies as alternative governance structures, that is, alternative "coordination instruments" for the "allocation of resources" (Coase, 1937, p. 389), Coase makes the transaction concept far more powerful. However, his solution raises another problem, namely: What constitutes a transaction, then? Coase did not address this problem explicitly, he merely seemed to assume (Coase, 1937, p. 388) that all work could, in

principle, be carried out by individuals who then interact and coordinate on the open market (at a higher cost, of course).[1]

This, however, is not a realistic assumption, to put it mildly. As already pointed out by Hodgskin (1825) at the dawn of the industrial era:

> "Wherever division of labour exists, and the further it is carried the more evident does this truth become, scarcely any individual completes of himself any species of produce. Almost any product of art and skill is the result of joint and combined labour. So dependent is man on man, and so much does this dependence increase as society advances, that hardly any labour of any single individual, however much it may contribute to the whole produce of society, is of the least value but as forming a part of the great social task. In the manufacture of a piece of cloth, the spinner, the weaver, the bleacher and the dyer are all different persons. All of them except the first is dependent for his supply of materials on him, and of what use would his thread be unless the others took it from him, and each performed that part of the task which is necessary to complete the cloth? Wherever the spinner purchases the cotton or wool, the price which he can obtain for his thread, over and above what he paid for the raw material, is the reward of his labour. But it is quite plain that the sum the weaver will be disposed to give for the thread will depend on his view of its utility. Wherever the division of labour is introduced, therefore, the judgment of other men intervenes before the labourer can realise his earnings, and there is no longer ally thing which we can call the natural reward of individual labour. *Each labourer produces only some part of a whole, and each part having no value or utility of itself, there is nothing on which the labourer can seize, and say: 'This is my product, this will I keep to myself.'* Between the commencement of any joint operation, such as that of making cloth, and the division of its product among the different persons whose combined exertions have produced it, the judgment of men must intervene several times, and the question is, how much of this joint product should go to each of the individuals whose united labours produce it?" (Hodgskin, 1825)[2]

That is, if the performance of an individual cannot be measured, the notion of a transaction does not make any sense. Thus, when confronted with the realities of cooperative work, transactions as a "unit of analysis" is not as simple as assumed by Coase (not to mention Commons). What is the exact relationship between the realities of cooperative work and transactions? This problem was addressed innovatively by Williamson.

2.3. Williamson

Following his predecessors, Williamson makes transactions "the basic unit of analysis" (Williamson, 1981, p. 549). However, in Williamson's analysis, economic interactions do not necessarily take the form of transactions. Rather, he posits, transactions take place between — at the 'interface' between — different cooperative work arrangements:

> "A transaction occurs when a good or service is transferred across a technologically separable interface. One stage of activity terminates and another begins." (Williamson, 1981, p. 552).

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[1]   That claim is made explicitly by Ouchi: "The 10,000 individuals who comprise the workforce of a steel mill could be individual entrepreneurs whose interpersonal transactions are mediated entirely through a network of market and contractual relationships." (Ouchi, 1980, p. 134).

[2]   Emphasis added.

Williamson makes is perfectly clear that the cooperative work activities that are brought together under the same scheme of common ownership in order to share resources are technologically separable:

> "the joining of separable stations — for example, blast furnace and rolling mill, thereby to realize thermal economies — under common ownership is not technologically determined but instead reflects transaction-cost-economizing judgments" (Williamson, 1981, p. 556).

That is, according to Williamson, a cooperative work arrangement (the cooperative activities taking place at a "station" such as a steel furnace or a hot rolling mill) is not "technologically separable".[1] In other words, according to Williamson cooperative work at "stations" has a unitary and indivisible character that is "technologically determined". Thus, in Williamson's conception, *cooperative work arrangements and transactions are complementary units of analysis*. The one starts when the other terminates, and vice versa.[2]

By defining the unit of analysis, the transaction, with reference to the interface between technologically separable cooperative entities, and by thus taking cooperative work into account, at least nominally and marginally, Williamson supersedes the implicit individualism of Neo-Classical Economics and of his predecessors and relates his reasoning to the realities of cooperative work that massively characterize the realm of work in modern industrial society. Thus, according to Williamson, firms are *aggregations of cooperative work arrangements*, not of atomic individuals. Nonetheless, for Williamson, like Coase, the reason for the emergence of firms is "market failure". The cooperative work arrangements are joined under "common ownership", even though they are technologically separable entities, in order to counter market imperfections caused by bounded rationality and opportunism. Williamson thus retains the dichotomy of market and hierarchy.

Accordingly, Commons' Hobbesian notion of the organization as a common power to keep the centrifugal forces of self-interest in awe is echoed in Williamson's notion of contracting as a means to curb "opportunism":

> "if agents […] were fully trustworthy, comprehensive contracting would still be feasible (and presumably would be observed). Principals would simply extract promises from agents that they would behave in the manner of steward when unanticipated events occurred, while agents would reciprocally ask principals to behave in good faith. Such devices will not work, however, if some economic actors (either principals or agents) are dishonest (or more generally, disguise attributes or preferences, distort data, obfuscate issues, and otherwise confuse transactions), at it is very costly to distinguish opportunistic from non-opportunistic types ex ante." (Williamson, 1981, p. 554).

The general conception of organization as developed by the Transaction Cost approach can be summarized as follows: Organizations are entities of *common ownership*: "islands of conscious power in this ocean of unconscious cooperation

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[1] Ouchi's analysis (Ouchi, 1980), while pretending to follow Williamson's, is acually an emulation of Coase's. Like Coase, Ouchi assumes that all economic activity could be carried out by individuals on the market.

[2] It is worth noticing that this definition of transaction is radically different from the one offered by Commons, the originator of the concept, and the one offered Ouchi, the vulgarizator of the concept.

like lumps of butter coagulating in a pail of buttermilk". They arise so a to provide a governance structure to certain types of transactions for which market exchanges are inadequate (less cost-efficient) as a governance structure. Outside the organizational boundary is the market, "inside management exercise authority and curb opportunistic behavior" (Powell, 1989).

3.   Critique of the Leviathan approach

As far as design of CSCW systems (as well as the design of work organizations) is concerned, the Transaction Cost approach suffers from the following fundamental problems:

1.   *The myth of the primordial market.* The basic methodological presupposition of the Transaction Cost approach is to conceive of the market as the default governance structure. The market is taken to be the Natural State, as it were: "The technique is to contend that all transactions can be mediated entirely by market relations" (Ouchi, 1980, p. 133). Hence the persistent preoccupation with the question why market forces have failed wherever an organization can be observed. However, this methodological contention is empirically unfounded — as any student of archaeological, historical, and ethnographic evidence will know. Or, to be quite candid, it is a fiction (Powell, 1989).

Along with the presupposition that the market is the default governance structure, the Transaction Cost approach has inherited the implicit radical individualism underlying Neo-Classical Economics. In the Transaction Cost world — that is, the world as seen from a Transaction Cost perspective — individuals only interact as opportunistic actors trying to maximize their own individual gains. Of course, opportunistic behavior is part and parcel of economic life, under the auspices of "common ownership" as well as on the "open market", and in designing CSCW system this fact of life must certainly be taken into account (Kling, 1980; Grudin, 1989; Orlikowski, 1992). But when promoted to the general generative mechanism of organization, the conception of organization as a (cost-efficient) governance structure for curbing opportunistic behavior among economic actors becomes a gross exaggeration. When this notion is applied as the dominant or exclusive conception of cooperative work in organizational settings, essential aspects the multi-faceted phenomenon of cooperative work is marginalized or simply lost: the work itself, the many technical and social skills required, the effort spent on maintaining mutual awareness and making one's own work publicly visible, the mutual help.

2.   *The dichotomy market versus hierarchy.* The organization is conceived of as a Leviathan, "a common Power to keep the all in awe" (Hobbes, 1651, Chap. XIII, p. 185). It is a monolith constituted by "common ownership" and controlled from one center in the sense that there is, somewhere, a set of consistent interests and goals to which the opportunist behavior can be subjected by a single and unitary will that presumably also exists somewhere.

It is difficult, if not impossible, to relate the highly abstract notion of "common ownership" to the infinitely differentiated relations of ownership and possession and rights and obligations that characterize the realm of work: Employees will for instance successfully treat the pencils, desks, computers, etc. they use in their work as *their* possession.

Also, as pointed out by, inter alia, Powell (Powell, 1989) and Best (Best, 1990), the rich variety of organizational forms adopted by contenders on the market is ignored by the market/hierarchy dichotomy: firms, corporations, multi-divisional corporations, joint-ventures, strategic alliances, equity partnerships, collaborative consortia for large-scale research, supplier networks (e.g., Toyota and its association of 35,000 suppliers), co-operatives, 'quasi-firms' in construction, tacit networks of recurrent contractors in publishing, and regional networks and industrial districts (e.g., Modena in Emilia-Romagna, the textile industry in Baden-Wurttemberg, the Route 128 in the US).

> "Many firms are no longer structured like medieval kingdoms, walled off and protected from hostile forces. Instead, we find companies involved in an intricate latticework of collaborative ventures with other firms, most of whom are ostensibly competitors." (Powell, 1989, p. 301)

The dichotomy of market and hierarchy underlying Transaction Cost theory does not help us here. In the words of Powell:

> "By sticking to the twin pillars of markets and hierarchies, our attention is deflected from a diversity of organizational designs that are neither fish for fowl, nor some mongrel hybrid, but a distinctly different form." (Powell, 1989, p. 299).

In fact, on closer inspection, categories such as 'market exchange' and 'common ownership' tend to loose their superficial clarity:

> "When the items exchanged between buyers and sellers possess qualities that are not easily measured, and the relations are so long-term and recurrent that it is difficult to speak of the parties as separate entities, can we still regard this as a market exchange? When the entangling of obligation and reputation reaches a point that the actions of the parties are interdependent, but there is no common ownership or legal framework, do we not need a new conceptual tool kit to describe and analyze this relationship? Surely, this patterned exchange looks more like a marriage than a one-night stand, but there is no marriage license, no common household, no pooling of assets." (Powell, 1989, p. 301).

3.   *The dichotomy of cooperative work and organization.* Williamson's attempt to define transactions as the interface between technologically separable units, 'stations' — which are, in their turn, non-separable cooperative work arrangements — suffers from a dichotomy quite similar to the market/hierarchy dichotomy. Williamson's concept of transaction does not take into account that cooperative work arrangements are constituted by interdependencies of different nature and intensity. In his analysis, the units are either 'technologically separable' — or not. Thus, while he attempts to accommodate for the realities of cooperative work, the notion of a singularity (as the subject of transactions), is still at work. As a result, since the formation of organization, in Williamson's analysis, begins at the boundary of the cooperative work arrangement, cooperative work and organization

are of different worlds. Organization is not organization of cooperative work but of transactions between otherwise unrelated singularities — like potatoes in a sack.[1]

The Transaction Cost approach does not enable us to grasp the rich multiplicity of interdependency and reciprocity among actors in cooperative work arrangements. The Transaction Cost world is populated by singularities (individuals in the case of Commons, Coase, and Ouchi, and 'stations' of cooperative work in the case of Williamson) who are partially conflicting and mutually repellent and whose only interactions take the abstract form of allocations of resources. What else might occur in organizational life is beyond Transaction Cost.

The Transaction Cost notion of organization is that of a system of decontextualized and dematerialized administrative regulation of transactions between singularities. That is, firms are only conceived of as *administrative governance structures*. In the words of Best:

> "It is an advance to envisage the firm as a governance structure as opposed to a production function, but Williamson's concept of governance structure is not given much force. The production activities themselves are independent of the governance structure. Governance refers simply to administrative coordination. But Big Business is about more than coordination of, in Williamson's words, 'technologically separable entities' […]; it is also about interrelations amongst mutually interdependent units. […] A theory of the firm must move beyond considerations of coordination with concepts that allow for links between governance structure and production performance…" (Best, 1990, p. 115)

The Transaction Cost approach has proved to be quite useful in requirements analysis in administrative work domains (e.g., public administration, corporate administration, banking, insurance) (Ciborra, 1985; Schmidt, 1986; Schmidt, 1988). Beyond these domains, however, the abstract notion of organization as an administrative governance structure is fundamentally inadequate. More importantly, in the context of CSCW, the facets of organizational life that the Transaction Cost approach can grasp are marginal to the rich variety of interactions of cooperative work and its articulation.

4. Beyond the Leviathan approach

The weaknesses of Transaction Cost approach as conceptual basis for the design of CSCW systems for organizational settings (and for the design of work organizations), can be attributed to its intellectual roots in Neo-Classical Economics and contract theory. These roots reveal themselves in the market mythology, the radical individualism, the dichotomy of market and hierarchy, the purely administrative notion of coordination and so on.

Its weaknesses notwithstanding, the Transaction Cost approach has been highly influential in organizational theory — not least because it is an attempt to develop a conception of organization as an emergent formation and, hence, a conception of

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[1]   "wie etwa ein Sack von Kartoffeln einen Kartoffelsack bildet." (Marx, 1852, p. 180)

organization that lends itself to the design and re-design of organizations and their computer-based infrastructures.

However, due to its weaknesses, the Transaction Cost approach is not suitable to the design of organizations — beyond the design of administrative organizational systems and the specific computer-based infrastructures for these domains. For CSCW, an alternative approach is required, namely a conception that conceptualizes organization from the point of view of cooperative work.

Such an approach will be outlined in this, the last section of the paper.

4.1. Perspectives of a 'cooperative work' approach to organizational theory

Organization is such an enormously complex and infinitely facetted phenomenon that the mere thought of developing an overarching theory of organization seems unrealistic (for want of stronger words).

Given that, we must learn to live with multiple perspectives — each serving and defined by a specific purpose.

From the point of view of cooperative work, the following four perspectives on organization are particularly relevant:

(1)   the *cooperative work arrangement* as an emergent formation;

(2)   the *work organization* as a relatively persistent pattern of cooperative work arrangements;

(3)   the *formal organization* as a governance structure regulating the diverse, partially incongruent interests within the cooperating ensemble;

(4)   the *firm*, the *network*, etc. as different forms of market-oriented organization.

The perspectives differ along two dimensions (see Figure 1): On one hand, in the analysis of the organization of cooperative work it is useful to distinguish the material content and social form of cooperative ensembles. An analysis *sub specie* the cooperative work arrangement and the work organization conceives of the ensemble in terms of its *material content*, that is, in terms of the characteristics of its field of work as well as the demands and constraints posed by the wider work environment, whereas an analysis s*ub specie* the formal organization and the firm etc., conceives of the ensemble in terms of its *social form*, that is, in terms of the systems of social control involved in the organization of cooperative work.

On the other hand, in the analysis of the organization of cooperative work it is useful to distinguish an analysis in terms of the *relations* among the members of the ensemble and an analysis of the ensemble as a *cohort*.

	Relational	*Cohort*
Material content	Cooperative work arrangement	Work organization
Social form	Formal organization	Firm, network …

Figure 1.

In the following sub-sections we will discuss these four perspectives on organization.

4.1.1. Cooperative work arrangement

A cooperative work relationship is constituted by the fact that multiple actors are transforming and controlling a complex of *mutually interacting* objects and processes. They are, so to speak, working on the same 'field of work'.[1] They are therefore mutually dependent *in their work* in the sense that one actor depends on the quality and timeliness of the work of the others and vice versa (Schmidt and Bannon, 1992).

In this perspective, cooperative work arrangements are conceived of as transient formations, emerging contingently to handle specific requirements — in response to the requirements of the current situation and the technical and human resources at hand — merely to dissolve again when there is no need for multiple actors and their coordinated effort to handle situations. Thus, in this conception the cooperative work arrangements that Williamson takes to be permanent singularities (… as far as the theory is concerned) are dynamic and emergent formations.

Furthermore, the relations of mutual dependence that constitute the cooperative work arrangement are by no means uniform. To the contrary, the field of work and hence the activities of the cooperating actors may have different salient characteristics, for example:

- *Structural complexity*: The members of a cooperative work arrangement may interact through and in relation to a field of work characterized by different degrees of interactional complexity (Perrow, 1984).

- *Temporal complexity*: The members of a cooperative work arrangement may interact through and in relation to a field of work characterized by more or less dynamic behavior or by being more or less tightly coupled and hence time-critical (Perrow, 1984).

- *Apperceptive complexity*: The members of a cooperative work arrangement may face a vast variety of problems in apperceiving (perceiving, making sense of, interpreting) the state of affairs in the field of work due to, for example, noise, unreliable sensors, indirect evidence from indicators, or from ambiguous, misleading etc. information.

That is, in a cooperative work arrangement different activities may depend on different activities in different ways and with different intensity. A cooperative

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[1]   The concept of the field of work is developed more fully in (Schmidt, 1993).

work arrangement is therefore not a uniform network that can be taken as a singularity, an atomic element solely interacting with other atomic elements via market-mediated transactions or via the administratively mediated transactions of a firm but should rather be conceived of as a complex of interdependent activities whose interdependencies differ in kind and intensity.

Thus, cooperative work arrangements are not discrete entities, singularities whose internal composition and topology can be ignored, but rather dynamic networks of varying intensity and density.

4.1.2. Work organization

Now, cooperative work is normally *organized* — in the sense that the articulation of cooperative work assumes a specific and relatively persistent *organizational form*. The reason for this is that establishing a cooperative work arrangement entails an *initial* overhead cost — not in terms of transaction costs, i.e., the cost of handling allocation of resources and performance measurement and remuneration — but in terms of (a) the need for identifying likely and appropriately skilled partners and negotiating the allocation of tasks and responsibilities, and (b) the need for new partners to acquire particular skills and become acquainted with local settings and practices.

In order to reduce this initial overhead, cooperative work arrangements exhibit a certain persistence in terms of the composition of the cooperative ensemble (as a cohort) and the allocation of tasks and responsibilities within it. That is, in order for cooperative work to be an economically viable way of working, the arrangements cannot — as the rule — be established in an *ad hoc* manner. A certain orderliness is required in terms of the stability and reliability of the composition and structure of the ensemble. The degree and form of orderliness required depends, of course, on the specific demands and constraints posed by the specific work environment such as, for instance, adaptability and safety of the operation, reliability of product quality, reliability and timeliness of delivery, and so forth. As observed by Weick: "organizations continue to exist only if they maintain a balance between flexibility and stability" (Weick, 1977, p. 215).

In accordance with the general usage in the literature, we will suggest the term 'work organization' to denote the relatively stable composition and structure of the cooperative work arrangement as determined by the demands and constraints of the work environment, that is, the decomposition of the work into tasks, the allocation of tasks within the ensemble, and the combination of tasks into jobs (Mintzberg, 1979; Blumberg and Gerwin, 1984; Child, 1987; Cummings and Blumberg, 1987; Cummings and Huse, 1989).

For example, having observed that advanced manufacturing systems are tightly coupled to vendors and customers and that this may place severe demands on the adaptive capacity of the system, Cummings and Blumberg conclude that for advanced manufacturing systems the "appropriate work designs should be oriented to groups of employees rather than individual jobs, and to employee self-control rather than external forms of control, such as supervision. This calls for self-regu-

lating work groups" (Cummings and Blumberg, 1987). In the same vein, Aoki observes that the semi-horizontal mode of coordination required in modern flexible manufacturing operations "crucially depends on the skills, judgment, and co-operation of [a] versatile and autonomous work force on the shop floor", and "a certain degree of blurring of job territoriality between workers on the one hand and foremen, engineers, programmers, etc., on the other" (Aoki, 1988).

Likewise, a cooperative work arrangement operating in a safety-critical environment, for example a governmental policy making body, will need to devote resources to prevent decisions that may jeopardize the system itself or its environment. The classical method applied by civil services faced with political risks and a high degree of task complexity is to deploy surplus agents to decision making tasks so as to ensure that any decision is assessed critically by multiple officers. The higher the risk and the higher the degree of discretion in decision making, the higher the degree of (apparent) redundancy in the work organization is likely to be.

By conceiving of the work organization as a relatively persistent pattern of co-operative relations, the work organization is demarcated by actual cooperative work practices as opposed to legal criteria such as ownership. A business firm may encompass multiple cooperative work arrangements with no mutual interaction. On the other hand, a cooperative work arrangement may cut across corporate boundaries and may involve partners in different firms at different sites, each of the partners producing but a component of the finished product.

4.1.3. Formal organization

As far as the *relationships of interests* is concerned — as opposed to the materially grounded relationships constituting cooperative work — an organization is a "coalition" of individuals motivated by individual interests and aspirations and pursuing individual goals (Cyert and March, 1963, p. 27). Cooperative work arrangements thus involve multiple individuals with partially diverging interests and motives. That is, cooperative work activities will hardly take place if these discordant interests are not mediated and regulated in some way. From this perspective, the ensemble is conceived of as a coalition of individuals with partially discordant interests and motives.

Thus, as observed by Barnard in an analysis that is quite close to Leontiev's analysis of the disparity between goal and motive under conditions of division of labor:

> "In coöperation the objective of action is necessarily removed from the individual, requiring a new form of activities, those of distribution." (Barnard, 1938, p. 36). "Personal purposes cannot be satisfied through coöperative action except as there comes into the action an intermediate process. This process is distributive." (Barnard, 1938, p. 32.)

In other words, participants in cooperative work activities will ask, overtly or tacitly: What's in it for me? And if they are not satisfied, or convinced, that their contribution to the joint effort is worthwhile they may withdraw their contribution (again overtly or tacitly) (Grudin, 1989). Thus, *a governance structure of contrac-*

tual arrangements administrating the allocation of resources and the measurement and remuneration of performance within the cooperative ensemble is required.

This analysis takes the fact that work is done cooperatively as the point of departure and conceives of the formal organization as a required governance structure of the cooperative ensemble. The formal organization of cooperative work is required independently of whether the members cooperating ensemble are independent operators, employees of the same firm or of several firms.

From a cooperative-work perspective, then, the formal organization is, essentially, a contractual governance structure influencing the behavior of individuals (and collectives) in accord with the interests of the other members of the ensemble as well as the interests of external stakeholders to which the ensemble may be accountable such as customers, shareholders, creditors, government agencies, industrial federations, trade unions, consumer groups, standardization agencies, etc.

4.1.4.   Firm, network…

Now, why do cooperative ensembles often take the form of a *firm*, in the specific legal sense of an entity of ownership within which resources are, in principle, common property, such as a corporation or a company? And why are cooperative ensembles that are only loosely interdependent, or not interdependent at all, subjected to one formal organization? Why do networks emerge? And all the other forms?

The Transaction Cost contention is that mediation of transactions at lower costs is the generative mechanism for the emergence of firms. A firm thus exists because it can manage the formal organization of a cooperative ensemble at lower costs than a market mechanism can. That is evidently *a* reason for the formation of firms conceived of a entities of common ownership. But it cannot be taken as the exclusive explanation. It cannot explain why cooperative work arrangements that are not interdependent at all in their work and hence do not engage in mutual transactions, are subjected to one formal organization, nor can it explain the emergence of networks of firms and all the hybrid forms. Other factors than the costs of transactions are clearly involved in the formation of firms and other forms of market-oriented organizational forms of pooled resources. For example: Technical and human resources may be utilized more efficiently and flexibly by joining several cooperative work arrangements, that otherwise are not interdependent and therefore not engaged in any mutual transactions, under the auspices of the same common ownership scheme. Moreover, financial scale it itself a competitive advantage. For example, large firms or strategic alliances may be able to establish and defend dominant positions in the market by being able to mobilize large amounts of capital for research and development, marketing, aggressive pricing, etc. And so forth. None of these alternative reasons for the formation of firms can be derived from the ability of a firm to mediate transactions at lower costs.

Anyway, when facing the market cooperative ensembles and clusters of cooperative ensembles adopt certain organizational forms - sometimes informal as

networks of mutual obligations, sometimes formalized contractually - that allow them to pool resources in order to acquire the required competitive impact.

4.2. Summary

In sum, *the* organization does not exist. The organization phenomenon is, rather, a complex of superimposed and interacting organizational formations.

Further, there is no overarching conceptual scheme for the analysis of organization — and none is required. No single generative mechanism — not even a strong contender as Transaction Cost — can explain the formation of organizations in general nor the formation of firms.

However, conceiving of organization from the point of view of cooperative work provides a foundation for overcoming some of the weaknesses of the Transaction Cost approach — without abandoning the undeniable gains made by that school, in particular the dynamic approach to an understanding of the emergence of organizations and the specific gains such as opportunistic decision making and the relative costs of administrating the allocation of resources and the measurement and remuneration of performance.

Conceiving of organization from the point of view of cooperative work also provides a foundation for relating the multiple perspectives that are required in order to deal with phenomena of this order of complexity.

Some of the specific implications of conceiving of organization from the point of view of cooperative work are:

(1)   There is no "common power to keep them all in awe". The distributed activities and interactions of cooperative work are not and can not be controlled by a single will. The formal organization is merely a governance structure of certain aspects of the multifaceted realities of cooperative work.

(2)   The organization of cooperative work is 'open ended'. Irrespective of the perspective applied to organization, *the organizational boundary is contingent and porous*. From the point of view of cooperative work, this does not lead to infinite regress, however, in the sense that everything under the sun may be taken to belong to 'the organization'. The concept of field of work, as constituted by activities that are more or less strongly interdependent provides the foundation for a non-arbitrary stop-rule!

5.   Implications for support of organizational context in CSCW systems

A particular cooperative work arrangement is always situated in an organizational context. From the above analysis, it is evident that the organizational context of a cooperative work arrangement is a multi-facetted and open-ended phenomenon.

In order for a particular cooperative work arrangement to be able to relate to its organizational context it requires access to a variety of information which may be described as a set of indices:

(1)   Index to other cooperative work arrangements that actually or potentially interact or intersect with the cooperative work arrangement in question. Which other cooperative work arrangements may interfere with ours (by competing for the same material, technical or human resources, by interacting with the same objects, customers, stakeholders)? Which other cooperative work arrangements may be similarly affected by our performance?

(2)   Index to statutory constraints imposed by the formal organization (procedures to ensure observation of various statutes concerning accounting, safety, health, security, personnel, publicity etc.)

(3)   Index to common resources which are available within the same firm and hence under the same 'common ownership' arrangement and which can be acquired 'free of charge' and without much ado:

   (a)   potentially relevant cooperation partners so as to reduce the cost of establishing cooperative work relations: Which partners are potentially relevant for a particular project in terms of skills, competing commitments etc.?

   (b)   potentially relevant material resources: Which materials, components, assemblies are available where, when, how, in which quantity? What are their characteristics? (For example, various taxonomies of this kind are used in large manufacturing operations, for example based on 'group technology').

   (c)   potentially relevant technical resources: Which equipment (tools, fixtures, machinery, software) are available where, when, how? What are their operational characteristics (machining tolerance, suitability for different kinds of materials and material dimensions, processing time and cost)? (Taxonomies of this kind are being developed in the CIM area).

   (d)   infrastructures: rooms, buildings, communication facilities, transportation facilities and so forth. What are their operational characteristics (capacity, compatibility, turnaround time, bandwith)?

   (e)   informational resources (documents, letters, applications, notes, files, memos, reports, drawings).

   (f)   services offered by various units within the firm as a legal unit (maintenance, travel arrangements, legal advice, layout, printing, copying).

Now, since organization is open-ended in several respects, organizational context is itself open-ended. The organizational context can be seen as a 'field' of varying intensity and density, thinning at the edges but seemingly without end: the

immediate cooperative work arrangement, other intersecting arrangements, the enterprise, the division, the corporation, the network of suppliers and other collaborative partners, and customers, unions, banks, shareholders and so on.

This has some severe consequences for the design of systems supporting organizational context. First, we cannot assume that 'the organization' is a well bounded, closed, finite structure. For instance, the boundary of a collaborative network is porous, fuzzy, and dynamic. What is within or beyond the organizational context is contingent, negotiable. And second, we cannot assume that the classification schemes supporting the indices are managed by one center. This point is illustrated vividly by Sørensen and Borstrøm in their analysis of the 'the intricate problems of manufacturing an ashtray' (Appendix A1) (Sørensen and Borstrøm, 1993).

Accordingly, in the design of systems supporting organizational context we need to address the issue of how to make the classification schemes for the management of common repositories amenable to be managed cooperatively in a ongoing process of distributed decision making. This issue is identical to the issue of mechanisms of interaction explored in COMIC Strand 3.

References

Aoki, Masahiko: *A New Paradigm of Work Organization: The Japanese Experience*, WIDER Working Papers, vol. 36, World Institute for Development Economics Research, Helsinki, Finland, 1988.

Barnard, Chester I.: *The Functions of the Executive*, Harvard University Press, Cambridge, Mass., 1938.

Best, Michael H.: *The New Competition. Institutions of Industrial Restructuring*, Polity Press, Cambridge, 1990.

Blumberg, Melvin, and Donald Gerwin: "Coping with advanced manufacturing technology," *Journal of Occupational Behavior*, vol. 5, 1984, pp. 113-130.

Child, John: "Organizational Design for Advanced Manufacturing Technology," in *The Human Side of Advanced Manufacturing Technology*, ed. by T. D. Wall, C. W. Clegg and N. J. Kemp, Wiley, Chichester, 1987, pp. 101-133.

Ciborra, Claudio U.: "Reframing the role of computers in organizations: The transaction costs approach," *Proceedings of Sixth International Conference on Information Systems, Indianapolis, December 16-18, 1985*, 1985.

Coase, R. H.: "The Nature of the Firm," *Economica N.S.*, vol. 4, no. 4, November 1937, pp. 386-405.

Commons, John R.: *Institutional Economics*, University of Wisconsin Press, Madison, 1934.

Cummings, Thomas, and Melvin Blumberg: "Advanced Manufacturing Technology and Work Design," in *The Human Side of Advanced Manufacturing Technology*, ed. by T. D. Wall, C. W. Clegg and N. J. Kemp, Wiley, Chichester, 1987, pp. 37-60.

Cummings, T. G., and E. F. Huse: *Organization Development and Change*, (4th ed. (1st ed., 1975)), West Publishing Co., 1989.

Cyert, Richard M., and James G. March: *A Behavioral Theory of the Firm*, Prentice-Hall, Englewood-Cliffs, New Jersey, 1963.

Grudin, Jonathan: "Why groupware applications fail: problems in design and evaluation," *Office: Technology and People*, vol. 4, no. 3, 1989, pp. 245-264.

Gunn, Thomas G.: *Manufacturing for Competitive Advantage. Becoming a World Class Manufacturer*, Ballinger, Cambridge, Mass., 1987.

Hobbes, Thomas: *Leviathan, or The Matter, Forme, & Power of a Common-Wealth Ecclesiaticall and Civill*, London, 1651. [Reprint published by Penguin Books, Harmondsworth, Middlesex, 1968].

Hodgskin, Thomas: *Labour Defended Against the Claims of Capital, Or, The Unproductiveness of Capital Proved with Reference to the Present Combinations Amongst Journeymen*, Knight & Lacey, London, 1825. [Reprint published by Augustus M. Kelley, Publishers, New York, 1969].

Kling, Rob: "Social Analyses of Computing: Theoretical Perspectives in Recent Empirical Research," *Computing Surveys*, vol. 12, no. 1, March 1980, pp. 61-110.

Marx, Karl: *Der achtzehnte Brumaire des Louis Bonaparte* (New York 1852); in K. Marx and F. Engels: *Gesamtausgabe (MEGA)*, vol. I/11, Dietz Verlag, Berlin, 1985, pp. 96-189.

Mintzberg, Henry: *The Structuring of Organizations. A Synthesis of the Research*, Prentice-Hall, Englewood Cliffs, New Jersey, 1979.

Ohmae, Kenichi: *Triad Power. The Coming Shape of Global Competition*, Free Press, New York, 1985.

Orlikowski, Wanda J.: "Learning from NOTES: Organizational Issues in Groupware Implementation," in *CSCW '92. Proceedings of the Conference on Computer-Supported Cooperative Work, Toronto, Canada, October 31 to November 4, 1992*, ed. by J. Turner and R. Kraut, ACM Press, New York, 1992, pp. 362-369.

Ouchi, William G.: "Markets, Bureaucracies, and Clans," *Administrative Science Quarterly*, vol. 25, March 1980, pp. 129-141.

Perrow, Charles: *Normal Accidents. Living with High-Risk Technologies*, Basic Books, New York, 1984.

Powell, Walter W.: "Neither Market Nor Hierarchy: Network Forms of Organization," in *Research in Organizational Behavior*, ed. by B. M. Staw and L. L. Cummings, vol. 12, JAI Press, Greenwich, Conn., 1989.

Schmidt, Kjeld: "A Dialectical Approach to Functional Analysis of Office Work," *IEEE International Conference on Systems, Man, and Cybernetics, Atlanta, Georgia, October 14-17, 1986*, 1986.

Schmidt, Kjeld: "Functional Analysis Instrument," in *Functional Analysis of Office Requirements. A Multiperspective Approach*, ed. by G. Schäfer at al., Wiley, Chichester, 1988, pp. 261-289.

Schmidt, Kjeld: *Modes and Mechanisms of Interaction in Cooperative Work: Outline of a Conceptual Framework*, COMIC Internal Report, Risø National Laboratory, Roskilde, Denmark, (version 1.1), February, 1993. [COMIC-Risø-3-3].

Schmidt, Kjeld, and Liam Bannon: "Taking CSCW Seriously: Supporting Articulation Work," *Computer Supported Cooperative Work (CSCW). An International Journal*, vol. 1, no. 1-2, 1992, pp. 7-40.

Sørensen, Carsten, and Henrik Borstrøm: "Small is Easy — The Intricate Problems of Manufacturing an Ashtray," , ed. by L. Bannon and K. Schmidt, Risø National Laboratory, Roskilde, Denmark, 1993.

Weick, Karl E.: "Middle Range Theories of Social Systems," *Behavioral Science*, vol. 19, November 1974, pp. 357-367.

Weick, Karl E.: "Re-Punctuating the Problem," in *New Perspectives on Organizational Effectiveness*, ed. by P. S. Goodman and J. M. Pennings, Jossey-Bass, San Francisco, 1977, pp. 193-225.

Williamson, Oliver E.: "The Economics of Organization: The Transaction Cost Approach,"
    American Journal of Sociology, vol. 87, no. 3, November 1981, pp. 548-577.

From Small to Large Scale

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This section of the deliverable focuses on the implications of large scale cooperative arrengements in the Organisational Context which are heterogeneous. Boundaries mark discontinuities of diverse nature (technology, geography, economic, accountability, organisation, etc.). In terms of cooperation, work is usually loosely coupled into functional units of situated work which may interact with other functional units by the use of abstractions, transparencies realized by mediators or interceptors.

Federation is an organisational structure which enables loosely coupling of previously disjoint organisations or work units: the OC of a large scale arrengement may include more than one organisation.

Trading is a key function which enables work articulation. It provides indexes to services, structures, other intersecting arrengements, statutory constrains, in a dynamic fashion, supporting the evolutionary nature of work.

1. Introduction

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Federation is an organisational structure which enables loosely coupling of previously disjoint organisations or work units: the OC of a large scale arrengement may include more than one organisation.

Trading is a key function which enables work articulation. It provides indexes to services, structures, other intersecting arrengements, statutory constrains, in a dynamic fashion, supporting the evolutionary nature of work.

The above concepts are shared with two other disciplines. *Enterprise Integration* (EI or Enterprise Engineering) is interested on coordinating large scale arrengements of people, departments and companies. *Open Distributed Processing* (ODP) is also interested on large scale distributed systems which in fact are the same real work systems, but from a slightly different perspective.

Our work is influenced and it will influence not only CSCW technologies but also distributed systems technologies such as ODP, and business integration technologies such as EI.

2. Components of the OC

The Organizational Context can be observed from different perspectives, with varying degrees of refinement. From our perspective, it can be decomposed into a set of agents, resources, activities, information, goals and policies describing the behaviour of a large scale cooperative arrangement[1] (composed by one or more organisations).

We will address the OC as a *conceptual and physical framework "in which" and "by which" enterprise activities are achieved.* The OC includes anything relevant and necessary to achieve the organizational goals.

The OC is the union of all particular perceptions that activities have about the enterprise. It would be desirable that (complex) activities were independent of the complexity of those organizational characteristics not relevant to them, concentrating on the required OC support (abstraction and transparency).

From our perspective of the Organisational Context, we propose to consider the model and classification schema proposed in the ESPRIT ORDIT project [ORDIT 93] that has been adapted to suit ANSA [Iggulden 92]. This model has similarities with *activity theory* (AT) [Kuutti 92], but while AT looks at the collective transformation of objects by subjects and tools, this model looks more at the relationship between activities and their Organisational Context. Thus, rather than being alternative, both theories have different complementary perspectives.

In this model, the basic component of the enterprise takes form of an entity relation schema with three sorts of entities: activities, agents and resources; they are defined as follow:

- *Agent*: This is a name attached to a set of responsibilities. An agent must always be an appropriate answer to a *Who?* question.
- *Activity*: An activity is to be distinguished from the performer of the activity. Thus an activity is an answer to a *What?* question, and takes the form of a verb.
- *Resource:* Resources are answers to *With?* or *ByMeansofWhat?* questions.

The responsibilities assigned to agents through their functional roles are expressed in terms of *obligations* with three characteristics:

- *responsibility:* who is blamed if something goes wrong?
- *accountability:* who has to explain what has gone wrong?
- *liability*: who has to pay for things that have gone wrong?

Between these three types of entity, there are a six kind of relations:

- *Agent — Action:* The set of actions with which an agent has some relation constitute the *functional role* of that agent.
- *Agent — Resource:* The relation between an agent and a resource is an *access right*, such as the right to create, to destroy, to allocate.

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[1]   A large scale cooperative arrengement will be also referred as an 'enterprise'.

- *Action — Resource:* Action and resources are related by notions of creation, destruction, use and transformation. The basic relation in IT terms is an *access mode*, such as read or write (for information resources) or provide, consume or transform when describing actions on commodity resources.
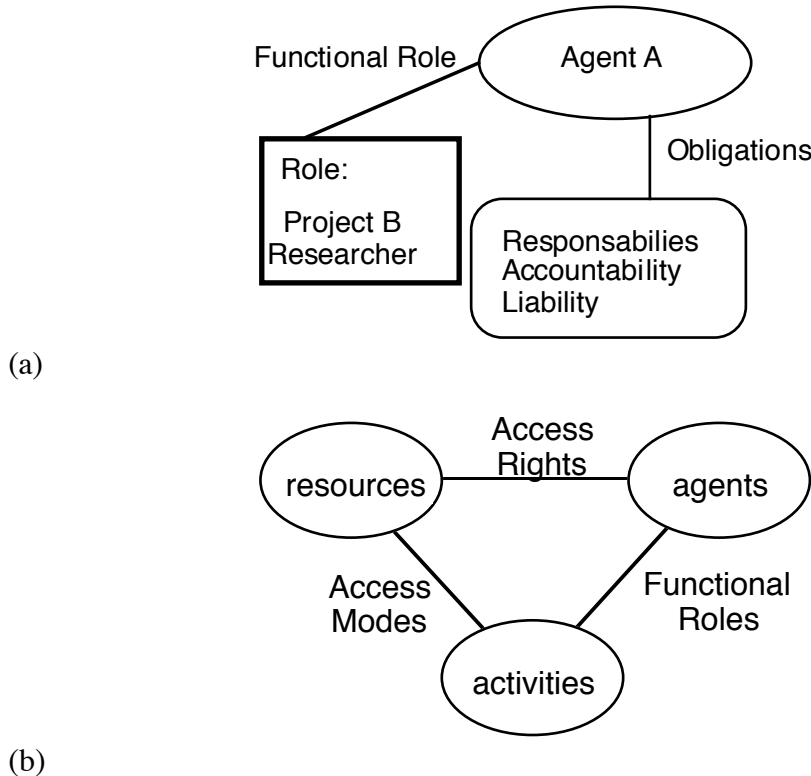

(a)

(b)

Figure 1. (a)Agent ; (b)Agent-Action-Resource Relationships

There are also intra-entity relations as follows:

- *Action — Action:* Actions interact with each other. Such interactions are usually mediated by the *exchange of resources*, though direct interactions can also occur.
- *Resource — Resource:* in terms of information processing, constitutes a *conceptual schema* (conceptual schema provides a common interpretation of the data).
- *Agent — Agent*: The set of agents with which an agent has some relation constitute the *functional structural role* of that agent.
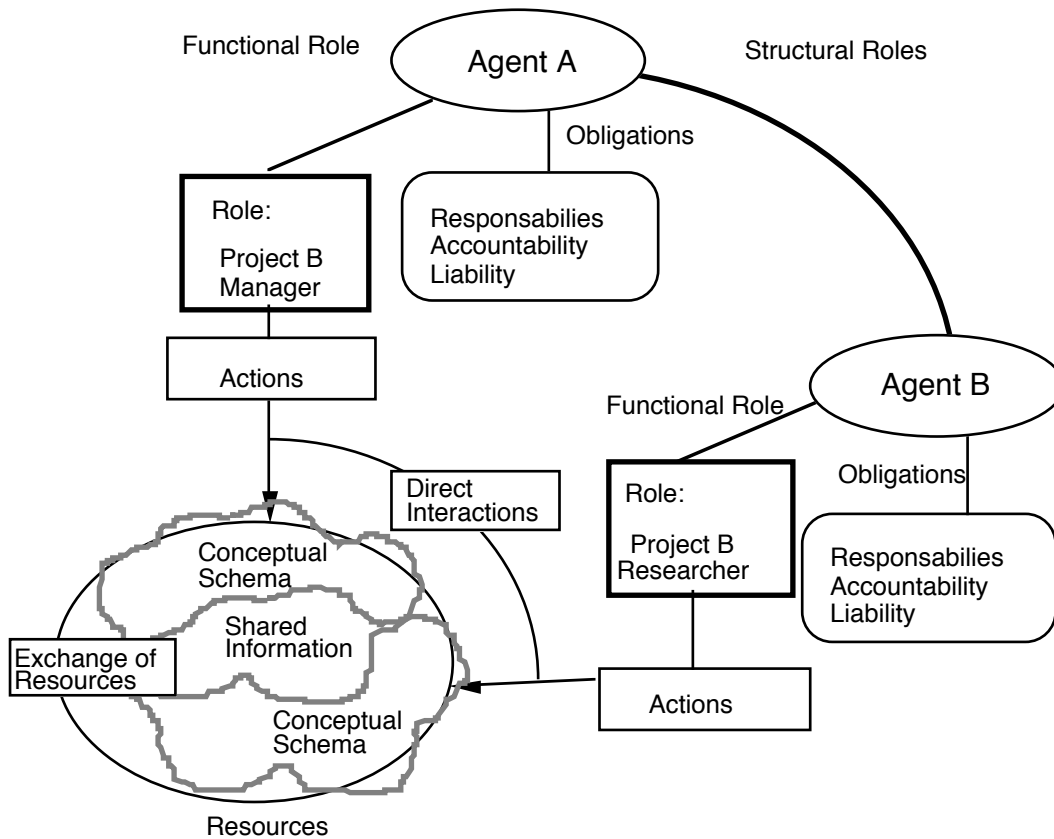
The definition of roles, activities, allocation of resources, etc., depends on the policies adopted by each organization.

A *policy* is a set of prescriptive requirements imposed upon the behaviour of an object in order to meet certain objectives. It consist of:

- the *objective:* the definition of a future state of affairs, that is desired and believed to be feasible.

- *missions:* a set of statements which define a set of activities designed to meet the objective.

- *constraints:* a set of predicates over behaviour which indicate what shall and shall not be done in undertaking some implementation of the mission statements.

The former concepts are useful to describe cooperation in terms of interactions and relationships between OC components described at the highest level of abstraction.

Cooperation among OC components could take place, among other, under the following scenarios:

- Cooperation could take place as a result of dependencies associated between structural roles of the agents. The structural role of one agent respect to another determines, for example, hierarchy dependencies and as consequence, the degree and type of interaction between such agents.

- Agents with related functional roles tend to cooperate more frequently that agents that not are related in terms of functionality, and this cooperation exhibits a high degree of interaction. These agents could be related, for example, due to causal dependencies between the actions performed by the agents, or/and due to shared resources dependencies, or due to synchronous or asynchronous requirements of interaction between actions performed by different agents, etc.

  Causal dependencies between two or more activities take place when there is a causal-effect relationship between the occurrence of actions. If the actions are performed by different agents some synchronisation mechanisms must exist.

  If agents share the *same conceptual schema* (for interpretation of the data: information) and the actions assigned to its roles manipulate the same sets of data, then these agents could *share information* through the modifications to the data and the observation of these changes.

  If agents interact through explicit *exchange of messages*, they must agree on a conceptual schema and a representation will be used in data exchanges.

  Agents can also cooperate through *sharing of resources*. Mechanisms of synchronisation in the use of such resources and rules to manipulate them are needed.

3. Functional Units

Associated to large scale is the concept of *separation* (i.e. division into a number of partitions by drawing boundaries). Functional Units is a generic term for the components that appear as a result of the separation of a large scale cooperative arrengement regarding certain types of boundaries, with a certain purpose. They are semi-autonomous and homogeneous *units of cooperation situated in their organisational context*: they include activity, agents and resources, they share a common conceptual schema, and they provide a service.

Each FU is a unit of concern. Large Scale cooperative arrengements may be decomposed into several units based on a classification schema. Different divisions may appear as a result of different classification schemas.
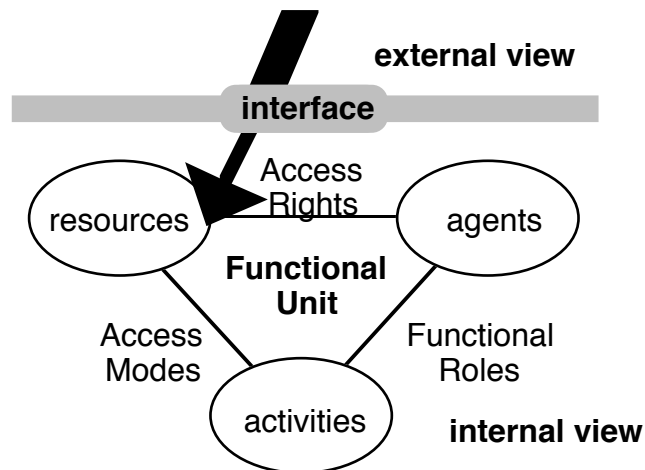
External and internal view of a FU

Each FU has a particular view of the OC. The Goal is to abstract from the part of the OC which is not relevant. Each FU has interests / applies transparencies on organizational resources and affairs, but also on other FU of interest (the function is visible, not the way work is done).

While Structural Units may fit into Functional Units, FU may be dynamic, transient: they reflect the state of affairs and they are situated in an static/organisational framework.

Articulating a large cooperative arrangement implies the definition of boundaries among more homogeneous domains, in order to reduce the overhead of articulating work. Articulation takes into account the function or service provided by each FU. Different concerns may lead to different decompositions. The actual organisation of work will emerge as a combination of them.

Concerning the threshold of sustainable complexity (see Milan contribution), abstracting from other classes of boundaries, the resulting representation marks which boundaries are required in order to enable agents to participate in that cooperative arrengement.

Concerning awareness or visibility, the resulting representation identifies the boundaries across which awareness is not complete.

Concerning the formal structure of an organisation, the resulting representation reflects the formal structure of the organisation.

In order to understand a large scale arrengement, it must be decomposed from different perspectives based on a framework of abstractions, leading to the division into units of analysis, which may or may not coincide with units based on a different criteria.

4. Organizational Context: complexity aspects

With the evolution of the organization, the number and forms of interaction among agents (and between the activities performed by such agents) increases and the need for articulation of these interactions appears naturally.

In simple cooperative arrangements the OC appears as a minimum set of agreements and policies, rules as a result of the agreements, resources (physical and information), planning and design of the cooperative activities to achieve the objectives of the organization; under simple ensembles work organization may be achieved by workers without any additional support.

Thus, when the ensemble becomes un-manageable/un-bearable for participants (agents: humans and/or applications) then the overhead cost of articulating work in the organization must be enhanced by *the adoption of mechanisms to reduce the visible complexity of the OC perceived by the agents*. There is a need for the establishment of boundaries. As a result, Functional Units appear reducing the perceived complexity of work articulation. This reduction of complexity comes with a lower degree of visibility (lower level of mutual awareness across the organisation, as a consequence of the establishment of boundaries).

As the organization grows, their context becomes much more complex. Reasons for that complexity may come from:
- The *diversity* of the OC elements (resources, activities, roles (functional & structural), policies, goals, organizational information).
- The real and potential *scaling* of such elements
- The number and forms of *interaction* among elements

Mechanisms to reduce this complexity are detailed descriptions of the steps to follow in order to provide certain function without forcing the user to:
- know the complexity hidden by the mechanisms
- to know the policies that was followed by the mechanism designers
- to know the attached organizational history of the mechanisms (why, when and how the mechanisms was implemented)

While mechanisms describe the steps to achieve a function, goals and policies restrict the long term behaviour of the agents (interaction between agents and the OC).

Mechanisms must be well interpreted by the users. Some mechanisms are specified in the form of a set of human-understandable rules / a set of functional specification rules.

When the number and complexity of these rules become too difficult to follow, the mechanisms could be encapsulated on a new entity (a tool which embodies the knowledge to do some work following the rules) with the mission of simplifying the use of the mechanisms by delegation.

The users of such mechanisms are the agents (people, machines, applications) which have a particular perception of the organizational context. Then, interactions

among these agents could be difficult given the diversity in the OC perceptions. If these agents have to collaborate in an activity, mechanisms to facilitate such interactions must be part of the OC tools: mechanisms of interaction.

Then, different type of mechanism could co-exist to simplify the work inside an organization. Thus, different types of mechanisms:

- To reduce the task complexity; e.g. automated procedures.
- To avoid the complexity to manipulate the OC; e.g. delegate the manipulation of part of the OC to a third party.
- To facilitate the interaction between agents (each of them have a particular perception of the OC); e.g. mechanisms of interaction.
- To enable interaction among physically remote agents; e.g. communication mechanisms.
- To enable interaction among inter-organisational agents; e.g. federation mechanisms.

The domain of applicability of these mechanisms (and tools to support them) could be restricted to a particular agent/activity, to a set of agents/activities, organizational agent/activities or to inter-organisational.

The creation and adoption of mechanisms and tools, with the initial purpose of simplification of work and interaction among agents, could become a complex problem when the number and diversity of such mechanisms grows, and with them, the OC. Then the organization must be prepared to deal with these problems: adoption of artefacts to provide localization, instantiation, customization, contextualisation of tools is needed.

5.   Scaling Organizational Context to Large Scale

Inside an organization, all of its members are subject to a common source of authority and share a collection of goals, values and beliefs; these characteristics define an *administrative boundary*.

Complexity increases due to scaling activities could require *cooperation between different* administrations. In addition, other types of boundaries between agents delimit accountability, judicial, economic, contractual, social, political and cultural domains [Deschrevel 92].

Thus, to enable cooperation in the large scale (i.e. among organizations) it is necessary to identify where and which boundaries are present in the cooperative arrangement, in order to set up mechanisms to provide a common umbrella across the cooperative arrangement.

Further sections describe *boundaries* which is the key concept that arises when dealing with the large scale. Cooperating Functional Units may decide to organise in a hierarchy or a *federation. Trading* is the basic mechanism to support in the negotiation and establishment of cooperative links among entities.

Boundaries

Boundaries mark the point at which autonomy of many kinds is permitted [Deschrevel 92]. In order to have cooperative boundaries (cooperative links across boundaries) there is a need for active objects located at the boundary: *Boundary objects are responsible of filtering undesired external interactions and enable actions that were previously impossible.*

Boundary objects may be either mobile or bound (to a boundary). Mobility in respect to boundaries is associated with objects that are capable of crossing certain types of boundaries. They are plastic enough to adapt to local needs and constrains, and when they cross boundaries they adapt to the new domain while maintaining their identity [Star 92]. They are aware of boundaries and reactive respect to them. Thus, these objects are transportable across some boundaries.

Interceptors are boundary objects associated to a discontinuity. Interceptors provide transparency across boundaries.

Objects at boundaries need to be aware of:

* the relationship between both sides: two extremes of relationship are federation (strict independence) and hierarchy (strict dependency).
* the gap between both sides: some discontinuities may be concealed by boundary objects, while others should be left to humans, increasing the complexity of the arrangement.

Boundaries between functional units may be one or more of:

* Organisational boundaries
* Accountability boundaries
* Judicial boundaries
* Economic boundaries
* Contractual boundaries
* Social boundaries
* Political boundaries
* Cultural boundaries
* Geographic boundaries
* Technological boundaries

It is important to identify the boundaries that occur in a large scale cooperative arrangement. There are many kinds of boundaries, as a result of the different criteria of the observers (different classification schemes) and the kind of cooperation that may take place.

For example, in the ANSA trading model, some boundaries are specially relevant: type system boundaries, naming system boundaries, property boundaries, interconnection boundaries. In addition, if we look at the scope of certain policies: system management domain boundaries, security domain boundaries.

In our work, (system) management domain boundaries may be of interest since it deals with monitoring and controlling the way people and objects use resources.

Thus, boundary objects (either those capable of dealing with certain classes of boundaries, or those devoted to provide transparency of a certain boundary) have to deal with the wide spectrum of differences between cooperating functional units. In particular, with technical discontinuities (different protocols, naming systems, file systems...), security discontinuities, providing translation at the boundary, checking of contractual agreements.

Cooperation across boundaries may happen as a result of a contractual agreement or it may occur occasionally. Interception may be of several types:
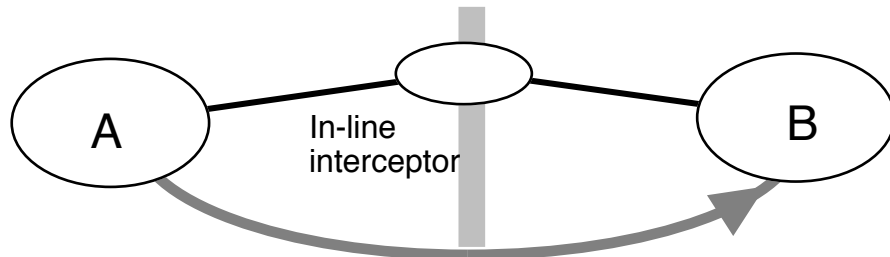
- *In-line interceptors* are placed in between objects at both sides of a boundary, doing filtering or translation "on the fly".
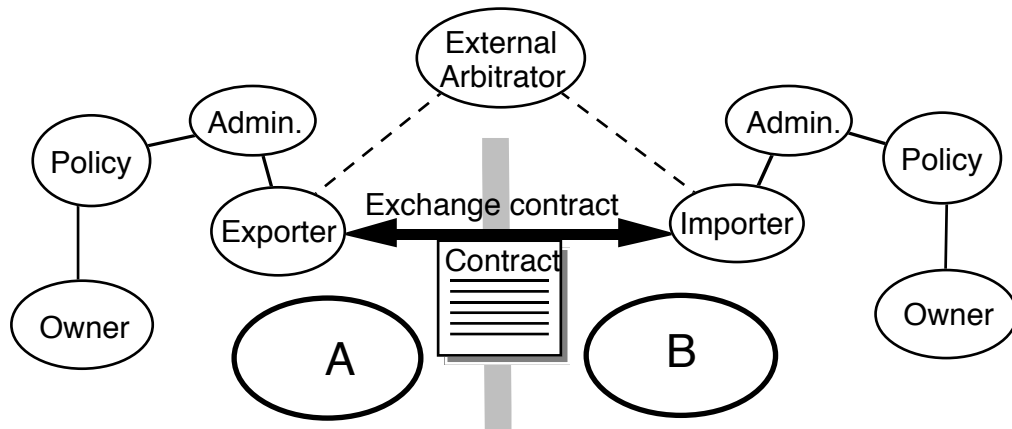
- *off-line interceptors* provide communication among parties mediating cross boundary interaction. Off-line interceptors provide support for the exchange and negotiation of contracts, exchange of cryptographic keys for one or several successive interactions, etc.
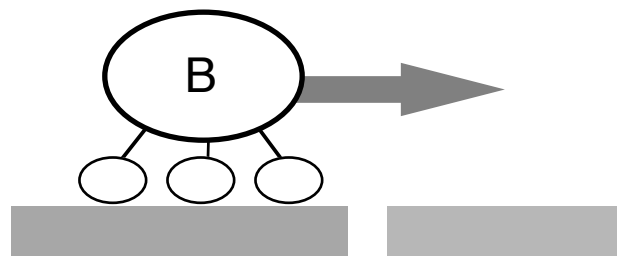
- *nomadic interceptors* provide support to enable migrating objects to work across boundaries.

There is no need for a central authority to control the compliance of the contract; this responsibility is distributed among boundary objects at the different domains.

However, external observers (e.g. government supervision, audit agents, arbiters) may be introduced. In large scale arrangements, following [Malone 87] we can expect the rapid emergence of new kinds of participants (i.e. new sources of authority: additional boundaries):

- middlemen who act as distributors, brokers, or agents in the transfer of the goods being sold (distributors).
- financial service firms such as banks or credit card issues who store, transfer, and sometimes loan the funds involved in the transactions.
- government agencies[1] or consortiums who enforce and support contracts, agreements or practices.
- IT vendors and standardisation bodies, who provide the networks, protocols, software and hardware necessary to support the cooperative arrangement.

6. Federation

Federation is an organizational structure in which the parties negotiate the extend to which they wish to share resources (physical and computational resources) and thus surrender their exclusive authority to over those resources.

In terms of autonomy, federation is one extreme case of organisation to enable scaling up. On the other end of the spectrum we find hierarchies. Hierarchy is a traditional way of organisation, but it usually implies adherence to the same standards for communication, naming and security mechanisms across all systems within the scope of the hierarchy. This work is being done by a central authority who organizes part of internal affairs of every organization in the hierarchy. An important aspect that would facilitate the scaling of distributed systems is that every organization was able to apply their own management policy and make their own design trade-offs for the systems they own. Thus the key to practical large scale cooperation without bottlenecks is federation of autonomous organizations (each member organisation may be a hierarchy).

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[1] From IEEE Spectrum (93/6): "The US White House said that the National Institute of Standards and Technology and the National Security Agency has created a voice and data encoding standard that should protect electronic communications for bussiness and individuals while letting the Government eavesdrop for law enforcement and national security reasons."
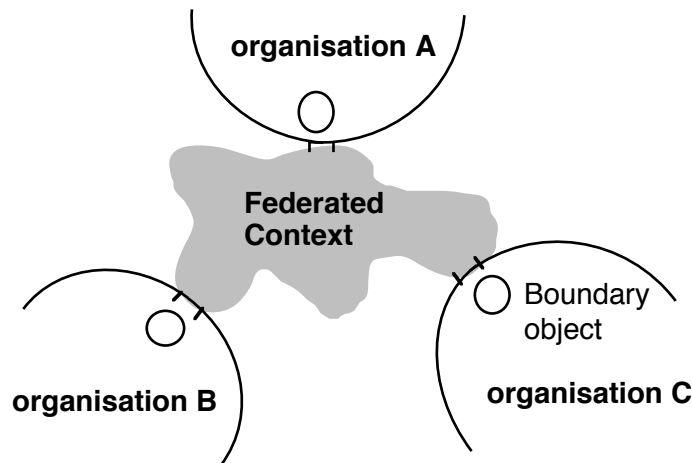
Federation of organisations. Without a central authority

Federation is a technique both for interconnecting previously disjoint organizations and for partitioning previously fully interconnected organizations. Each organization is responsible for itself and there must be freedom of association:

- to join or leave federations
- to extend or restrict interactions
- to control which internal resources can be used by external users
- to control which internal resources can be used by internal users.

Federation should require very little agreement and mutual knowledge between domains before interaction can occur. The knowledge required to agree a federation policy between organizations is a complex combination of social, political, economic and technical issues. This knowledge involves:

- some general laws that all organization must follow to belong to a federated environment
- some contracts between organizations
- technical issues (protocols used, naming system, file systems, ...). This technical discontinuity is normally overcome by adopting standards of other organizations to which an organization is federated.

After an agreement between two organisations is achieved, and before the federation is operative (cooperation will then be possible across both organisations), boundaries have to be identified and circumvented with boundary objects.

An organisational agent (human/application) may be aware or unaware of the federation. When it is unaware, boundary objects at the boundary provide **transparency**: agents don't realise whether they are working in a federated arrangement or not. Transparency allows any agent to operate in a federated environment without any further complexity: they doesn't need to know about the insights of federation. *Multi-organisation cooperative arrangements* appear as the result of applying transparency to federation. The result appears to simple agents as a unique organisation.

The two following figures show the difference between what is happening and what an simple agent perceives.
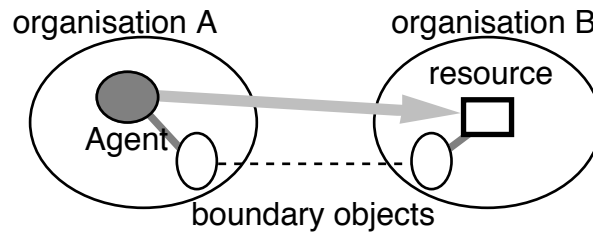
When an agent tries to use a resource from another organization two boundary objects do all federation work and the agent acts as it wasn't federated
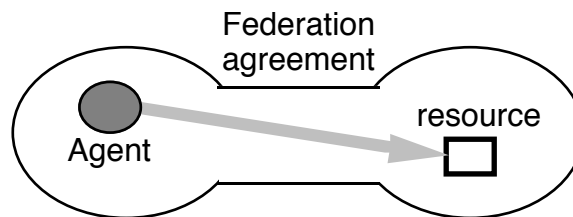
The effect of transparency: the agent acts as if it were accessing to their own organization.

7. Trading

Trading is basically the activity of choosing partners, such that they match some service requirement. The choice is based on the comparison of the specification of requirements (provided by prospective consumer) and the specifications supplied by providers or their agents.

The trading function is key component to enable work articulation in a large scale cooperative arrangement of people, resources, processes, objects, services, etc. It provides support for the articulation and meshing of individual activities. In order to make articulation work more flexible, efficient, and effective, the trading function provides a matchmaking service where mutually interacting objects come together. This process of negotiation may occur dynamically and it provides support for the emergence of transient formations. In addition, trading takes into account the formal structure of the organisation, and the regulations imposed by policies, law, contracts, etc.

This dynamic process entails an initial overhead cost of identifying prospective partners, negotiation of tasks and responsibilities, compliance with contracts and organisational policies, etc.

According to [Risø-1-3], trading provides several indexes:

- an index to services provided by units within the formal organisation that can be procured without additional contract negotiations. This may include resources, people, etc. (exported service offers)

- an index to potentially related entities in the cooperative work arrangement classified in terms of the formal structure of the organisation. (trading contexts)
- an index to other related cooperative arrangements that may actually or potentially intersect (federated/hierarchical trading & contract exchange and negotiation)
- an index to statutory constrains imposed by the formal organisation (type management and conformance services)

Trading (articulation) may be supported across boundaries, and it provides support for the establishment and monitoring of contracts among different administrations (off-line interceptors).

Functional Units, in an Organisational Context provided with the trading function, may offer their services to a *unexpected* and *evolving* audience through this function. The level of complexity is kept low by the transparencies offered by the trading function who orchestrates the work articulation across boundaries, under a number of different policies, eavesdropping the flow of actions among components of cooperative work formations, keeping track of the compliance of the diverse contracts under which components work, introducing any kind of monitoring and interception agents.
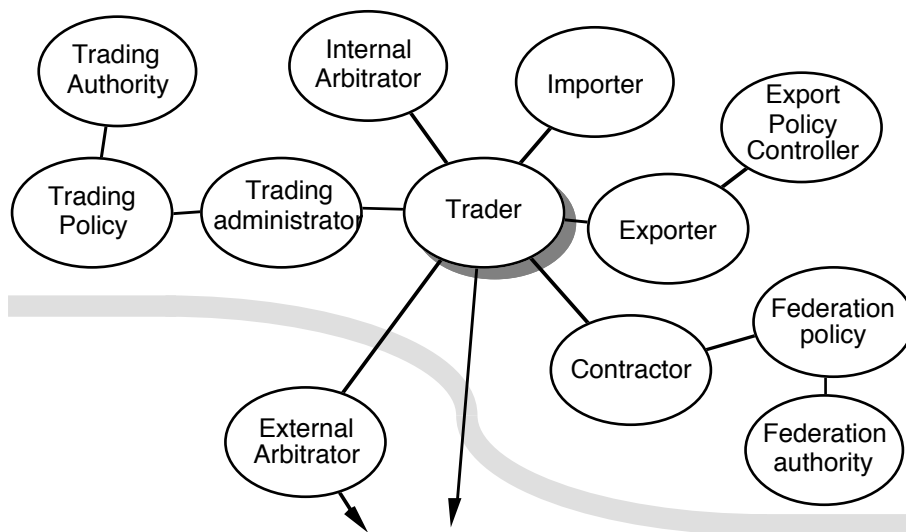
Work articulation may involve complex negotiations among a varying number of partners

Often, mainly in large scale systems where usually users don't know all the available people, resources, services, someone wants to contact others without knowing if they exist, their location, or how to collaborate with them. It may occur that there are many entities so we have to choose. That is exactly the job the trading function does for us (hiding, reducing complexity).

From a computational perspective, trading is a distributed service that provides support for work articulation among entities by matching (and negotiating) offers with requests considering restrictions and policies. When an entity needs to contact

someone else, he specifies what *type* is looking for, which *restrictions* he imposes (these restrictions are usually expressed by some *attributes*, e.g.: cost, quality, time needed to complete the job...) and then a request is made to the *trader* entity. The trader selects the best provider among those matching the **request**. If no success (no provider for that type or there are some but they are not fit into the user requirements), depending on the search policy, the trader may propagate requests to other traders to which it is connected. Those traders may be located inside the organization (usually a hierarchy) or outside (the latter is usually a federation of traders) as well. When the trader finds a service matching user requests, it returns a service reference to the user.

Functional Units, from the same or different organisation, may publicise service offers: exporting a service which includes a *service description*, some *attributes* qualifying the offer and a *reference* to that service.

8.   Enterprise Integration

As proclaimed by [Petrie 92], the goal of Enterprise Integration (EI) is the development of computer-based tools that facilitate coordination of work and information flow across organizational boundaries.

The construction of a space station tests the limits of our ability to coordinate the decisions and actions of subcontractors with a bureaucracy. The manufacture of airplanes requires also the coordination of not only thousands of people within the manufacturing organization, but myriad subcontractors and suppliers. These are the 'Grand Challenges' addressed by EI: supporting the interactions of participants on large complex processes.

Enterprise Integration occurs when there is an improvement in the task-level interactions of people, departments, services and companies.
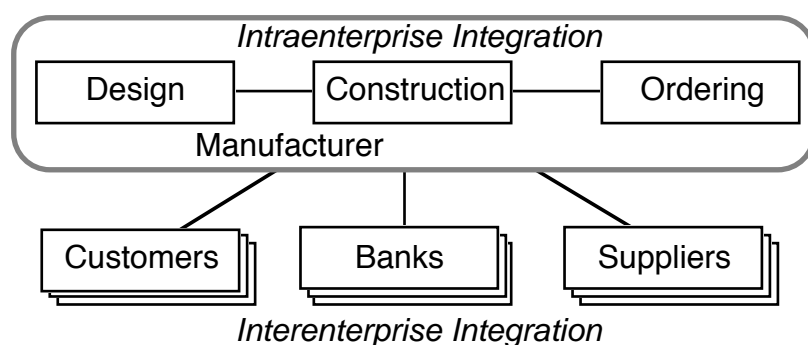
Future effects of EI is that many existing hierarchical bureaucracies which are only artifacts of our current lack of coordination technology will experience a revolution. Being an employee of a company will be no longer a prerequisite for performing services for that company. Currently huge companies may become composed of a few hundred direct employees that "farm out" nearly all of the companies service and manufacturing requirements to a shifting web of subcontractors

and suppliers via electronic contracts and coordination mechanisms: *virtual companies*.

For EI, an Enterprise is a collection of business entities (people and organizations) in functional symbiosis. In order to connect computer applications of different departments or companies, it is required to determine the conceptual consistency and efficiency of the functions in the departments. Integration may be achieved at the level of models: *model integration* and *federation* are key issues in EI.

EI is interested in the integration of computer-supported services of enterprises. This interest is shared in our research, because the OC of an enterprise (a large scale cooperative arrengement) provides the appropiate level of abstraction and support for loosely coupled cooperative work across units, departments, companies, organizations, etc: cooperative work across boundaries.

9.   The ODP approach

In this section, we provide a brief description of an standardization effort for description, formal definition and implementation of open distributed information systems to fulfil the requirements of people inside enterprises.

ODP stands for *Open Distributed Processing*. ODP is an standardisation effort to provide support for large scale open distributed processing systems. ODP is going to provide a framework of integrated standards for building world-wide open computer-based systems. This will enable interworking and sharing of data between applications and it will provide a framework of common concepts and language for specification. Thus ODP is an enabling technology for large scale inter-organisational Cooperative Work.

ODP recognises that large scale computer-supported work arrangements are complex beasts. Rather than attempt to deal with this full complexity, an observer may adopt different viewpoints based on their interest. The *Reference Model of Open Distributed Processing* (RM-ODP) [Wood 93] deals with the complexity of a system by using a *framework of abstractions* that considers such system from a set of interrelated *viewpoints*, where each viewpoint represents a different abstraction of the original system. A viewpoint leads to a representation of the system with emphasis on a specific concern, and the resulting representation is an abstraction of the system which recognises some distinctions and ignores others. Different viewpoints address different concerns, but there will be a common ground between them. The five viewpoints are:

1.   The *enterprise viewpoint* system focuses on the expression of purpose, policy and boundary for an open distributed system. This is the viewpoint of the users of an information system. It is concerned with business *policies*, management policies and human users *rôles* with respect to the systems and the environment which they interact; the word enterprise does not imply a limitation to a single organisation; the model constructed may well

describe the constrains placed on the interaction of a number of disjoint organisations.

2. The *information viewpoint* focuses on the expression of the meaning of information and information processing functions in a distributed system. This is the viewpoint of information managers, information engineers and enterprise system analysts. It is concerned with *information modelling*, providing a consistent common view covering information sources and sinks and information flows between them.

3. The *computational viewpoint* focuses on the expression of the functional decomposition of the system, and of the interworking and portability of the functions. This is the viewpoint of application designers.

4. The *engineering viewpoint* focuses on the expression of the infrastructure required to support distributed processing. This is the viewpoint of (software) system designers and communications experts.

5. The *technology viewpoint* focuses on the expression of the suitability of technologies to support aspects of open distributed processing. This is the viewpoint of programmers, system maintainers and system managers.

In order to represent an ODP system from a particular viewpoint it is necessary to define an structured set of concepts in terms of which that representation can be expressed. This set of concepts provides a *language* for writing specifications of systems from that viewpoint, and such a specification constitutes a model of a system in terms of the concepts.

The enterprise viewpoint and enterprise concepts (language) reflect our concerns at this stage.

The *enterprise language* is used to specify the system in terms of agents, artefacts, roles and policy and the context of an enterprise. The ODP system and the environment in which it operates are represented as a community, where a community is a group of agents that play different roles, established form the purpose of achieving an objective. [Wood 93]

The enterprise viewpoint of an ODP system shows what functions it provides, but not how these functions are implemented. An ODP enterprise specification should not be confused with a total enterprise specification: the ODP enterprise specification is limited to the description of the relationship between an application and the functions (services) in their environment (black boxes). In contrast, a total enterprise specification will refine the former specification with details on how to achieve the goals of the enterprise (transparent boxes). ODP specific standards will specify functions to provide transparencies and control over interactions among objects. At present, there are two categories identified in the working draft: the trading function and the security function.

The ODP enterprise model is focused on the specification of enterprise activities associated with ODP functions and their transitions between them.

The ODP Enterprise model defines a set of minimal constructor types to define the information elements describing the enterprise in this viewpoint. For more details on the BRM-ODP see [UPC-1.1].

10.   References

[Wood   93]

Proposed text on viewpoints and languages for clause 12 of SC21/WG7/N755, *Basic Reference Model of ODP — Part 1: Overview and guide to use,* UK contribution for discussion at the SC21/WG7 meeting in Yokohama, 1993.

[ORDIT   93]

ESPRIT 2301, 1989-1993 Project Documentation.

[Iggulden   92]

APM/RC.422.00, D. Iggulden, *Enterprise Architecture*, ISA Project, 1992.

[VdLinden   91]

APM/RC.308.01, R. van der Linden, *ANSA Enterprise Concepts: A Preview*, ISA Project, 1991.

[Deschrevel   92]

APM/RC.367.00, J-P. Deschrevel, *Trading across boundaries*, ISA Project, 1992.

[Malone   87]

T.W. Malone, J. Yates, R.I. Benjamin, *Electronic Markets and Electronic Hierarchies,* Communications of the ACM 30, 6 (1987), 484-497, CSCW: A Book of Readings.

[Petrie   92]

C.J. Petrie, *Enterprise Integration Modelling, Proceedings of the First International Conference,* MIT Press, 1992

[RtorRvd93]

APM/RC.430.01, Rees Owen & R. van der Linden, *Information Projection and Model*, ISA Project, 1993.

[Risø-1-3]

K. Schmidt, *Organisational Context in Context, Position Statement*, ID: COMIC-Risø-1-3, 1993.

[Star   1992]

S. L. Star, *The Trojan Door: Organisations, Work, and the 'Open Black Box'*, 1992, Systems Practice — forthcoming.

[Kuutti   92]

K. Kuutti, *Identifying Potential CSCW Applications by Means of Activity Theory Concepts: A Case Example*, CSCW 92 Proceedings, 1992.

[UPC-1.1]

J.M. Marquès, L. Navarro, M. Sarmiento, *ODP Enterprise Models & Functions*, COMIC Project, 1993.

Appendices

Small is Easy

The Intricate Problems of Manufacturing an Ashtray

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Risø National Laboratory

In the last couple of decades much research has been aimed at exploring how the integration of manufacturing functions can contribute to increased productivity. This article investigates cooperative aspects of integration between detailed design and process planning, i.e. the cooperative aspects of Design For Fabrication (DFF). The aim of the article is to present an initial analysis of a case study at Stainless, a Danish manufacturing company. The article focuses on the organizational context of engineering design and process planning of a stainless steel ashtray. Organizational context is in this article interpreted as the context of the cooperative work aimed at solving technical problems. The main result of the analysis is that the plant manager to a large extent personifies the organizational context. Because project meetings aimed at coordinating the problem-solving process are very rare, the cooperative process is characterized by much interaction. This particular cooperative work arrangement mainly works because only a small number of people is directly involved in the projects.
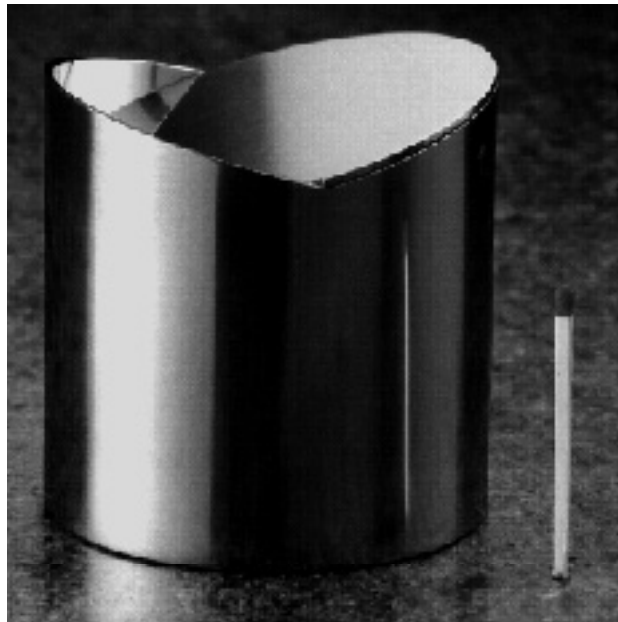
... When the boss hasn't much else to do ... he'll bloody chase us around in here with both his big-toe nails in our back pockets, and it's driving us crazy.

(John, tool shop foreman)

In the beginning I thought that it must be easy to make such a shape. But one gets quite surprised about how difficult it really is. All the things that lie behind. When browsing in

shops, my view has totally changed. I value the products more than just something that is spit out of a machine

(Susan, technical assistant)

... We always make some hand-made samples. But these samples they don't provide us with any experience about how it can be manufactured .... it can be easy to make a hand-made prototype, and it takes a week. But you can't spend that amount of time on it when you're going to spit them out in hundreds at a time ... What you do is you make a sample-batch on 100 or 200, and that batch is sent all the way down in production. Then one can notice whether or not there are holes in the production

(John, tool shop foreman)

The problem often is that you sit and is really ready for some serious thinking, then BANG, BANG, two doors slams open, and "John, how ... eeeh?", "well, look here ... ", then ,"John, we're out of 8 mm nuts", and BANG, BANG, "John the broom handle is broken", and so on and so on and so on. Some shit breaks down in production, or Bo comes running "now we're going to make these for this company", then I have to put the problem away for two weeks in order to take care this new problem. Then, when I get back to it, I wonder "how the hell was it I was going to fix this damn problem? If only you were allowed to drive all the shit home in a taxi to your own kitchen and were told "now you stay at home until you've fixed it", or something like that ... all these interruptions are ruining a lot.

(John, tool shop foreman)

1. Introduction

If one of the primary goals of a research project is to develop CSCW technology to support the articulation work in a particular domain, then studying the domain is essential. This article reports some preliminary results from a field study of the cooperative aspects of detailed engineering design and process planning. Integration between detailed engineering design and process planning is named Design For Fabrication (DFF). The field study has the purpose of providing input to an elicitation of requirements for a CSCW application supporting cooperative aspects of DFF.

It is the aim of this article to present a case study at the Danish manufacturing company Stainless, and to analyze the case in order to describe important aspects of the organizational context of the engineering design and process planning process. It is important to stress that we study the organizational context of manufacturing. There might be great differences between this domain and other domains, such as, for example, office work, academic work, and so on. Furthermore, the field study has been focusing on cooperative aspects of the participants work on solving technical problems related to making mutual adjustments between design and process planning. The organizational context is interpreted as knowledge about what is and what is not possible regarding the combination of skills, machines, and materials.

Others have performed field studies of the manufacturing process. Bucciarelli has performed en ethnographic study of the totality of the engineering process

(Bucciarelli, 1984; Bucciarelli, 1987). Hansen and Kaavé has studied production planning systems (Kaavé, 1990; Hansen, 1993). This article, however, focuses on Design For Fabrication, an area that has mostly been researched using theoretical or experimental research approaches (Haudrum, 1993). The DFF literature does, furthermore, not specifically address cooperative aspects of DFF, but aims at eliciting general principles for DFF as seen from the product, i.e. minimize total number of parts, develop a modular design, use standard components, design parts to be multi-functional, and so on. The general perspective of the research documented in this article is human factors in Design For Fabrication, and similar to the research in the broader topic Design For Manufacturability documented in the collection edited by Helander (1992), especially the contribution by Rindom (1992).

The main point of the article is that some of the participants in the decision process find the process of creating and maintaining organizational context in projects to laborious, unstructured and difficult. This is mainly true because it is a fairly small organization where each participant has several areas of responsibility, and because the manufacturing plant manager does not impose a more strict project work structure with project meetings. Furthermore, the manufacturing plant manager is acting as a "master-mind" in design and process planning. Even though the organizational context is created and maintained in an *ad hoc* manner, the cooperative arrangement actually works. This can mainly be attributed to the small number of people cooperating. The case also illustrate the problem of supporting context of the design and production planning process by repositories which is only maintained centrally.

Section 2 provides a short presentation of Design For Fabrication. Section 3 characterizes the research approach used for data-collection. Section 4 presents the organizational setting at Stainless, the manufacturing company where the field work is conducted. In Section 5 we describe the case — a stainless steel revolving ashtray. Section 6 analyzes the organizational context of the case, and Section 7 concludes the article.

2. Integrating Design and Process Planning

> *A group of people, especially from the tool shop, are involved already from the beginning.*
>
> (Bo, plant manager)

Integration between manufacturing functions are important research areas within the manufacturing engineering community. The main idea is to abandon the view that the manufacturing process can be described as a sequence of sub-processes where output from one is input to the next, and with a strict hierarchical division of labor. Instead the manufacturing process is viewed as:

> *... and indivisible, monolithic activity, incredibly diverse and complex in its fine detail. The many parts are inextricably interdependent and interconnected, so that no parts may be safely separated from the rest and treated in isolation, without an adverse impact on the remainder, and thus on the whole.*

(Harrington, 1984)

Integrating activities affecting the process from initial idea to finished product has by several been promoted as a viable strategy for boosting both quality and productivity (Harrington, 1984; Gunn, 1987).

In the manufacturing community one can find the "Design For X" concept. The "X" can then be substituted with various activities in the manufacturing process, such as (Haudrum, 1993): Design For Manufacture or Design For Manufacturability (DFM), Design For Assembly (DFA), Design For Quality (DFQ), Design For Production Planning (DFPP) etc. Design For Manufacture can be divided into a set of analytical categories, where Design For Assembly and Design For Fabrication are the two most important (Borstrøm, 1993). The focus in this empirical study is on a particular part for the integration between design and process planning: Design For Fabrication, or DFF for short. Design For Manufacture is a broader concept than Design For Fabrication. DFM implies relative high-level decisions — it denotes a general trade-off between design and process planning (Sinclair, 1992). DFF is also mutual optimization of engineering design and process planning within the given manufacturing context, but at a relative detailed technical level. Regarding the product this implies decisions about: surface quality, details of shape, and tolerances of dimensions. Regarding the manufacturing process it is optimization of primarily: choice of tools in the process chain, design of fixtures, choice of machines, decisions about process-parameters and tool-trajectories (Lenau, 1992; Borstrøm, 1993; Haudrum, 1993). The basic idea behind improving integration between detailed design and process planning is that optimization in both can be obtained by mutual adjustments. If they are performed strictly sequential, the designers might impose too many constraints on the object to be manufactured with respect to process planning. The process planners then are exposed to what has been labeled an over-constrained environment.

3. Research Approach

Designing a system to support design to manufacture requires more than innovative and capable system designers, skilled in the design of software systems. There is a need to understand the knowledge processes that humans bring to bear in design activities; the various design styles they exhibit, the discontinuities in design behaviour, the slips and errors to which they are prone, and the way the design process occurs in practice. It is important to know how design teams collaborate in solving problems and to understand how and when different kinds of knowledge are combined as the design solution progresses, in order design a system that will support true design for manufacture.

(Siemieniuch, 1992) reporting on experiences from the Alvey Programme.

We want to analyze cooperative work in a manufacturing setting when the participants deal with the complexity and uncertainty of getting from a design idea to actually producing a product. The emphasis is on Design For Fabrication. Knowledge about cooperative aspects of DFF, and identification of key areas that could be supported by CSCW technology, are the analytical components of our effort.

The constructive components are: requirements specifications, demonstrators, and prototypes. The main goal is to study how computer support could facilitate these cooperative aspects of the DFF process. This article only focuses on the first analytical component — knowledge about the cooperative aspects of DFF. As very well argued by Bucciarelli (Bucciarelli, 1984), traditional sequential models, describing the decision process as matter of rational top-down problem solving, are not very well suited for describing what actually goes on. Which research approach will then provide us with the most relevant data?

We have chosen to apply the analytical distinction between different research approaches, suggested by the "The Information Systems Research Challenge", Harvard Business School. It divides research approaches into the three analytical categories of: (1) Experimental research (Benbasat, 1989), (2) qualitative research (Cash and Lawrence, 1989), and (3) surveys (Kraemer, 1991). Actual research approaches might incorporate elements from different categories. The research approach used in collecting data at Stainless can, however, be characterized quite precise as qualitative research. The qualitative approach can be further characterized as an approach heavily inspired by both Work Analysis (Schmidt and Carstensen, 1990), and by ethnographic approaches to studying engineering work (Bucciarelli, 1984; Bucciarelli, 1987). The approach is similar to the one applied by both Hansen, Kaavé and Rindom, as documented in (Kaavé, 1990; Rindom, 1992; Hansen, 1993).

Qualitative research implies collecting data by, for example, interviews and observation, with the purpose of capturing the richness of worldly realism, hence potentially jeopardizing the tightness of control (Mason, 1989; Sørensen, 1993). Potentially trading tightness of control for richness of worldly realism can imply that the results of the study looses generality. Currently the production facilities has been inspected and a series of interviews have been conducted. The interviews can primarily be characterized as open-ended qualitative interviews (Patton, 1980). Later on in the process, observation will play a major role. In order to evaluate the generality of some of the results from the qualitative study, two measures are planned: (1) Qualitative studies of an additional manufacturing company, and (2) quantitative analysis of data from 100 Danish manufacturing companies (Christensen and Clausen, 1992).

The research approach in this article is empirically based analysis of qualitative data. The results obtained are primarily of an analytical nature, i.e. reflecting descriptive statements, as opposed to results of a more constructive nature, i.e. proposing normative statements in the form of, for example, frameworks, conceptual models, computer-based systems etc. The different "Design For X" concepts described in the previous section can be interpreted as both normative principles guiding actions, as well as different analytical perspectives to be used when collecting and interpreting empirical data. Because the research documented in this article is analytical and inductive, we apply the Design For Fabrication as a perspective for understanding the case studied.

4. Stainless — The Organizational Setting

Our greatest pride is that we participate in manufacturing products like these. So when one sits at home and watches CNN, then suddenly there is a Stainless thermos in the middle of the table at a big meeting in the U.N.. That's damn neat!

(John, tool shop foreman)

Stainless produces items for domestic usage, and has a product line of approximately 150 different products, such as: Thermos, tea-pots, ice-buckets, bottle openers, cork screws, candlestick holders, ashtrays, salad servers, sauce ladles, serving forks and -spoons etc. The primary material is stainless steel and all accessories in plastic and other materials are produced by sub-contractors. Stainless' products can be characterized as being on the border between manufactured products and arts and crafts, and some of the classic products are designed by a famous late Danish architect, who also was one of the founders of the company. The company has for a number of years worked together with another Danish designer, and he has designed a substantial part of the product line. Other designers also contribute to the product line by sending in suggestions for design. Some of the products are designed by the company itself.

The company is divided into two divisions — the administrative headquarters and the manufacturing plant. The CEO, who is also the owner, and the sales manager and a small secretarial function are located at the administrative headquarters, the rest at the manufacturing plant. The two divisions are located approximately 100 km apart. Stainless does not only manufacture the products. The company also acts as wholesaler, which implies that they trade directly with about 4000 hardware stores in Denmark. The wholesale function is located at the manufacturing plant.

Stainless has an annual turnover on about 50 million Dkr (7 million ECU) and employs 70 people, i.e. in the same category as around one third of the Danish manufacturing companies (Christensen and Clausen, 1992). Of those, 50 are working in production. The remaining 20 are working in administration, management, inventory, product development, production planning etc. The company sells about 50% of the production on the Danish home market. Of the 50% that are exported, 25% are sold to Germany and the remaining 25% are sold in various countries, mainly in Europe. In rare cases Stainless acts an a sub-contractor on special components in stainless steel. The overall strategy of the company is not to expand. It is instead to consolidate, to produce high quality niche products, and to enhance the organizations' abilities to manufacture new products. Productivity gains does not lead to reduction in staffing, but results in increases in the product portfolio.

The production type is batch-production to stock (Harrington, 1979), a type that covers about 75% of Danish manufacturing companies (Christensen and Clausen, 1992). Process planning is done mainly by two people in close cooperation with the plant manager and the production manager. The engineering design process is primarily driven by the plant manager who has extensive experience in what the company is capable of producing, and who also is driven by a strong urge to ex-

plore new territories and in expanding the capabilities of the organization. Apart from the plant manager, the owner, the sales manager, the designer, and the production manager, are involved in making the strategic decisions about which products they want to manufacture. The main decisions concerning engineering design and process planning at Stainless are closely integrated, because a relatively small group of people are the primary actors: the plant manager, the tool shop foreman, the process planner, the production manager, the technical assistant, and the designer. It is characteristic that in the process of making decisions about the detailed design of products, the participants utilize an extensive knowledge about the capabilities and constraints of the manufacturing processes that the organization masters. When a decision has to be made regarding whether or not the company will produce an given product, the plant manager promotes two important criteria:

1   Based on an estimate of what the product can be sold for in the hardware shops, can the company produce it and make a profit? and

2   Based on the design presented by an industrial designer, can the manufacturing organization learn something new from producing it?

These two rationales for deciding on whether or not to embark in a new project can be labeled as the economical challenge and the technical challenge. They might at a first glance seem quite superficial and shallow, but they are not rough guesses made on dubious grounds. They are made on the basis of qualified estimates, and are founded on many years of experience.

5. The Revolving Ashtray

The Dutch designer approached us with the idea about one year ago ... he sent us a prototype cast in aluminum ... we looked at it and said "that's a good idea". He had made a sculpture, and it looked interesting ... The prototype was a made of a little too thick material, 3 mm.. It was going to be too heavy, when made in steel. In aluminum it was all right. We said that we thought 1.5 mm would be more suitable .... he didn't care about that.

(Bo, plant manager)

This section describes the revolving ashtray case. The first part describes the ashtray project, the second part briefly characterizes the manufacturing process, i.e. how to get from a slab of stainless steel to the revolving ashtray shown in the beginning of the article. The remaining four subsections describes in more detail four major problems in relation to detailed design and process planning.

The Ashtray Project

The first time I saw it, was in Bo's office. There was this 'cardboard tube' in front of him. He said "I have this funny thing I want you to have a look at. Perhaps we will produce it". And there it was. An aluminum tube, with a smaller diameter, but in a thicker goods, but otherwise the same. My first impression was that I thought it was awful, because it was made in aluminum, and sandblasted. It looked dreadful. Then Bo said "but if we can have it made in our own material, we've decided that we probably would be able to sell it."

(John, tool shop foreman)

In the beginning of 1992 the owner and the production plant manager of Stainless were attending the big Frankfurt Trade Show, and were contacted by a Dutch designer, who had designed an ashtray. They briefly discussed the possibility of Stainless producing it, and the designer handed over a prototype cast in aluminum and sandblasted. Bo evaluated that they would be able to produce it to a price a little below the price for their old ashtray, which still is being produced. He also judged that there were some technical problems in producing it, but no problems that they could not solve. In fact, one of the reasons why he liked the project was that the ashtray was a challenge, and they could learn something from solving the problems.

We saw right away that we couldn't just produce it, using existing production processes.

(Bo, plant manager)

The ashtray was, on the one hand, a new product that imposed technical challenges, but it was, on the other hand, quite similar to some of the other products they produce. The company has for many years produced another ashtray, and they had been discussing the possibility of producing one that would better fit into their new product line. They had even begun discussing the project with a designer, but the process did not get anywhere, and the designer sold the design to another company in Malaysia. The Dutch ashtray was also attractive to Stainless because it had a lid that kept the smoke in the ashtray, a feature their old product did not have. They planned on selling about the same number as the old one, which is around 15.000 ashtrays per year. They discussed the technical aspects of producing the ashtray, which raised a number of problems:

- The aluminum prototype was made of 3 mm thick goods, which presented a problem, not so much in relation to deep-drawing, but it would simply be too heavy, and too expensive because the material is a large part of the total production cost.
- The old ashtray had rounded edges at the bottom, which is what is obtained from a conventional deep-drawing process. The Dutch ashtray had sharp edges at the bottom, which also imposed a technical problem.
- The biggest problem in relation to producing the ashtray was how to make the two cuts at an 15° angle (see Figure 1, left). It was the most serious problem, because it introduced performing a production process on a three-dimensional object, an operation which was very rare. Stainless produces a bottle opener, where a stainless tube is milled, but this operation is fairly simple and can be made using a simple fixture. Here, the two cuts implied a fairly complex fixture.
- This led to the problem of designing a fixture.

They produced a hand-made prototype in 1.5 mm stainless steel in order to evaluate how the ashtray looked in this material. This was around April 1992. By then they also began specifying the product on AutoCAD. They also experimented with

how to grind and polish the surface. They spent about three month discussing how to make the two cuts. In August they bought a numerically operated manufacturing-cell, and built a temporary fixture. In the meantime, they had been producing thousands of ashtrays using one of the mills in the tool shop. In January 1993 they had designed the final multi-purpose fixture, which they are still in the process of building.

From Material to Product — The Quick Tour

The ashtray is made of special deep-drawing steel. With only two components — the ashtray cup and the lid (see figure 1) — it is not a very complicated product.
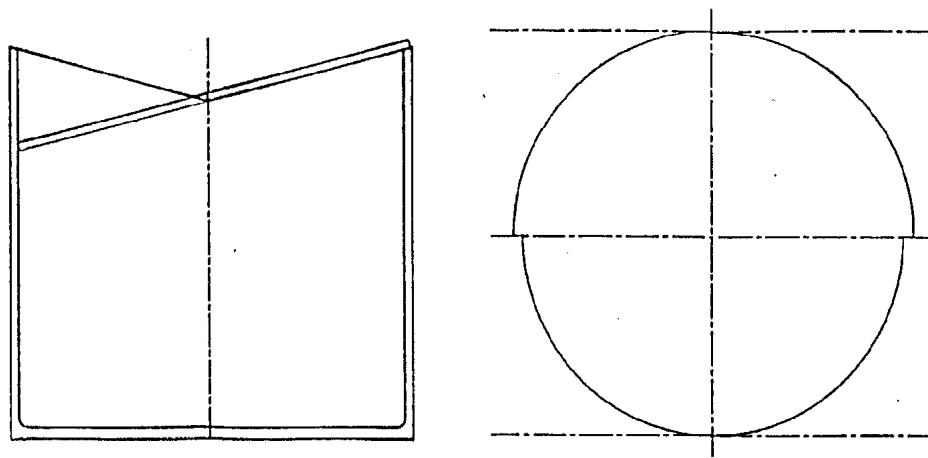
Figure 1: The Revolving Ashtray — 72 x 72 mm. Left: Cup with lid in place. Right: Lid seen from above.

The lid is cut by a laser cutter from large steel plates 1.5 mm thick. After being cut the surface is grinded and polished. The process of manufacturing the ashtray cup from a steel plate is a little more complex, and the 6 main steps are explained in the following:

1 Circular discs are laser-cut from a large steel plate 2.5 mm thick.
2 The discs are the deep-drawn in two steps. Figure 2 shows the cup after deep-drawing. First a piston deep-draws a cup. After the first motion in the deep-drawer, the cup is enclosed on all sides and a piston is forced upwards on the bottom on the cup, in order to force the material to flow out in the corners (Figure 2, R2) resulting in a sharp edge at the bottom and a slightly conic bottom (Figure 2, Ø30). This also implies that the cup does not rock when placed on a surface.
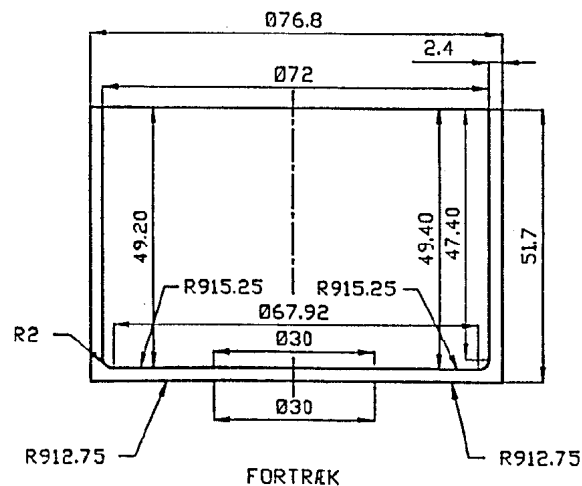
Figure 2. The ashtray cup after it has been deep-drawn from a laser-cut disc.

3 Then the cup is rolled in order to reduce the thickness of the material, and in order to produce a higher cup. The cold rolling mill is adjusted so that the cup is rolled conic on the inside — the wall is slightly thicker at the top than that at the bottom. This is not shown on the drawings.

4 A few millimeters are milled off the top because the rolling process produces cracks in the surface, due to material characteristics of the steel plates. Although two cuts are made at a later stage in production it is essential to mill the top off in order to stop the cracks from getting deeper.

5 The surface of the cup is grinded and polished before sawing and milling in order not to destroy the sharp edges of the cuts.

6 Two cuts in an angle of 15° are made by sawing. Figure 3 shows the finished ashtray cup. In order to ensure a sharp edges and smooth surfaces, the two cuts are milled. It is important that this process results in a tiny notch in which the lid can pivot — marked by the center line on Figure 3.

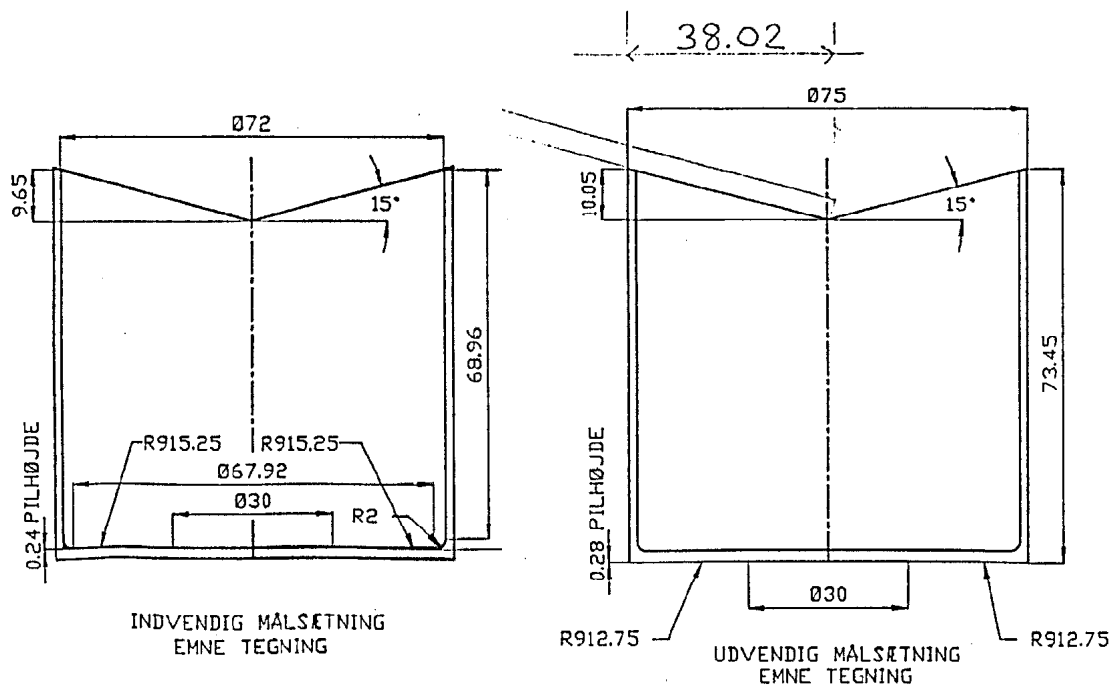7 Finally, the ashtray gets a last polish and is washed and packed.

Figure 3. The ashtray after the deep-drawn cup has been rolled, the top has been milled off, and two cuts have been sawed and milled. Left: The inner measures. Right: The outer measures.

Laser Cutting the Lid

... it was something about when the lid is positioned in the notch, then the upper part of the lid hits the inner side of the ashtray in a 15° angle. It's an ellipse when it's in 15°. And then you needed to move it a little. And then we did that wrongly because we drew the distance from the top and down in 15°, but we totally forgot that the disc is 1.5 mm thick, which meant that the front of the ellipse would be bound to hit the cup a little earlier. It was something like sinus to 15° multiplied with the thickness of the steel and some mumbo-jumbo. And I was a little too slow catching it, and it tricked us a couple of times, also because it coincided with one of the slips when some DXF cutting-file was send to the laser-cutter, and they haven't been cleaning up in their file system, and he just looks on the harddisk and says "but it's right here, I already have it", and immediately cuts 20 and sends them further down the production line. Then they of course didn't fit the ashtray when we got them. Of course you could say that the problem with the 15° angle is logical, and .... well, we don't make that mistake again. But it's one of those where you just forget the thickness of the plate. It's a real trap.

(John, tool shop foreman)

The main problems in relation to designing the lid was a mix of two problem settings:

1   A technical problem of specifying the lid in 2D on the AutoCAD system. When specifying the lid in relation to the cup, they forgot to take into consideration that the lid was 1.5 mm thick.

2   A problem of cooperative nature between the tool shop foreman and the technical assistant on the one hand, and the laser-cutter operators on the other hand. The core of the problem was that there was no consistency in how the laser-cutter operators named the DXF files from AutoCAD, when they uploaded them. This resulted in several lids being cut using a wrong cutting file.

The first problem had not directly anything to do with the cooperative setting. The version of the CAD system they have at Stainless does not support making 3D specifications. The problems they had with the ashtray lid was a problem of producing a 2D specification on the CAD system, of a 3D object. It was, hence, a problem derived from the need to specify the ashtray on AutoCAD in order to be able to use the drawings as mechanisms of interaction in the further cooperation. This, rather technical, problem was then further complicated because the cooperation between the tool shop and the laser cutter operators did not work properly. The DXF files from AutoCAD are uploaded to the laser cutter via floppy diskette. The laser cutter operator then adds on information specific to the cutting process. The core of their problem in cooperating was simply that there was no common standard for naming files.

Susan, the technical assistant has much interaction with the laser cutter operators. They have had some problems, regarding how to interpret the specifications.

> *I've also gone down to the laser-cutters, and said to them "but take a slide gauge and measure it" because sometimes it just doesn't fit. They've just been cutting, and thought "well, that looks fine, it's all fitting". And many times they've been cutting much too fast. The result is a bunch of nasty grates on the backside of the disc. And that's when I've got to tell them that "you have to do something about this!", or I perhaps try to arrange the material a little better on the plate, or perhaps I find a better way of cutting the objects ... I spend a lot of time on that, you know.*

(Susan, technical assistant)

One of the problems they have had is that the specification only shows the lines, whereas the laser-beam is not a line, it has a thickness. This implies that Susan and the laser cutter operators needed to agree on whether they would cut according to the middle of the line, right of the line or left of the line on the specification. The ended up agreeing that she just off-set the drawing with 5/100 mm. Another problem is the speed with which the discs are cut. The DXF file specify curves from a set of discrete points, and if the speed of the laser cutter are not tuned according to the complexity of the object, the objects does not comply with the specification. The problem is, however, that not all these decisions are documented in the specifications. When they then use the specification after a period of time, this agreement might be forgotten.

Deep-Drawing and Rolling a Flat-Bottom Cup

> *The designer had made a cup that had edges right down to the table. He had designed a sharp corner. That we didn't discuss with him ... Technically, that's a problem, unless you take a tube and weld a disc on. But we felt that we damn well could do the job.*

(Bo, plant manager)

The sharp bottom-edge (marked "0.28 PILHØJDE" in Figure 3) imposed a problem in relation to process planning. They had to come up with a solution that would produce sharp edges from deep-drawing. Normally, if a cup is deep-drawn, the edges will be round. Making the ashtray from welding a disc on a tube was not a relevant for two reasons:

1 It is their strategy to minimize the amount of welding, amongst others, because it is a relatively time-consuming, and hence, costly process.

2 If they were to weld a disc onto a tube, it would result in a sharper edge than the one they could get from just deep-drawing the traditional way. The edges would, however, not be as sharp as the design dictated.

The solution was to produce the cup from a two-step deep-drawing process, where they after the first, conventional deep-drawing, enclose the cup on all sides, and applies heavy pressure on the bottom. This results in a slightly conic bottom, and in steel flowing to the edges.

The process of rolling the deep-drawn cup was relatively uncomplicated to plan, but can produce some problems in the daily production. Rolling a deep-drawn stainless steel cup is not an exact science. The basic material used to produce the ashtray cup is deep-drawing steel, DIN 439–4301. The alloys of the deep-drawing steel that is used vary within a margin of 10% from batch to batch. The thickness of the plates are allowed to vary about 8%. This especially affects the rolling process.

> *It's likely that we at some point in time go in and adjust the specification of the ashtray if* [the rolling operator] *repeatedly reports back and says "but I simply can't get them as conical as you want them, or as round as you want them"*

> (John, tool shop foreman)

Cutting The Edges In a 15° Angle

> *.. and they [the plant manager and the process planner] worked themselves into an euphoric state about laser-cutting the ashtray. But as they talked, I sat and calculated "now they are going to spend 150.000 [Dkr] on building it". And I thought "let them go on with it", and we talked some more about it, until we got around to the notch ... and they were about to spend 3–400.000 in their eagerness to get this damn ashtray laser-cut .*

> (John, tool shop foreman)

This was the major challenge when planning the production process. The problem was that the two cuts had to be made while the cup was in a fixture. The surface quality of the cuts was of major importance. The smoothness of the cuts, and the small notch in which the lid can pivot, is important for both the aesthetics and functionality of the ashtray.

The manufacturing plant manager and the process planner had the idea that they could use the laser cutter. This would, however, impose some problems. They had previously only used the laser cutter for cutting discs from steel plates. Using it to make the cuts in the ashtray implied that they had to design a very complicated, and very expensive, fixture. They would also have a problem with the height of the

fixture, and would probably have had to rebuild the motor-driven table that moves the objects under the laser beam. Furthermore, even if they had the fixture, they would need to reprogram the laser-cutter, in order for it to cut smooth edges, and they were not sure about the quality of the result. Laser cutting the ashtray was, however, the predominant solution for a considerable period, and John, the tool shop foreman, was skeptical all the time. He calculated that the whole arrangement would result in an investment on roughly 3–400.000 Dkr. He also knew that he would be the one responsible of getting all the details fixed.

They had also thought about sawing and milling the cuts. The did, however, not have the proper machinery to do so. The first couple of thousand ashtrays were, as a temporary solution, produced in the tool shop. They already milled the bottle openers on the same machine. Then one day he discussed the problem with Bo, and they started discussing the possibility of buying a numerically operated manufacturing-cell. They could then do all sawing and milling on that machine. The result was that they decided to buy the machine, although it was a larger investment. It would, on the other hand, provide much more flexibility in production capability. Building a fixture for laser cutting the ashtray would mean a big loss if they could not sell the ashtrays.

> *And then we seriously started to work on getting the manufacturing cell, and we forgot all about the ashtrays. They were milled in the tool shop in 2, 3, 4000. And there was a wild panic, because it was sheer hell. It takes a long time, and there's a lot of noise, and everybody was mad. I just said "you just shut up now, it's going to be OK", and then I showed them my brochure of the new machine and said "just take a look at our new toy, which we're going to place in the back of the production hall", and SMACK, they all shut up.*
>
> (John, tool shop foreman)

Designing The Tool Fixture

> *... When we were finished with it, and wanted to assemble it, then it looked like a small oil-refinery with fittings and tubes and all. But he bloody wouldn't have that either. He wanted us to drill oil-pipes inside it from all sides. And sitting there with something that was done, and suddenly not able to use the fittings, but instead have to fit oil-pipes into it ... it had something to do with cleaning the fixture, and something about it being more aesthetic. It's more pretty. There's a little more Rolls Royce over it, than Skoda ... and it's right, I can see that now. But for one like me sitting and sweating over it, it's a lot more easy if I just could plant some tubes in the shit and get it out of here in a hurry.*
>
> (John, tool shop foreman)

They had now decided not to laser cut the ashtray, but instead saw and mill it in a manufacturing cell. The problem of designing a proper fixture to be used, however, still imposed a big challenge. Mostly because the fixture that was designed was a far more complex construction compared to the fixtures they had build previously. They produced a temporary fixture that would hold four ashtrays at the time, and began designing a multi-purpose fixture so they could optimize the use of the machine by mixing different products in one fixture. This project was not finished when we conducted interviewed. The problem is primarily a technical one, where

the tool shop foreman and the technical assistant work closely together on implementing Bo's ideas.

> *The typical problem is that I am not an engineer, which I perhaps ought to be in order to do the job I do. I'm a skilled tool-maker, and then I've been acting as wise-guy around here for about 8–10 years. That's my only background. But it all helps. Then again, the grand overview that will help you in big projects so you'll know that if you do this in this end, then that happens in the other end, that I will be quite honest to admit can lack a little. It never happens when we build a deep-drawing tool or a cutting tool, they go right through in no time.*

<div align="right">(John, tool shop foreman)</div>

6. The Organizational Context of an Ashtray

> *... we could just as well all sit down in the same room, when we begin a new project, with the prototype, and discuss it properly. It wouldn't cost us much to use one day one it, if it means that all problems are solved and everyone knows who is supposed to what from the beginning.*

<div align="right">(John, tool shop foreman)</div>

After having presented the case, we will in this section analyze the case from the perspective of organizational context. The organizational context is roughly interpreted as what is, and what is not possible when making and implementing decision that bridges detailed design and process planning. Elements of the organizational context of cooperative work, amongst others, include (see Chapter 1):

- Organizational structures, e.g. working groups, projects, people, departments, etc. At Stainless the most predominant way of arranging cooperative work is informal working groups, with Bo running in front of everyone else and creating new ideas. There are no formal structure of project groups with formalized schedules for meetings etc. The groups that work together on a project are formed in a more or less *ad hoc* manner. In one project they tried to have a few formal project meetings in the beginning of the project where participants from both planning and production discussed the anticipated problems. John liked this procedure, but it was abandoned in other projects.
- Resources of cooperation, e.g. documents, paper, tools, etc. The main resource of cooperation at Stainless is the specifications produced on the CAD system.
- Organizational rules, e.g. access control, procedures for distribution, rules for handling activities, etc. They have few formalized organizational rules. The technical assistant tries to impose some structure on identification codes for components, and for files. One of their problems is that they would like to have a common standard in the whole organization on product-codes. The technical problem that produces a hurdle is that the operating system MS-DOS only allows 8 character filenames. The system that handles inventory al-

ready has a standard for naming products, but it is a system that allows more than 8 characters in filenames.

- Communication media, e.g. face to face, mail, video, etc. Most communication is face to face or by telephone.
- Awareness about organizational progress and status, e.g. who is doing what, what needs to be done, etc. The participants mainly keep up to date about projects by "putting an ear to the ground". Susan mentioned that the production manager is placed a little on the edge of the decision process because his office is not placed right next to the tool shop. When we asked John about when he is told by the ones responsible for quality control when something is not good enough, John replied:

> *"You use the word quality control, but in this house it's called "hearing it from the first guy that detects the error". We do not have a quality control function. The production manager is very keen on the idea that people are aware of what they must do and what they must not do.*

(John, tool shop foreman)

Regarding the organizational setting at Stainless, the "big picture" is relatively easy for the participants to obtain. The organization is relatively small. Especially in relation to developing new products and planning how to produce them, a small number of key-personnel is involved in the decision process. On the other hand, it is clear that the "big picture" is far from sufficient in order for a participant in the project to make sound and good decisions. In relation to dealing with the everyday problems of development projects, it is the small things that matters. Each new project introduces a multitude of detailed evaluations, decisions, and actions, that has to be made based on a deep knowledge and expertise with the constraints imposed by skills, machinery, and materials.

As the main driving force in planning new products, the manufacturing plant manager expresses the problem of evaluating the organizational context in order to decide whether or not Stainless is able of producing a given design:

> *The choice of manufacturing processes are already in my head when I see the product "how the hell am I going to produce this one?" It all takes around 10 seconds or something like that, where I evaluate the possibilities we have. In reality, I have this list in my head, where this process, well, it's over there and that process is over there, and then there's a couple that are a little uncertain, but these are the ones that makes it all exciting.*

(Bo, plant manager)

It is not the overview of the general possibilities and limitations that imposes the biggest problems. Quite on the contrary, when he has convinced himself that they probably are able to pull it through somehow, the interesting and funny part are all the small detailed problems that can not be solved right away. In most cases Bo's initial overall evaluation is correct, but as the tool shop foreman said:

> *... it has something to do with Bo's optimism,. His desire that we're able to produce anything is huge. He just loves when somebody comes around and say "couldn't you ....?", then PANG, he grabs it right away. And sometimes one asks oneself, whether it wouldn't be a better idea to assess whether or not this project is something for us. Sometimes he*

does it all totally according to his own head, and slaves on and on for weeks until it works. And he always makes it work. I don't think I've ever experienced him saying "we give up". Maybe a little in the case of the radio-box. At the end he said "it's not exactly us, this one".

(John, tool shop foreman)

Because Bo has many years of experience, and because of his enthusiasm, he is able to make quite complex decisions based on little information. Because of his skills, he is very well respected among the tool-makers and machine-operators. This means that he can get away with a development strategy that is unstructured, and which implies heavy burdens on the cooperative setting. The lack of formal communication and coordination channels, such as formal project groups with regular meetings implies that the participants mainly obtain knowledge about project status and progress, and coordinate efforts, through direct modes of interaction. One of the prime exceptions from this pattern is emphasized by John, the tool shop foreman, namely the AutoCAD specifications:

A couple of years ago we wrote the specifications on the backside of cigarette packages, or what was available. But if you just make this mean pencil draft, you're bound to forget something. ... If there is some corner that is difficult to make, then Susan can magnify it [using AutoCAD] and put on the 8 measures needed, so the man doesn't need to run around out there and be confused for several days before he has the gismo made.

(John, tool shop foreman)

The AutoCAD drawings are used as mechanisms of interaction to coordinate the manufacturing of production tools, as well as in the production.

When you make tools today, it's not like when they were made 10, 15, or 20 years ago, where one person got the assignment and were told "make this one!". Even if it were a huge one with 411 components. ... What you do is to take out the 7 easy pieces and throw them at the apprentice who just began the day before yesterday. Then he can fool around with them for a while. Then you arrange so the lathe expert does all the turning. The milling expert do all the milling ... and if each of them use their own private tolerances, then the shit is impossible to assemble. Volkswagen can make a car, and it's several thousands of components, and they can screw the shit together so it fits. Then we ought to be able to make a damn tool with only 15 or 20 components, or we couldn't, but we can now.

(John, tool shop foreman)

The drawings minimizes the amount of direct negotiation about what has been decided, and furthermore, provides the tool shop foreman with an instrument of delegating responsibility. John mentions an example, where the rolling mill operator did not adjust the machine according to the specifications, and made ashtray cups that had too large diameter, which resulted in marks on the surface when the cups were mounted in the fixture at the manufacturing cell:

... and he did not work according to the specification, and he couldn't say "I didn't know that", because the drawing was on his desk, under a lot of his own private junk. And that's one of the situations where we say "you could just have looked at your drawings, young man". And then there's nothing to argue about. Otherwise people are world champions in saying "I didn't know that", or "nobody has told me anything about that".

(John, tool shop foreman)

Some of the participants in the decision process find the process of creating and maintaining organizational context in projects to laborious, unstructured and difficult. This is mainly true because it is a fairly small organization where each participant has several areas of responsibility, and because the manufacturing plant manager does not impose a more strict project work structure with project meetings. The plant manager, Bo, plays the role of enthusiastic front-runner, and to a large degree acts as a "master-mind" in design and process planning.

The organizational context at *Stainless* is maintained in an *ad hoc* manner. There is, however, some computer support which provides rudimentary help. The AutoCAD models, amongst others, serve as points of reference for the actors, i.e., as resources of cooperation. It is clear that the cooperative arrangement only works because of the relative small size of development projects, and because of the proximity of the actors. The plant manager is in many respects acting as an omniscient agent. He handles a major bulk of the important decisions. Larger organizations can, however, not rely on the existence of an omniscient agent. Here, the organizational is far too complex for one person, and the maintenance of the organizational context must be performed in a network of distributed agents, hence, making computer support of some aspects feasible.

There has been several efforts in the Computer Integrated Manufacturing (CIM) field aiming at providing designers and process planners with Decision Support Systems (DSS), e.g. the Alvey Programme (Siemieniuch, 1992). A central element in many of these systems are repositories containing, for example, design templates, and manufacture process specifications, providing the decision maker an overview of technical resources. As an example, the repository in the Design to Product demonstrator contains data on: conceptual design, solid modelling, process planning, part programming, assembly planning, robot planning, area controller, DNC machining, and flexible assembly (Siemieniuch, 1992). One of the basic assumptions behind many of these CIM-DSS is that the format of the repository, which is used by a multitude of different users, can be maintained centrally.

The decision process at *Stainless* concerning how to cut the two angles in the ashtray illustrates one of the reasons why these repositories might be unfeasible if they are not subject to local maintenance. The seemingly isolated problem of manufacturing an ashtray were connected with other needs, pertinent to the manufacture of other products. Once these problems were joined, the path was cleared for a more feasible solution, i.e. the purchase of a numerically operated manufacturing-cell. Similar findings have been reported by Anderson *et al*. (1993), who stress the importance of recognizing that: *... in the design process, design considerations must often be subordinated to organizational priorities.*

Conclusion

We have in this paper presented the results from a case study at *Stainless*, a Danish manufacturing company. The organizational setting has been presented, and the

technical problems in the Ashtray project, which we focus on, were discussed in detail. The Ashtray project was used as a background for discussing the organizational context of development projects at *Stainless.*.

The concept of organizational context is very broad and generates a host of difficult research questions. The aim of this paper has been to present end interpret the results from a case study in a manufacturing organization. The case is not representative for organizations needing computer support for handling the complexity of the organizational context. It is, however, a prototypical case of the limits for handling problems regarding the organizational context in an *ad hoc* manner. It was, furthermore, concluded that the plant manager to a large extent defined the organizational context of projects.

This initial case study are followed by an analysis of an organizational setting very different from *Stainless*. This organization, which is currently being studied, is much larger than *Stainless* — approximately 400 employees. The projects typically involves 40–60 people, and the products consists of around 8000 parts. We hope that two fundamental different cases can provide interesting insights regarding the diversity of organizational contexts in different settings and, hence, provide a sound basis for designing tools supporting different aspects of cooperative work, e.g., organizational context and mechanisms of interaction.

References

Anderson, Bob, Graham Button, and Wes Sharrock (1993): Supporting The Design Process Within An Organisational Context. In *ECSCW '93. Proceedings of the Third European Conference on Computer-Supported Cooperative Work, Milan*, ed. Giorgio de Michelis, Carla Simone, and Kjeld Schmidt. Kluwer Academic Publishers, pp. 47–59.

Benbasat, Izak, ed. (1989): *The Information Systems Research Challenge: Experimental Research Methods*, vol. 2. Boston Massachusetts: Harvard Business School Research Colloquium Harvard Business School.

Borstrøm, Henrik (1993): Design For Fabrication — A Proposed Definition? In *Approaches to Integration in Manufacturing — Proceedings of the eighth IPS Seminar, Fuglsø, Denmark*, ed. Jens O. Riis. Institute for Production at Aalborg University, pp. 43-56.

Bucciarelli, Louis L. (1984): Reflective practice in engineering design. *Design Studies*, vol. 5, no. 3, pp. 185-190.

Bucciarelli, Louis L. (1987): *An Ethnographic Perspective on Engineering Design*. M.I.T., Cambridge, Mass.

Cash, James I. and Paul R. Lawrence, ed. (1989): *The Information Systems Research Challenge: Qualitative Research Methods*, vol. 1. Boston Massachusetts: Harvard Business School Research Colloquium Harvard Business School.

Christensen, John and John Clausen (1992): *Produktudvikling, planlægning og produktion i dansk industri 1992 [Product Development, Planning, and Production in the Danish Manufacturing Industry 1992]*. Technical Report — Questionnaire study Institute of Manufacturing Engineering, Institute of Industrial Engineering and Production Management, Technical University of Denmark.

Gunn, Thomas G. (1987): *Manufacturing for Competitive Advantage. Becoming a World Class Manufacturer*. Cambridge, Mass.: Ballinger.

Hansen, Poul H. K. (1993): *Integration som en ledelsesparameter — en model af objekter og mekanismer for integration [Integration as a Management Parameter — A Model of Objects and Mechanisms of Integration]*. Ph.D. Dissertation, Integrated Production Systems.

Harrington, Joseph (1979): *Computer Integrated Manufacturing*. Malabar, Florida: Krieger.

Harrington, Joseph (1984): *Understanding the Manufacturing Process. Key to Successful CAD/CAM Implementation*. New York: Marcel Dekker.

Haudrum, Jan (1993): *Process Selection in Design — State of the Art*. PI.93–02–B. Institute of Manufacturing Engineering, Technical University of Denmark.

Helander, Martin and Mitsou Nagamachi, ed. (1992): *Design for Manufacturability — A Systems Approach to Concurrent Engineering and Ergonomics*. London: Taylor & Francis.

Kaavé, Bjarne (1990): *Undersøgelse af brugersamspil i system til produktionsstyring [An Investigation of End-User Participation in Development of a Production Planning System]*. M.Sc dissertation Technical University of Denmark.

Kraemer, Kenneth L., ed. (1991): *The Information Systems Research Challenge: Survey Research Methods*, vol. 3. Boston Massachusetts: Harvard Business School Research Colloquium Harvard Business School.

Lenau, Torben (1992): Manufacturing Constraints in Concurrent Product Development. In *Integrated manufacture and Design: The IT Framework, Heathrow, London*. UNICOM, pp. 45–55.

Mason, Richard O. (1989): MIS Experiments: A Pragmatic Perspective. In *The Information Systems Research Challenge: Experimental Research Methods*, ed. Izak Benbasat, vol. 2. Boston Massachusetts: Harvard Business School Research Colloquium Harvard Business School, pp. 3-20.

Patton, M.Q. (1980): *Qualitative Evaluation Methods*. USA: Sage Publications.

Rindom, Ole (1992): Design of a computer supported cooperative work system in an integrated production environment, based on field studies. In *Design for Manufacturability — A Systems Approach to Concurrent Engineering and Ergonomics*, ed. Martin Helander and Mitsou Nagamachi. London: Taylor & Francis, pp. 339-360.

Schmidt, Kjeld and Peter Carstensen (1990): *Arbejdsanalyse. Teori og praksis*. Risø-M-2889. Risø National Laboratory, DK-4000 Roskilde, Denmark.

Siemieniuch, Carys (1992): Design to product — A prototype of a system to enable design for manufacturability. In *Design for Manufacturability — A Systems Approach to Concurrent Engineering and Ergonomics*, ed. Martin Helander and Mitsou Nagamachi. London: Taylor & Francis, pp. 35-54.

Sinclair, M. A. (1992): Human factors, design for manufacturability and the computer-integrated manufacturing enterprise. In *Design for Manufacturability — A Systems Approach to Concurrent Engineering and Ergonomics*, ed. Martin Helander and Mitsou Nagamachi. London: Taylor & Francis, pp. 127-146.

Sørensen, Carsten (1993): A Study of the Introduction of CASE Tools. In *Introducing CASE Tools into Software Organizations*. Aalborg: Department of Mathematics and Computer Science, Aalborg University. Ph.D. Dissertation, pp. 15–44.

TOSCA
Providing organisational information to CSCW applications

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Most cooperation support systems require information about the organisational context in which they are used. This is particularly required when systems are used in a large organisation or for the support of inter-organisational cooperation.

Following from this requirement, this paper presents the design and functionality of an organisational information system for cooperation support systems that has been implemented as a working prototype. The system presented here is composed of two major components: an organisational information base server, which provides services to applications and an organisational information browser, which provides direct user access.

The paper describes the motivation for an organisational information system, the object oriented data model that is used for the information representation, the architecture of the overall system, and the design of the user interface that presents and provides access to the multimedia information. It concludes with the description of how this system supports a task management system and the role it would play in a CSCW environment.

1. Introduction & Motivation

The overall aim of the TOSCA[1] system presented in this paper is the representation of knowledge about organisations and their resources which are relevant for the support of communication and cooperation. Major issues of the system are:

• provision of organisational context information

Cooperation in teams and organisations is always embedded in an organisational framework. This requires the provision of information about the organisational context in which users work which helps to choose the right patterns for communication and cooperation. Information must be provided to answer questions such as: Who is responsible for carrying out a specific task? Whom can I ask for help? Furthermore the system should provide information as to how particular tasks are handled in the organisation. What are the organisational rules one has to consider? Whom do I have to ask first? Which document type do I have to use? All this information belongs to the knowledge which is normally not or only very implicitly provided by CSCW applications, although it plays a significant role in cooperation.

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[1] The organisational information system for CSCW applications

• distributed provision of directory information

Communication requires reachability information about the cooperating partners. This includes communication addresses as well as information about reachability and preferred communication methods. Most applications tackle this by providing simple address directories, which are often not distributed and furthermore can not be shared between different applications. So, in the worst case, each user manages his own directory for each cooperation support application he is using. It is one of the aims of the organisational information system presented here to overcome this problem by providing and integrating a distributed directory service to applications and users.

• integration of standardised external resources

An approach chosen in [HeKE93], which we also have investigated [PrPe92], is the application of the X.500 Directory. X.500 has been standardised by CCITT and ISO as a standard for a world-wide electronic address book [X.500]. With its potentially world-wide distribution, its methods for distributed management, and its standardised service interface, it fulfills the requirements for a distributed address directory and scaleability. However, shortcomings arise when the directory is applied to a more detailed modelling and administration of organisational information. Major problems deal with the representation and modelling of organisational relationships and data integrity. Nevertheless, in order to benefit from the existence of X.500, we found it important that TOSCA integrates access to the X.500 world.

• integration of cooperation resources

Comprehensive cooperation support benefits when the resources for cooperation support such as documents, calendars, structured message types [Pank89, MaFL92, Bore92] can be integrated with the context in which they are used. The advantage of TOSCA is that it is more than a storage server for this information. It allows the association of this information to its organisational context, i.e. by linking it to the projects, departments, etc. where they are used or to the people who use it.

• support for scaleability

Organisational information is of particular importance in large geographically distributed organisations and for the support of inter-organisational cooperation [Enge90]. This raises the aspect of scaleability which we see as a crucial issue for the success of CSCW applications. From the administrative viewpoint it must be easily possible to extend the number of users of an application. This requires an underlying distributed service environment which provides a set of common services needed by cooperation support service. The organisational information service presented here is one fundamental component in such an environment. As a

support service it simplifies the introduction and use of new applications into the working environment and this may increases the acceptance of these services [MaCo90].

• visible and user tailorable model

We aimed to develop a flexible data model that allows an adaptation of our system to various organisations. This is required, because organisations change and it is impossible to develop a single representation that fits all considerable organisations. For that reason an object oriented approach has been chosen. Together with the provision of an object modelling tool TOSCA provides visibility of the concepts and allows users and groups to tailor the object model to their specific need.

This paper is organised as follows. First we will present the data model for the representation of organisational information. The design of an organisational browser is described afterwards, showing three different scenarios of use. Then, the architecture of the system is presented followed by an examination how the system is integrated into a larger CSCW environment. The paper concludes with a brief description of future plans and a summary.

2. A Data Model for the representation of organisational information

2.1. General considerations

Before we explain our data model we should define what we understand by organisational information. We consider organisational information to be information about the entities of an organisation that determine and describe the working context of users. This includes information about the employees, projects, roles, committees, departments, locations, etc. of an organisation. Furthermore, the resources of cooperation such as documents, calendars and other kinds of commonly used data must be considered. In order to provide helpful information on how to perform tasks in an organisation, the system needs to represent guidelines which can be used as resources for planning and carrying out a cooperative activity.

All these discrete bits of information become expressive only when they can be related to each other. Therefore we need ways to describe organisational relationships such as: who is member or leader of a project, which projects are undertaken by a particular department, who is the projects secretary, who is occupying the role of the technical administrator of a special file-server, or who supports which task, or which forms do I need to apply for an organisational procedure? It is also necessary that these relationships can be defined in a dynamic way according to the organisational rules. For example, if a committee consists of the members of the projects of a department, we do not want to list all these people explicitly as would be required in X.500, but we want to express this by an appropriate rule. This reduces

redundancy, management overhead and increases consistency when the information is changed.

These requirements and the fact that we wanted to develop a system that is extendible and tailorable to different organisational settings led to the decision to choose an object oriented model for the representation of the organisational information.

The meta object model distinguishes between organisational components and relationships between these entities. Two different basic object types are defined for the representation of organisational objects and organisational relationships. Based on these basic object types a comprehensive set of subtypes for the specific representation of organisational information is defined. The definition of a type requires the specification of several properties each instance of the type must fulfill.

All organisational objects and relationships inherit from basic types which implement the required methods to access and manage object instances. Additional methods can be added for subtypes if needed, but this requires programming which is not expected to be done by end users. Therefore we will focus only on the structural and not on the functional issues of the object model.

2.2. Model of an organisational object type

Organisational object types are used to define a schema for the representation of organisational components. Such a type is specified as follows:
- type name & super type
- corresponding X.500 object class name
- scope of type definition
- textual description of the type
- user friendly name construction rule
- graph layout description
- mandatory and optional attributes
- mandatory and optional relationships

The **type name** is a unique identifier which should describe the semantics of the type. The model provides single inheritance, i.e. one **super type** must be identified.

If available, the name of the corresponding **X.500 object class**[1] can be provided This information is used to map X.500 entries which have been retrieved from the Directory onto the appropriate object type in the organisational data model.

Assigning a **scope** to a type restricts its use to a special organisational context, e.g. a project or group. For example, the usage of a type can be restricted to the context of a group which avoid type clashes and a proliferation of types throughout the whole distributed system. However, users must be aware that it might also hinder cooperation.

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[1] The notation X.500 object class corresponds to the notation of an object type in our object model.

The name of an object is often not expressive or user friendly enough for its use in a user interface. Therefore a construction rule for a **user friendly name** can be supplied for an object type. This name can be built by a combination of attributes as well as by retrieving information from objects that this object is related to.

To supply a description of the context in which an object is embedded it is very helpful to provide a graphical view. A **graph layout description** is used for the creation of organisational charts which describe the organisational context of a focused object.

The object model distinguishes between **mandatory and optional attributes** of an object type. Attributes can be basic data types but they might also contain picture, audio or video information (see the section on the user interface). Furthermore attributes can contain expressions which are evaluated on access. These expressions are used to refer to other objects, to express general rules, or to generate a value from others.

Relationships between organisational objects are represented by objects of a special relationship object type. Like attributes, relationships can be either mandatory or optional.

In the past, approaches to model organisations were mainly undertaken in the context of organisational science for the analysis of organisations [Heil88], or for the planning and support of office procedures [ViSo91, Rupi90]. Although these systems do not address all the specific issues of TOSCA, our object model has been influenced by their investigations in organisation modelling. A full description of all object types that have been defined for our prototype system is not possible in the framework of this paper. Therefore an overview of the object model is given by the type hierarchy in the following figure.
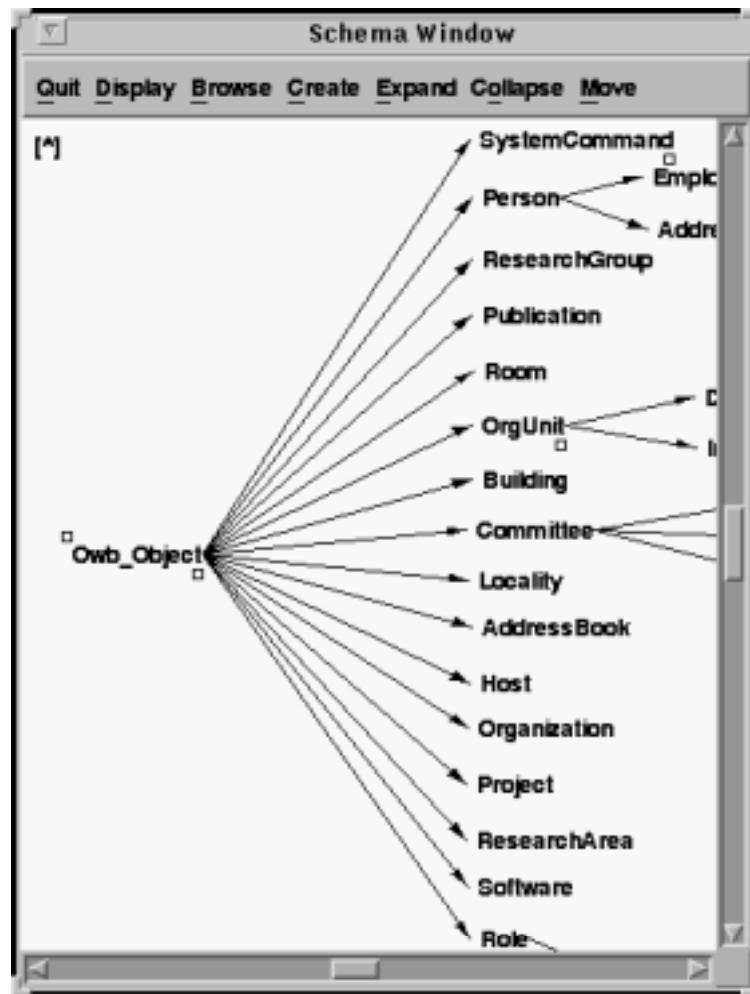
Fig. 1: partial view of the organisational object model

The types shown have been used to model our organisation (GMD). During this exercise we found it very useful to be able to change the object model on the fly. This allowed us to react immediately to new requirements which where raised during data acquisition. The same experience was made when the system was used as a demonstrator for other organisational settings.

2.3. Specification of an organisational relationship type

The organisational relation object type has the following characteristics:
- type name & super type
- corresponding X.500 attribute name
- relation identifiers
- value set attributes

Type name & super type are same as for the organisational object type.

If available the name of the corresponding **X.500 attribute type name**, is used to map X.500 attributes which have a distinguished name syntax, i.e. which point to another entry onto the appropriate relation object type and vice versa.

A relation object describes a relationship between two organisational objects. Depending from which entity the relationship is viewed, it needs to be denoted differently. For example a project membership relation between a project and an employee object is called "has members" from the project view, but "is a member of" from the employees view. These identifiers are called **relation identifiers**.

Relationship object include two **value set attributes** (source and destination) which contain the description of the related organisational objects. These objects can be described by naming them or by expressions which allow for a dynamic description of the relationships. These expressions allow the description of organisational rules such as: voting members of this committee are the project leaders of all projects of the department. Also, they can be used to reduce redundancy by describing rules such as: employees of this institute are the members of all projects of this institute. Furthermore it is possible to define user dependent rules. This is needed for example, when the person who is responsible for a task, depends on the users membership in a project. In this case the actual user identity is needed to answer a request.

The following figure presents a partly view of the relationship object model that has been defined in the TOSCA prototype.
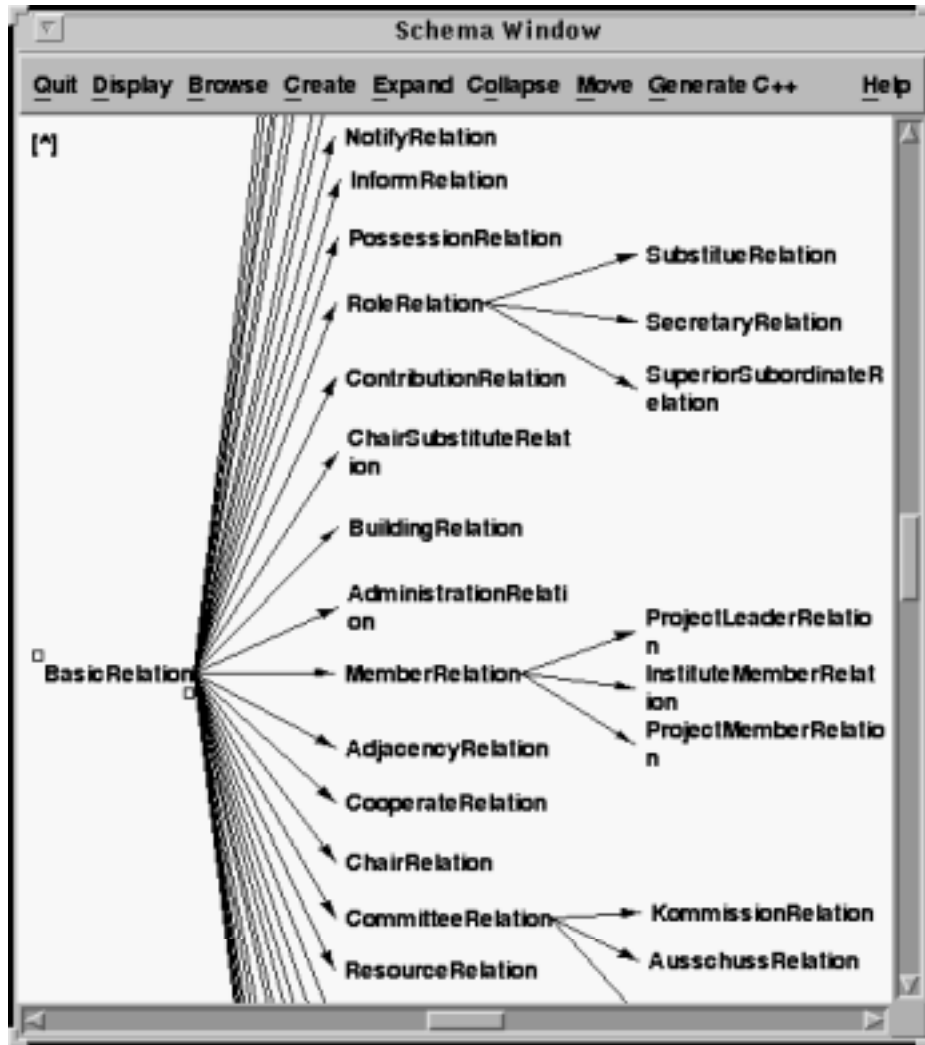
Fig. 2: partial view of the organisational relation model

2.4. The object model designer — creating and extending the object model

The meta object model was designed to be tailorable to various organisational settings. For that purpose, a window-based object model designer has been realised. Fig.3 shows a part of the interface which allows the modification of an organisational object type.
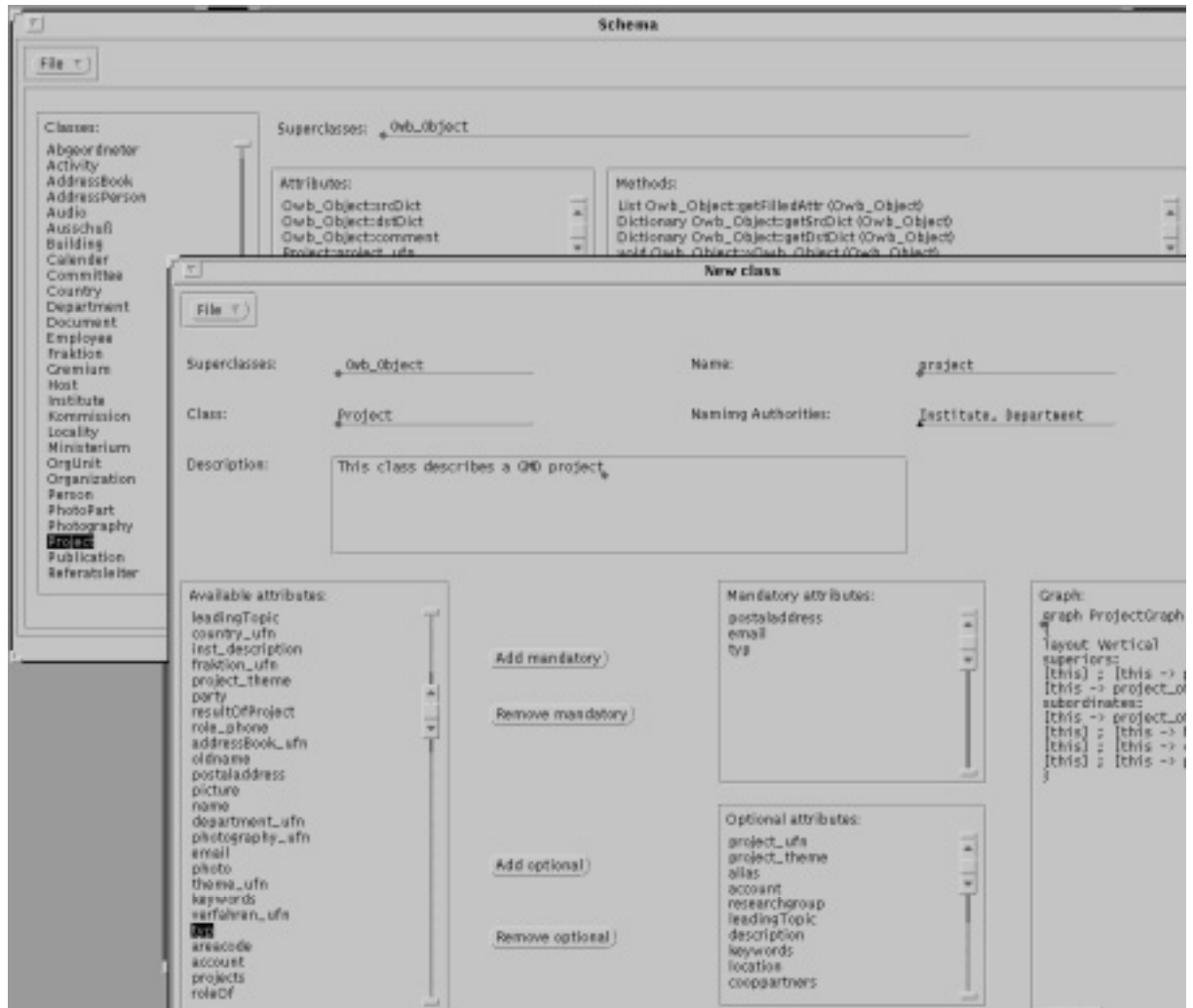
Fig.3: Partly view of the object model designer, displaying a window that allows the modification of an organisational object.

Administrators are allowed to create and modify the object types which are used to represent the basic organisational components such as project, department, etc., i.e. which are needed for the structural modelling. Users are allowed to extend the model by definition or subtyping of types which are relevant for their local or cooperative work. For example these are types for the storage of addresses, or for the representation of shared working resources such as texts or notes.

An interesting application of that functionality is the definition of message type objects similar to the approach of semi-structured messages presented in [Pank89, MaFL92]. Members of a project might define their own message types which are used to exchange meeting dates, automatic generated notes, etc. To support such applications the object model defines some basic message object types which can be subtyped for further purposes. Although this approach is comparable to the one taken by the Oval system [MaFL92], the difference lies in the fact that our system allows the association of these message types to an organisational context, e.g. a

project or a committee. This scoping of object types helps to avoid a proliferation of types throughout the whole system. Supplementary solutions for that problem can be found in [John92, LeMa90].

Although the system has not been primarily designed for that purpose, the facility of a user tailorable object model combined with automatically generated forms, makes the system applicable for a simple emulation of cooperative hypermedia applications [HaWi92]. The additional advantage is that our system allows an association of such documents into their organisational context, e.g. a hypermedia document can be easily linked to the appropriate project in which it was produced. Thus, organisational context information is augmented with working resources, and vice versa the resources are linked to their originating context. This provides access to the information via different associations.

3. The Organisational Information Browser

3.1. Introduction

The organisational information browser provides user access to organisational information. Three major patterns of cooperative work are supported. First, it allows access to and multimedia presentation of organisational information Second, the interface integrates different communication media to support ad-hoc communication. Third, in combination with a task management system, it provides means for the planning, instantiation and coordination of cooperative tasks.

3.2. Querying and presenting organisational information

Cooperation requires information about the cooperating partners. This ranges from simple address and technical reachability information to their organisational context which helps to choose the right patterns for communication and cooperation. It is furthermore very comfortable, when the resources of communication are integrated and can be accessed in the same way. This section describes how that information is presented by the interface and how it can be accessed.

The interface allows browsing and searching for organisational information and tracing of organisational relations via a graphical window interface. As well as text information the interface is able to present different media which is represented in the information base: graphics used for maps and the presentation of organisational hierarchies, relations, procedures and rules; photos (people, groups, buildings, rooms), audio (explanatory text) and video (video demonstrations of software, presentation of public services, etc.).

Normal user interaction starts with a window that provides browsing and querying functionality, as well as means for an easy switching between both search methods (figure 4).
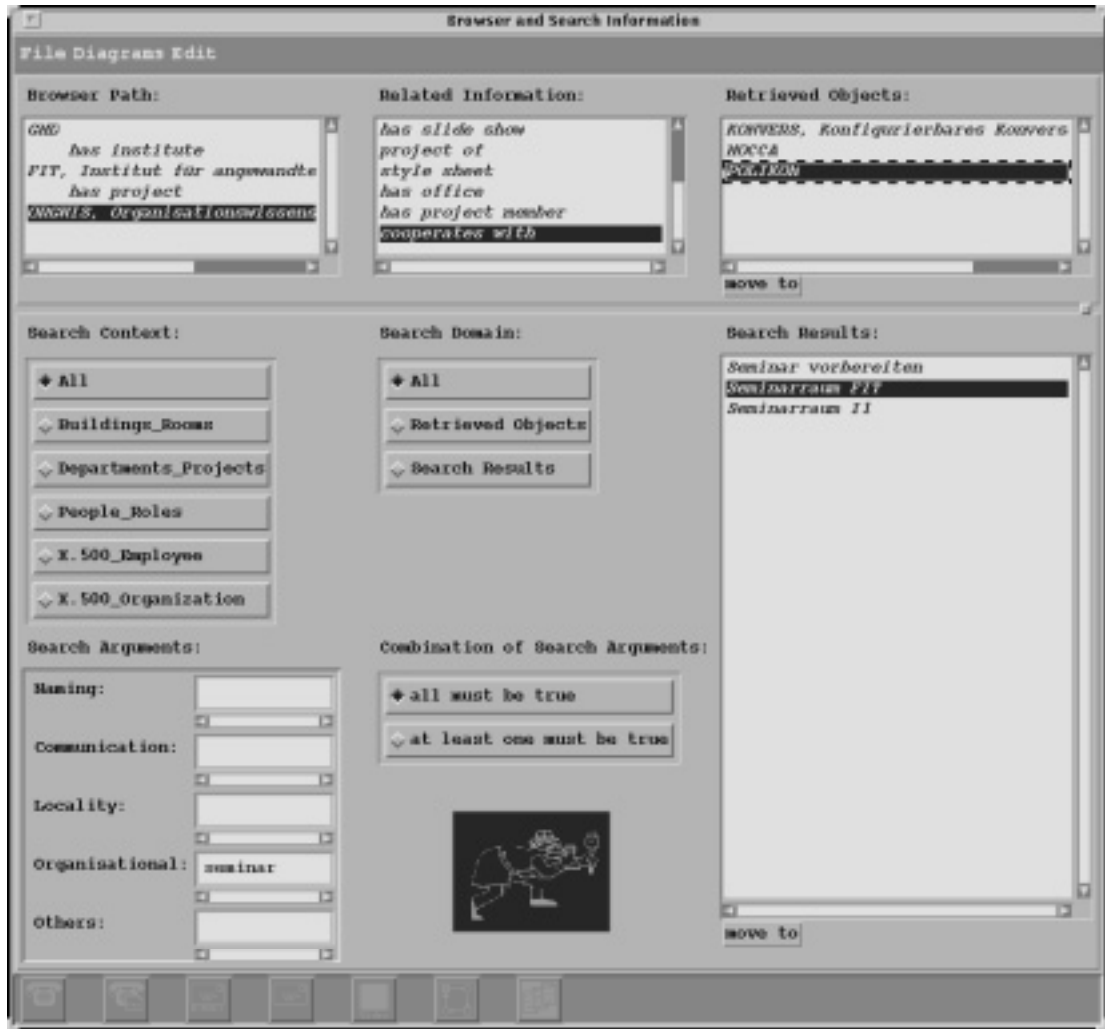
Fig. 4: The browser and search window

A set of predefined windows for the display of particular object types and their organisational interrelations has been implemented. In addition, for those which don't have a special presentation a generic window is displayed that is automatically generated from the object's type information. This reacts flexible on model extensions done with the object model designer presented above.

The whole system is realised as a hypermedia interface. Thus, whenever information is displayed which refers to another information object, this can be immediately retrieved by a user action. That allows manifold ways to access and browse through the organisational information, but it also expresses the various relationships which exist.

Using the mapping information provided as type information for each object the user interface is also able to display objects which have been read from X.500 directory. This is useful for example, when an international project description contains references to members which are not stored locally but represented as entries in the X.500 directory. Thus, the administration of that information is done re-

motely by that person, while we still have access to it. This reduces redundancy and guarantees actuality. This external information object is viewed like an internal one. Of course, the user sees a difference in the richness of the data, because X.500 doesn't provide the same amount of data and relations as our system.
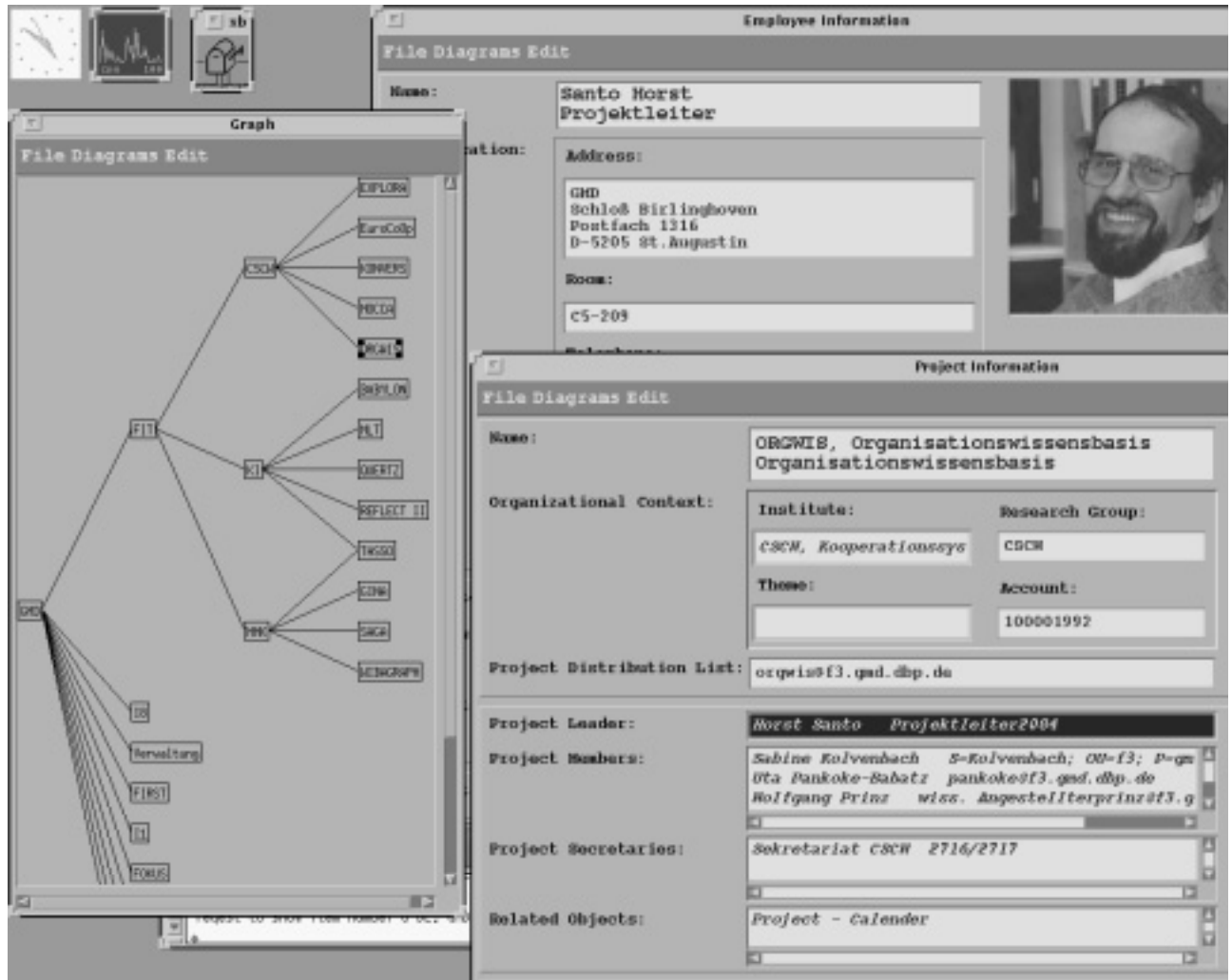

Fig. 5: Windows displaying partial information about a project , an employee and a graph that displays the organigram for the project and its supervising institute.

For getting an overview on an organisational object and its relationships a graph can be displayed. This is typically an organigram that shows an object in its organisational context. Figure 5 shows a graph for an institute. The graph shows the research groups and projects of this institute, as well as the other institutes of the organisation. It is generated interpreting the object types graph description. The graph can be used for further browsing, i.e. by selecting any of its entries the appropriate object is displayed.

When pictures or maps are used to represent information, they can be used for browsing, too. Linking a picture object by special relationship objects to other ob-

jects, areas of a picture become sensitive, so that additional information, e.g. a more detailed map, or text information is displayed when this area is selected. Audio information can be used to give an online description of a picture.

Cooperation support systems and their user interfaces can not be treated as closed applications. Integration and interworking with other applications must be possible [Enge90]. In our system this has been achieved via object adapters for external applications or data. By that technique we have integrated calendars, document editing systems, etc. into our organisation browser. This allowed us to turn the information system into a kind of general desktop interface that groups the working resources of a user according to his organisational context (private and project calendars, project papers and documents, etc.).

3.3. Support for ad-hoc communication

For the support of immediate communication with partners or about resources that have been identified it is very important to integrate communication support applications. Currently we have integrated mail and a broad-band video-conferencing tool that has been implemented locally. So, when appropriate, a user can send mail to a person he has just retrieved, or start a video conference with a partner without launching another application first. The system provides information about the communication partners preferences as well as their technical infrastructure. This helps to avoid unsuccessful contact approaches and delays. Obviously, this will not replace the standalone communication applications, but the idea is to provide a stronger integration of these applications also into other applications which deal either with resources that can be communicated or with communication partners.

Fig. 6: A video conference has been launched in which a video is shown to the communication partner.

Figure 6. gives an example for a scenario which illustrates the integration of video-conferencing with the browser's ability to manage and present video clips. A user has started a video-conference with a partner he retrieved using the browser (upper left window). Then, he selected a project video from a project entry (lower right window), which he is now transmitting in the conference. The video is retrieved from a video tape which contains a set of video clips. It is controlled remotely by our application using time coordinates which are stored for each clip in a video entry. This scenario exemplifies the benefits received by the integration and support of a video-communication tool with the organisational information system.

For each object that is displayed a simple white board functionality is provided. This allows users to communicate on information they have found in the system. For that purpose, comments can be patched on each object (similar to yellow post-it notes). These comments can be viewed, added and modified by all users. It can be used to leave useful experiences or to express problems for other users who lookup the same information. It can also be used as by a group of users who start a dis-

cussion about an information object, e.g. about possible extensions on a service that is described, or about informal work-arounds for organisational procedures. With that functionality a communication and discussion tool is directly integrated with the context of discussion, i.e. with the information and its organisational context that caused the discussion.

3.4. Support for cooperative tasks — application by a task management system

TOSCA provides means to describe how tasks or procedures can be carried out in an organisation or in a group. This is represented in task template objects. Fig 7 shows the display of a task template that describes a workshop preparation.

Fig. 7 A task template that describes how a workshop preparation is carried out.

The representation of task templates has been adapted from a model that has been developed by our local partner project at GMD [HeKE93]. A task is described in an outliner format. This allows the description of major and subordinate tasks. For each single task it can be specified who can support that task or who is responsible to carry it out. Furthermore, resources can be associated to each task, such as documents, forms, calendars, etc. This is done by appropriate relationship objects. These are described user specific. Each user gets individual information about the people who are responsible or the forms which are valid for him. Thus,

TOSCA represents abstract templates which are interpreted and individualised on retrieval.

We would like to stress that the task templates are understood as resources for users to develop their own plan. They are not intended as a prescription how a co-operative task should be carried out [RoBa91].

Task lists can be interrelated, so that users are informed about alternatives or related templates. This increases the visibility of organisational procedures [Schm91]. The white board functionality can be used to comment on work-arounds or experiences one has had in carrying out a task.

Although this information is already very useful as a resource to initiate and carry out a cooperative task, it becomes more useful when it can be transferred into a system that supports its coordination. That integration has been realised with the task management system in the framework of the ASCW prototype [Ho91]. Users can export a task template from TOSCA and then import it into their personal task list. This is convenient for routine task descriptions and it helps when the user carries out a task for the first time. Then the distributed execution of that task is supported by the task manager. In the further process TOSCA is used for address lookup, to resolve role descriptions when administrative offices are involved, or to look for substitutes, etc.

4. Architecture & Implementation

TOSCA consists of two major components, an organisational information server and the organisation information browser. The server stores and manages the organisational information objects and relations.
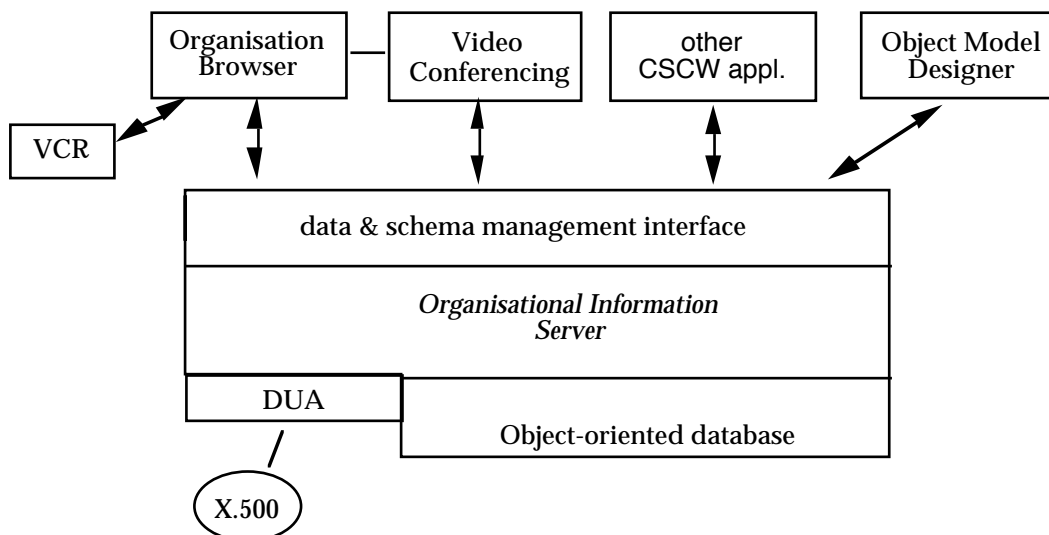

Fig. 8: Architecture of TOSCA

The server is realised on top of a distributed object oriented database (Ontos). Access to the X.500 world is provided by an integrated directory user agent. All requests for external information are forwarded to the X.500 service. References from the organisational information to X.500 information are automatically resolved. Entries retrieved from X.500 are translated into the internal object schema.

The server provides a data and a schema management application interface to applications. These interfaces are used by the organisational information browser, the object model designer, by communication and cooperation support services .

The whole system has been implemented in C++, using GINA [SpBe91] as an interface toolkit, and Quipu [Kill89] for the X.500 directory components. The server contains currently appr. 750 organisational objects and 600 organisational relationships which are used to represent parts of GMD.

5. Integration with a CSCW environment

With TOSCA, we have developed a system for the support of CSCW applications. However, a comprehensive support requires the provision of additional underlying services among which an organisational information service plays an important role. This is illustrated in the following figure showing the relationships between the developments from e-mail services to CSCW systems and the required supportive services starting from a directory service and ending with a CSCW environment in a simplified way.
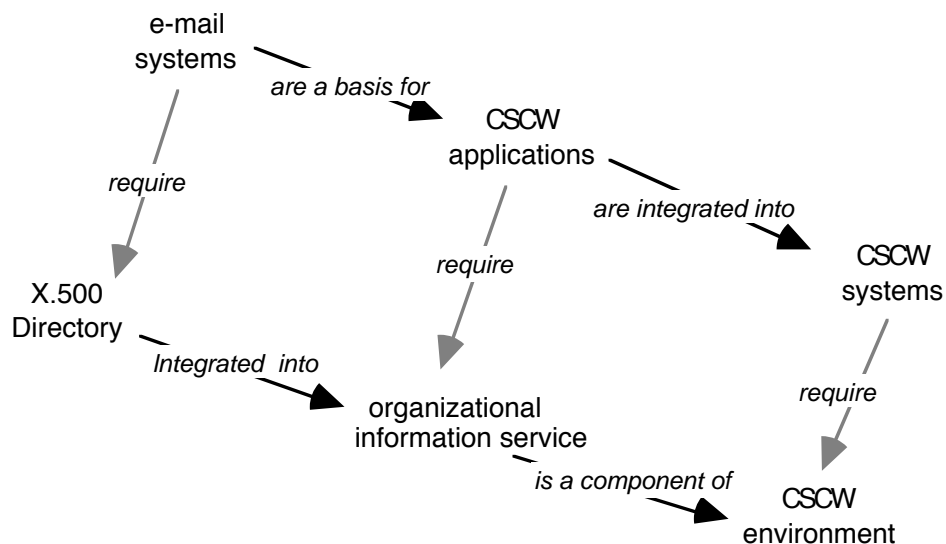

Fig. 9: Relationships between cooperation support applications and supportive systems

As a member of CO-TECH[1] project Mocca [NaPR92] we are working on the requirements and design of a CSCW environment. That environment aims to provide a platform for the support, integration and interworking of CSCW applications.

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[1] CO-TECH is a basic research action aimed at establishing a Europe wide CSCW community.

Five views on cooperative work have been identified: information, organisation, workspace, distributed architecture, and a rooms metaphor. For the first three views models have been developed while the others lead to the design of an architecture and a virtual world. The organisational model presented in this paper has been chosen as the model for the organisational view.

Integrated into a CSCW environment, the organisational information service provides a set of services to the other components. To list the major ones:

- Distributed environments require a unique naming and addressing scheme that allows the identification of objects. This naming scheme is provided by the organisational information base for the other environment components.

- Workspaces are used to model shared working areas for groups of people. The definition of a workspace includes the specification of its relation to the organisational context in which the work takes places, e.g. the members of the workspace, a project for which the workspace is created, etc. Since all that information is already present in the organisational information server, no additional information needs to be provided and furthermore access rights or other organisational rules can be automatically derived from the policies described for the members context.

- The virtual world user interface requires an underlying system that provides information about the topology of rooms, access and constraints on rooms, the tools and resources available in rooms, etc. This information is represented in the OIS. It comprises both, the representation of real rooms, buildings and locations and of virtual ones.

6. Open aspects and future work

Our first prototype will be extended by a more powerful user interface for the distributed administration of the organisational information. Our concept for future developments will allow a distributed administration of the information by users and administrators, since it would be wrong to assume that the whole information base is administered by a single organisation expert. This will be based on the description of access rights and responsibilities. Using these rules, objects will automatically request update-information from the appropriate administrator when they are newly created or when inconsistencies are detected.

Another interesting aspect is the provision of awareness about changes in the organisation. This will be realised using an eventing concept. Modification of objects which reflect changes in the organisation will produce events of different types. Based on the event type an event is then forwarded along appropriate organisational relationships to other objects which then can react on this. For example: The creation of a new employee object in a department produces an event that is forwarded as an informal notification mail to all other employees related to that department while it will also produce a request for the e-mail administrator to install a new ac-

count. Or, changing a task template description leads to a notification of all people who are involved.

This work will be partly carried out in the framework of the Esprit Basic Research project COMIC[1]. In the long term, our aim is to extend the organisational information service to a general CSCW object service in the context of the Polikom programme.

7. Summary

This paper presents the motivation, design and realisation of an organisational information service for the support of CSCW applications. We believe that such a service is a fundamental service in a CSCW environment which provides common services to other applications and serves as a helpful information service for users in their cooperative work. To summarise:

- the system allows the representation of the organisational context for the support of:
  - applications for cooperation support
  - users as an information and cooperation support service
- it provides and integrates different communication media and facilitates ad hoc communication
- it represents task descriptions as resources for cooperation support of users and applications
- it provides a visible and user tailorable object model and thus allows an adaptation to various organisational settings.
- it provides an integrated access to the internationally standardised X.500 directory service
- in order to provide the best possible representation of information, the system is capable of handling multimedia data

The application domain for such a service are larger organisations as well as the support for inter-organisational cooperation which becomes more relevant for CSCW in the future. That requires scalable systems on the underlying support and application level. Our design decisions to realise a tailorable, flexible object model, to integrate X.500 access, and to base our implementation on a distributed system makes the system scalable to a large extend. In addition its use by other applications will also simplify their scalability and technical integration into an organisational setting.

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[1] Computer-based Mechanisms of Interaction in Cooperative work.

8. Acknowledgements

9. References

[Bore92]   Borenstein N., "Computational Mail as Network Infrastructure for Computer-supported Cooperative Work", Proc. of CSCW ´92 conference, Toronto, ACM, 1992, pp. 67-74.

[Enge90]   Engelbart D., "Knowledge-Domain interoperability and an open hyperdocument system", Proc. of CSCW ´90 conference, Los Angeles, ACM, 1990, pp. 143-156.

[HaWi92]   Haake J., Wilson B., "Supporting Collaborative Writing of Hyperdocuments in SEPIA", Proc. of CSCW ´92 conference, Toronto, ACM, 1992, pp. 138-146.

[Heil88]   Heilmann H., Sach W., Simon M., "Organisationsdatenbank und Organisationsinformationssystem", in Handbuch der modernen Datenverarbeitung, 1988, 119-129.

[HeKE93]   Hennesy, P., Kreifelts, Th., Ehrlich, U. "Distributed work management: Activity coordination in the EuroCoOp project", *Computer Communications*, to appear 1993

[Ho91]   Hoschka P., "Assisting Computer — A New Generation of Support Systems". in Brauer, Hernandez (eds.), Verteilte Künstliche Intelligenz und kooperatives Arbeiten, Porc. 4. Int. GI-Congress, München, Springer, 1991, pp. 219-230.

[John92]   Johnson P., "Supporting Exploratory CSCW with the EGRET Framework", Proc. of CSCW ´92 conference, Toronto, ACM, 1992, pp. 298-305.

[Kill89]   Kille St., "The QUIPU Directory Service", in Stefferud, Jacobson, Schicker (eds.), Message Handling Systems and Distributed Applications, IFIP 6.5 Int. Working Conference, Costa Mesa, 1988, North Holland.

[LeMa90]   Lee J., Malone Th., "Partially Shared Views: A Scheme for Communicating among Groups the Use Different Type Hierarchies", ACM Transactions on Information Systems, vol. 8, no. 1, jan. 1990, pp. 1-26.

[MaCo90]   Markus K., Connolly T., "Why CSCW Applications Fail: Problems in the Adoption of Interdependent Work Tools", Proc. of CSCW ´90 conference, Los Angeles, ACM, 1990, pp. 371-380.

[MaFL92]   Malone Th., Fry Ch., Lai K-Y., "Experiments with Ocal: A Radically Tailorable Tool for Cooperative Work", Proc. of CSCW ´92 conference, Toronto, ACM, 1992, pp. 289-297.

[NaPR92]   Navarro L., Prinz W., Rodden T., "Towards Open CSCW Systems", Proc. of the 3rd IEEE Workshop on Future Trends of Distributed Computing Systems, Taipeh, IEEE, 1992, pp. 4-10.

[Pank89]   Pankoke-Babatz U. (ed.), "Computer Based Group Communication: the AMIGO Activity Model", Ellis Horwood, 1989.

[PrPe92]   Prinz, W., Pennelli, P., "Relevance of the X.500 directory to CSCW applications", in D. Marca, G. Bock (eds.) Groupware: Software for computer supported cooperative work, IEEE computer society press, 1992, pp. 209-225.

[RoBa91]   Robinson M., Bannon L., "Questioning Representations", in Bannon, Robinson, Schmidt (eds.) Proc. of ECSCW ´91, Amsterdam, Kluwer, 1991, pp. 219-234.

[Rupi90]   Rupietta W., "An Organization &Resource Model for Adapting Office Systems to Organizational Structures" in Tjoa, Wagner (eds.): Database and Expert Systems Applications, Springer, 1990, 346-350.

[Schm91]   Schmidt K., "Riding a Tiger, or Computer Supported Cooperative Work", in Bannon, Robinson, Schmidt (eds.) Proc. of ECSCW ´91, Amsterdam, Kluwer, 1991, pp. 1-16.

[SpBe91]   Spenke M., Beilken Ch., "An Overview of Gina — The Generic Interfactive Application", in Duce et. al (eds), Poc. of the Workshop on User Interface Management Systems and Environment, Lisbon, Springer, 1990, pp. 273-293.

[ViSo90]   Victor F., Sommer E., "Supporting the Design of Office Procedures in the DOMIO System", in Bowers, Benford (eds.) Studies in Computer Supported Cooperative Work , North-Holland, 1991, pp. 119-130.

[X.500]   CCITT, ISO 9594-1, "Information Technology — Open Systems Interconnection — The Directory", rcommendations X.501-X.509, 1992

Papers produced within COMIC Strand 1

GMD

Wolfgang Prinz: First Research Agenda Strand 1, 23/11/92, COMIC-GMD-1-1, Working Paper.

L. Fuchs: Review: How organisational context is provided by CSCW applications, 26/1/93, COMIC-GMD-1-2, Working Paper.

Wolfgang Prinz: X.500 support for the representation of an organisation, 11/1/93, COMIC-GMD-1-3, Working Paper..

Wolfgang Prinz: TOSCA: Providing organisational information to CSCW applications, 28/1/93, COMIC-GMD-1-4, Working Paper.

Wolfgang Prinz: Minutes of the strand 1 sub-meeting at the COMIC meeting in Bonn, 28/1/93, COMIC-GMD-1-5, Minutes.

L. Fuchs and W. Prinz: Aspects of Organisational Context in CSCW (Draft version), 23/4/93, COMIC-GMD-1-6, Working Paper.

Wolfgang Prinz: Minutes of the Strand 1 subgroup meeting in Barcelona, 23/4/93, COMIC-GMD-1-7, Working Paper.

L. Fuchs and Wolfgang Prinz: GMD Position Paper on Organisational Context, 23/4/93, COMIC-GMD-1-8, Working Paper.

L. Fuchs and Wolfgang Prinz: Aspects of Organisational Context in CSCW, 6/8/93, COMIC-GMD-1-9, Contribution to Deliverable.

John A. Mariani, Wolfgang Prinz, Peter Sawyer: An Overview of User Interface Techniques for Database Management Systems 26/1/93 COMIC-GMD/LANCS-1-1, Working Paper.

University of Manchester

John Bowers and Tom Rodden: The Interface in an Organisational Context: A Field Study of a CSCW Network, 23/11/92, COMIC-MAN-1-1, Working Paper.

James Pycock: Initial consideration of memory in organising cooperation, 23/4/93, COMIC-MAN-1-2, Working Paper.

John Bowers: Boundaries, Awareness and Interaction in Virtual Spaces: The COMIC Spatial Model and Representing Organisational Context, 17/2/93, COMIC-MAN-1-3, Working Paper.

John Bowers: Understanding Organization Performatively, 29/8/93, COMIC-MAN-1-4, Contribution to Deliverable.

University of Milano

Giorgio De Michelis and M. Antonietta Grasso: How to put cooperative work in context: Analysis and design requirements, 24/9/93, COMIC-MILAN-1-1, Contribution to Deliverable.

Giorgio De Michelis and M. Antonietta Grasso: The organizational context of a work process 29/4/93, COMIC-MILAN-1-2, Working Paper.

University of Nottingham

Steve Benford: Review of Existing Systems and Models, 23/11/92, COMIC-NOTT-1-1, Working Paper.

Adrian Bullock: Organisational Knowledge Browsers, 11/1/93, COMIC-NOTT-1-2,Working Paper.

Adrian Bullock and Steve Benford: Position Paper on Organisational Context, 23/4/93, COMIC-NOTT-1-3, Working Paper.

Adrian Bullock: Network Information Retrieval Services, 29/4/93, COMIC-NOTT-1-4, Working Paper.

University of Oulu

K. Kuutti: Notes on systems supporting "organizational context" - an activity theory viewpoint 23/4/93, COMIC-OULU-1-1, Contribution to Deliverable.

Risø National Laboratory

Liam Bannon: Supporting Organizational Context with computers: What does it mean?, 19/4/93, COMIC-Risø-1-1, Position Paper.

Liam Bannon: Can information technology support "Context" & "Community" ? 19/4/93, COMIC-Risø-1-2, Working Paper.

Kjeld Schmidt: Organizational Context in Context, 26/4/93, COMIC-Risø-1-3, Working Paper.

Carsten Sørensen and Henrik Borstrøm: Small is Easy: The Intricate Problems of Manufacturing an Ashtray, 26/9/93 COMIC-Risø-1-4, Working Paper.

Kjeld Schmidt: The Organization of Cooperative Work: Beyond the 'Leviathan' Conception of Organization, 26/9/93, COMIC-Risø-1-5, Contribution to deliverable.

SICS / KTH

Konrad Tollmar: Organisational Context: A Review of Earlier Systems and Studies, 11/7/93, COMIC-SICS-KTH-1-2, Working Paper.

UPC

Joan Manuel Marques, Leandro Navarro, and Mildred Sarmiento: ODP Enterprise Models & Functions, 11/1/93, COMIC-UPC-1-1, Working Paper.

Mildred Sarmiento, Leandro Navarro, and Joan Manuel Marquès: From Small to Large Scale, 11/8/93, COMIC-UPC-1-3, Contribution to Deliverable.