# Modeling Organizational Forms of Virtual Enterprises

## The Use of CSCW Environments for a Team Based, Distributed Design of Virtual Organizations

Ott, Marcus - Nastansky, Ludwig
University of Paderborn, Business Computing 2
Warburger Str. 100, D-33098 Paderborn, Tel. ++49-5251-603368
{MOtt; NastansL}@notes.uni-paderborn.de
http://fb5www.uni-paderborn.de/winfo2

**Abstract:** This paper examines the notion of virtual organizations under the influence of traditional organization design aspects. It explores the view that the classical design of organizations remains a fundamental management task for virtual organizations, as well. It then looks closely at how traditional structural design processes are constructed and points out to their weaknesses. An evolutionary and distributed multiple level team-approach to design will be proposed. Furthermore, this paper introduces the CSCW oriented prototype environment GroupOrga for modeling and informing about the structures of new organizational forms. This concept's base, a comprehensive data model for enterprises, will be delineated and its prototype implementation will be described. Concluding, a graphical tool for design support will be introduced and the overall architecture will be pictured. An outlook on further conceptual ideas, such as an integration with the World Wide Web will be given.

## 1 Introduction

Conventional organization design variables have been used for hundreds of years and they have served organizations well. As competition becomes more intense, organizations will have to react more quickly to environmental change and to competitors. Harder rivalry, a worldwide supply of goods, globalization of the markets and higher expectations of customers put growing pressure on organizations. A major effect can be seen in the increasing speed of technological change which ordered the factors of competition in a new way: *Time* plays the dominant role in the markets.

Organization design that results in hierarchies, bureaucracies, and many levels of review and approval seem to be incapable of fast response. Information technology (IT) offers additional variables that, when combined with considerations of structure, people, and tasks, can help design more responsive organizations. In the area of *Computer Supported Cooperative Work* (CSCW) exist many approaches to overcome this problem. The notions of *Business Process Reengineering* (BPR) or *Workflow Management* discuss solutions which explicitly address the component *time* and are aimed to reach an essential improvement in reaction to environmental changes. However, it will be difficult, and in some instances virtually impossible, to move a traditional organization to adopt new process structures without changing or dissolving the *underlying organizational structure*.

This paper defines a set of technology-based organization design variables. Some of these variables are similar to traditional design variables, while others are unique. The IT-enabled

design variables allow to combine virtual organizational components, electronic messaging, and electronic workflows to name a few. It describes an environment to design the organizational structure of virtual enterprises as consisting more of knowledge nodes and inter-organizational networks than physical spaces. *Designing virtual* organizations might appear to be a contradiction in terms, but what is meant here is the indication of the bounds of action within the virtual infrastructures, leaving the detailing of the organization's structure to the choice of the knowledge workers.

## 2 Virtual Organizations and Organization Design - a Contradiction?

With information technology, the basic assumption of modern organization theory and practice such as the need to physically group people and units together to provide for coordination or supervision, or the need to choose between centralized or decentralized structure, are being increasingly invalidated. In the case of linking mechanisms for example, IT such as e-mail or groupware solutions may now play this role, making task forces or liaison agents unnecessary. In contrast to physical presence, IT design variables allow for virtual organization (VO) structures[1]. The VO had its beginning some years ago as people began to see the potentials of using information technology for work at distributed workplaces. For almost any organization that does not turn out a material, durable product, one possible form would be a combination of independent agents. In this scenario, with IT, there is no longer the need to generate an organization with conventional structures and the personal meetings that this entails.

The use of the term VO varies strongly in today's IT supported approaches to networked organizations. Literature proposes diverse interpretations of VOs and defines different emphasis: Davidow and Malone's "Virtual Corporation" for instance, refers only to the outer form or the organization itself when they describe virtual organization as an object without specific outline and with continuously changing interfaces between organization, supplier and customer [DM93, p. 15]. Other authors focus on different types of cooperation between the cooperating partners. A narrower concept is proposed by Byrne who states, that "... the virtual corporation is a temporary network of independent companies [...] linked by information technology to share skills, costs, and access to one another's markets" [Byrn93, p. 37]. Yet again other authors understand the idea of virtual organizations not only to explain the inter-organizational dependencies between partner organizations but also as an explanation of the intra-organizational principles. Arnold et al. [AFHS95] have examined the term *virtual organization* in detail. They have identified varying notions of virtual organizations and they have delimited this form of organization from other forms such as joint ventures, cartels, trusts, strategic alliances and the like. It is not the focus of this paper to give yet another overview of what virtual organizations are or how they can be identified or defined - this has been done sufficiently[2]. For our purpose, complying with the definitions given by [WP96, p.383] and [AFHS95, p. 10] we understand a VO as a

---

[1] The term "virtual" was first used with respect to IT for a virtually unlimited logical memory for computers. A program was split up into pages and only necessary ones are loaded into memory. A virtual organization uses IT to operate like a classical one.

[2] Some references for further studies which give an overview and refer directly to the term virtual organization are [AFHS95], [Byrn93], [DM92], [Klei94], [Mert94], [MF95), [N.N.94], [Sieb95], [WP96]

- voluntary cooperation of several legally independent performers of varying types (whole organizations, single departments, project groups, single persons, etc.),
- who produce an output based on a common understanding of their business rules.
- All cooperating partners provide their resources, core competencies or skills and know how in order to become quicker in reaction, more flexible and more international.
- At least one partner represents the VO to the external world (and most of the time has the structural responsibility, as well),
- and the partners are connected with each other by means of modern information and communication technology.

Based on this understanding, we still think that the classical design of organizations remains a fundamental management task for VOs, as well. Klein defines this design of an organizational architecture as an elementary management task: "Virtual, flexible organizations require a minimum of structure, too. Therefore basic organizational principles have to be determined and rights and responsibilities of organizational units and their agents have to be clarified" [Klei94, p. 313]. There are a large number of ways to divide labor and to coordinate tasks in the organization and there are also various design strategies and variables that can be used in the organizational design process. Surely the giving up of central management functions is one of the most marking characteristics of VOs, which distinguishes this form from other forms of cooperation. Many authors stress, that information technology supports communication processes and coordinates the tasks to be carried out in the network. The necessity of using information technology like the one conceptualized in this paper becomes very obvious under the notion which Gurbaxani and Whang emphasize: Virtual organizations can grow into a large scale organization with global reach, while the partner organizations remain relatively small themselves [GW91]. To the customer (as well as to the participating partners) the VO presents itself as a transparent organization of enormous size and complexity, which is why some organizational information system is inevitable.

Additionally, it still seems that people will be more comfortable in the immediate future with the familiar metaphor of a traditionally structured organization - even if it is in the virtual form. At present it is rather unlikely to have pure VOs, but rather a combination of real organizational structures plus some virtual components.

In the following chapter, a distributed, evolutionary design process of organizational structures will be formulated. It is a multiple layer design advance which involves all organizational members in an ongoing and evolutionary process.

Mertens and Faisst [MF95] name a palette of instruments from the field of computer science and business computing, which have not intentionally been invented for the use in VOs. Nevertheless, these instruments can prove to be advantageous for the design of VOs, as well. Chapter 4 describes a CSCW concept and prototype environment GroupOrga which addresses a critical factor in the design process of VOs: The provision of always updated knowledge about structure, processes, partners and persons, as well as skills, know-how and services provided by the individual partners in the network to the internal partakers or to external customers who want to make transactions with the VO.

# 3 An Evolutionary and Distributed Design of Organizational Structures

## 3.1 Traditional vs. Innovative Organization Design

The *traditional* approaches to organizational design show four major characteristics, which prevent from an evolutionary and constant change of potential VOs: They rely on the sole view of one particular person, they base on formal models and focus on explicit organizational roles and structures and they ignore processes. In contrast, an effective approach of structural design should be based on multiple, personal perspectives to match for the problem's complexity. Supporting this view, Eccles and Nolan "propose that only key, high level infrastructures can be explicitly designed by senior management" [EN93, p.63]. The design process should be an evolutionary, not rules based procedure which addresses informal roles and structures and does not ignore the processes undergone by VOs. In addition, arguments can be given for implementing the design process as a *group*-process: The problem is complex and all members and customers of a VO have considerable motives to solve the organizational problem efficiently. This process should be understood as evolutionary and never ending. Additionally, networked computers can be seen as standard and provide the technological means to support the team design[3].

| | |
|---|---|
| Taditional organization design | • relies on one person's expertise and view (generally an "organizer"),<br>• is based on formal methods which are in existence for a long time already,<br>• focuses on formal roles and structures which have been laid down long ago,<br>• ignores existing everyday business processes which may change. |
| Effective organization design process | • relies on multiple views in order to cover the whole complex problem,<br>• is an evolutionary and never-ending process involving all members,<br>• includes formal and informal roles and structures, and<br>• explicitely includes the day-to-day business processes in the design. |
| Organization design as a group-driven process | • supports solving the problem's complexity due to group communication,<br>• allows internal members and external partners to get involved in the design,<br>• supports the idea of an ongoing process due to multiple process drivers, and<br>• will in the future be supoorted through varied computer technology. |

*Table 1: Weaknesses of traditional organizational design and new approaches, [Rei92]*

## 3.2 A Team Design Process

In the concept of the presented approach, the team design process brings about virtual organizations which model themselves as self-organizing systems. It includes everybody in the organization, i.e. not only its management level, and is based on a continuous, computer-assisted arrangement about functions, activities, roles, positions and their interactions of all persons involved. The technology to promote this process is the computer-assisted groupware environment to be sketched in the following chapter. It enables the involved individuals to inform about their own roles and interactions. One major advantage is, that other people can watch changes and alterations in the VOs structure and set-up, they can understand the connections and thereby contribute to the process.

The information base proposed in this paper is founded on a client server architecture with a distributed directory model. The distribution of directory information can be allowed onto a variable number of information systems (computers) within the virtual network which makes

[3] Further details on the problems of current organization design practices and their potential solutions can be found in [ON97]

provision for an enormous scalability of the data model. Each node in this network can store an optional portion of the complete data set.

Through a specification of which partial information is stored on which node in the network, a distributed design and administration of the complete data set becomes possible. In this environment a central authority (possibly *a broker*) might be responsible for some coordinating, structural information while the decentralized partners in the VO with their respective information technology provide the detailed organizational structure information about their particular role. Bartlett and Goshal [BG89] accent the need for and evidence of new models of organization (e.g. VOs) in a similar way, except that they ignore the role of information technology. The central point in our approach is that managing a modern networked company requires at least two levels of organization design: The first level, which could be called top-level (or superordinate) design, is the responsibility of the coordinators in a virtual cooperation - in a *traditional* organization this group would be called *senior management*. This group is concerned with framing and constituting the infrastructure of assets, resources, hierarchies, and management practices. These structural elements will be utilized by the individual partners throughout the VO to perform the second level of design, which can be termed bottom-level design and which is a self-design process. Of course, this self-design must not be restricted to only one level below the structuring component. On multiple levels it might involve the individuals using the proposed infrastructure to shape their own working environments and organizational sub-structures. In the following, for simplicity reasons, we will focus on two levels only.

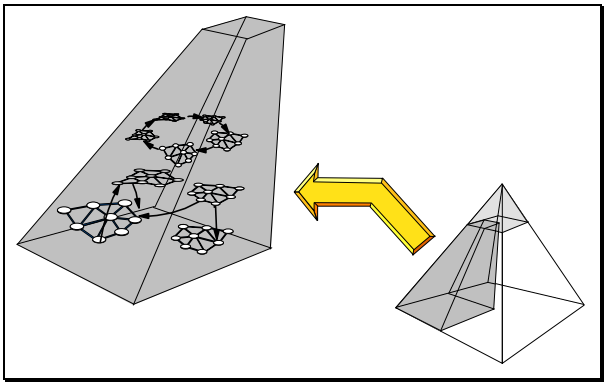

*Figure 1: The top-level design and self-design*

### 3.3 Top-level and Bottom-level Design Approaches

Each networked partner in this system models and discloses its own structures, competencies, roles and workgroups (as far as they are considered important for the joint project and not confidential) to help building the unique appearance towards the environment. By the extensive usage of communication and information technology such as the groupware environment, the information will be distributed to the partners in the network, who in turn designate process tasks to particular elements in the virtual structure.

In another context Nolan and Pollock described such a notion of two levels of design as a "network floating on top of a hierarchy" [NP88], but this picture serves well for describing the concept advocated here. On top of these functional hierarchies, or, more generally, initially designed infrastructures, individuals access other individuals and resources in the VO, which are, in a sense, held or stored in the underlying infrastructures.

**Top-level organizational design**

The *top-level organizational design* consists of establishing the major shared infrastructures and more or less hierarchical elements in which the organization will virtually operate. These infrastructures, although they must of course be flexible, are the points of stability in which the VO operates and by which the respective partners can effect outcomes. Using the term *"virtual"* in connection with *"design"* through an intermediary or broker seems to be a contradiction in itself. However, what is designed here are the rough bounds of the virtual infrastructures, while the detailed plan of the organization's structure itself will be done by the

knowledge workers. To operate in an environment of high uncertainty, the VO must rely on innovation and continuous learning by the participating *real* organizations.

The broad structural outline of a VO exists primarily for organizing its human assets and may have very little to do with how work actually gets done in the network. This structural profile is the functional hierarchy on top of which exist the self-designed networks of relationships between the partner organizations. And although the mediator is not explicitly responsible for creating this structural basis, s/he may be responsible for providing tools like those delineated in this paper for doing so.

**Bottom-level structuring processes**

The multiple *bottom-level design* processes which actually define how the integral parts of the VO are structured in which the work gets done are performed by the workers which reside in the distributed organizations. The distinction between top-level and bottom-level design made here, should not be mistaken for the contrariety between centralized and decentralized performance of tasks. Top-level structuring is a superordinate task but its main purpose is to provide a framework for the necessary outcome to be achieved. Nor is bottom-level design *only* decentralized decision making - the purpose of self-design is to allow the knowledge workers to shape the surrounding environment in whatever form they find feasible for carrying out the tasks in the most beneficial manner. Organizational structure is the most apparent and most discussed variable in this report and the most popular term used, the *network* does not totally replace the hierarchy but operates of it. The network structure is designed by anyone who needs to get something done, whatever the designer's level in the functional hierarchy is. Because the overall network structure of the VO is the result of a collection of many distributed organizations, it may be extremely complex and constantly shifting. No one person, at any level in the VO, has a total picture of what the structure looks like, but nevertheless it is optimized due to the optimization of each organization's structure by the responsible knowledge workers.

# 4 A CSCW Environment for Modeling Virtual Organizations

The design process of VOs can be compared to the process of designing the internal structures of a traditional organization [MF95, p. 63], i.e. the design of business processes and underlying structures. Instead of having single persons in one organization performing the tasks to produce the outcome, in a VO the cooperating organizations perform these tasks. Nevertheless, processes and structures have to be laid out once in order to clarify each partner's responsibilities.

The environment to be described in this paper will be based on a comprehensive organizational data model, and a computerbased tool will be available to the partners to design the meta-structure of the VO cooperatively and to later refine each organization's contributing part in a distributed environment. In the idealistic form a complete picture of the organizational structure and its potential skills and know-how is available to everyone, afterwards. Moreover, the outcome of this evolutionary and ongoing process will be stored in an electronic organization handbook. It will be available to every VO member and supplies with information about each partner's internal structure, its competencies and personal contacts. If such an electronic organization handbook is opened through the support of a standardized platform (such as the World Wide Web - $W^3$), it can be developed into some type of on-line yellow pages where companies present themselves. Here they would inform about their core competencies and their main know-how, whereby such an environment would evolve into a virtual partner-organization catalogue.

## 4.1 An Organizational Data Model of Virtual Organizations?

In order to set up for such an integrated computer supported environment which aims at full integration with operative IT systems such as Workflow Management Systems (WfMS), a comprehensive and concrete data model for organizations is necessary. While previous work [Ott96] focused on all three submodels of a data model, here we will exclusively explain the appearance of the structural model, since it presents the basics of the electronic organizational handbook to be later focused on.

### *4.1.1 Data Entities for the Basic Design of Infrastructures*

In VOs, conventional workgroups, units, divisions and enterprise sectors *reform themselves* as required. Tasks and influences change constantly and even the positions and competencies of organizational members shift in short periods (cp. [DM93, p.15]). However, despite the absence of hierarchy and organizational overhead, it is necessary to somehow document and model the existing virtual organizational structures at any time, in order to meet the thesis from chapter 2, that people are still more familiar with the metaphor of a structured organization.

In addition, the growing implementation of WfMS to control workflows within or across organizational borders, necessitates a means to model and illustrate the structures of VOs to assign process tasks to organizational elements (e.g. the 'virtual employees'). This aspect will be further delineated in chapter 4.2.3.

Complex processes and the large number of tasks which have to be carried out to complete a process need to be solved through the division of labor. The infrastructure model as a part of the data model describes the people who work at different locations in different departments of the VO, the resources (e.g. tools) they use to perform their tasks, the formal groups they belong to and the relations and formal communication paths between those groups. The infrastructure model uses various entities to model the organizational structure and determines their relations like subordination of units to other units and assignment of persons to units. This sub-model of the data model, which is based on research on various existing approaches of data and enterprise modeling[4], defines the structural components of an organization:

The entity **editor** summarizes the different entities that tasks of a common process may be assigned to. In the current data model an editor can be a person, a department (or unit), a post, a workgroup, a role, and a software agent.

Originally, organization directories were created to support messaging systems and thus their first and most important entity was that of a **person**. Addressing persons in (virtual) organizations through messaging systems is an important application field of directories, but recently messaging is also used by some WfMS to deliver work items to the appropriate user and for notifying users about their tasks. In addition to a mere listing of addresses, a directory needs to inform about an employee's preferred address at any point of time. The directory points potential communication partners to the appropriate address and, if a person is absent, **substitution rules**[5] will be applied.

To model an organization's departmental structure, it is not sufficient to simply add the **department** to which a user belongs as an attribute to the user's record. Since departments

---

[4] The data models used as reference have briefly been compared in [Ott96]

[5] Complex substitution rules of this data model are explained in [Ott96]

have their own attributes, such as their position in the organization chart, they need to be distinct entities. The department structure grows into a tree, in which each department resides higher than various other departments but has only one superordinated department. Besides these structural attributes, there are others like the manager, the secretary or equipment assigned to the department. A **post** is an abstract means that can optionally be used to model membership of persons to departments. Instead of assigning persons directly to departments, functions and tasks which are to be performed are defined in a post. A person fills a post and is thereby given authorities to hold a set of roles that are connected with that post. A post is filled by exactly one person and a person fills exactly one post. **Software agents** perform tasks instead of personal editors. Examples are database queries or automatic information retrieval, which may utilize external software resources.

To model modern process- and team-oriented VOs it is necessary to create additional views of the organization. **Workgroups** combine people that may belong to different departments or even to different organizations and that may work in separated locations. Workgroups may exist only for the duration of a particular project, as well as the whole VO may only exist through the presence of various interacting workgroups. The conception of workgroups will also be used to model multi-layered organization structures which are much more common for VOs than completely hierarchical approaches.

For building flexible and easily maintainable organizational structures for process enactment, it is crucial to keep the processes independent of the actual employees who finally complete the tasks. Assigning departments or workgroups to tasks may not be detailed enough, when particular skills are required - **roles** may be a first feasible means. Roles form a layer between the physical grouping concepts of departments and workgroups and the actual persons in an organization. In contrast to a post, a role describes a person's function within a process, whereas the former describes a person's place in the hierarchical context of an organization.

In addition to storing information about editors and the adequate organization structure, a directory can be used to control software and hardware **resources**. These resources can be assigned to tasks during process design in order to support users to complete the task. Moreover, the definition of resources in a directory can help members of VOs to identify who owns necessary resources and where to locate them in the network. Software resources, for instance application programs or databases, can be referenced in the directory by specifying their location and methods for their invocation. Furthermore, links to definite pieces of information such as databases, documents or web pages can be managed in the directory for the partner organizations. Similar concepts are valid for hardware resources, as well. Managing devices facilitates their use for the partners in the network and gives an overview over the equipment at disposal.

| | | |
|---|---|---|
| Classical and widely accepted and implemented | • department<br>• unit<br>• person | • post<br>• location<br>• etc. |
| Less classical, yet currently disussed | • role<br>• workgroup | • competency<br>• etc. |
| Currently rather unpopular | • skill<br>• knowledge | • capability<br>• etc. |

*Table 2: Three classes of organizational entities in the current discussion on data models*

Most of the data model entities which have been focused on so far remain absolutely necessary to design the basic infrastructure of a VO. Chapter 3 termed this basic design step the *top-level design*. Equivalently important but less concrete and less well know entities are

some of those shown in **table 2**: While unit or department, person, post and sometimes workgroup or role are already widely accepted for describing organizational structures, the following chapter shows that in the future less definite organizational entities will be required in data models, as well.

#### *4.1.2 Skills, Know-how and Core Competencies - The Qualities of Virtual Organizations*

Know-how, the knowledge and skill required to do something correctly, is a critical factor in VOs. Expertise, mainly technical know-how, knowledge about customers and markets, as well as organizational and procedural acquired knowledge is a determinant which all partners contribute to the VO as their respective core competence[6]. The core competencies and the expertise on which they are built are the basis of an organization's involvement in a networked VO. Thus, each partner must focus on those competencies and must give a clear understanding of it to external partners in existing or new VOs. The optimized cooperation between the partners depends upon shared knowledge, some of which can be captured in information data. In a VO mechanisms must exist to capture the information about the *"where and who?"* of skills and knowledge in the geographically dispersed parts of the virtual company to be made available throughout the organization.

In order to supply with this information, the data model of the electronic handbook should be expanded with data model entities such as ***know-how***, ***skill*** or ***knowledge***. Information stored in these entities could answer simple informational requests such as "Who is capable of preparing a balance sheet?" or "Where can we get a partner that can give information on WWW security management?".

More significantly, these rather unprecedented entities should also be taken into account when automatically determining the performers of tasks in process or WfMS. I.e. as an alternative to designating persons or departmental members to tasks, an assignment of tasks to specifications like "Someone who can set up a balance", i.e. know-how, proves to be much more flexible. Such a possibility would allow to predefine processes for VOs without having to specify who has to carry out which of the distributed tasks - this would be done at runtime referring to the varying skill-specifications made in the organizational directory.

In order to give a complete overview of the modeling environment, the preceding definition of the data model, its entities and relations had to be only brief. A complete description of all relations and possible exception leads to an extended infrastructure model which is described in detail in [Ott96].

### 4.2 An Information Base for the Virtual Broker

The knowledge representation about the organization's structure will be done in an information base for the broker as well as for all members of the organization. The current scenario of communication in distributed organizations and the information base developed through this project will be the focus of this chapter.

---

[6] On the idea or core competencies see [PH90].

#### 4.2.1 The Current Communication Scenario

Organizations are forced to improve or even optimize their business processes in cooperation with partners in order to reach a higher productivity or to gain competitiveness. A key factor for networked virtual organizations is a fast and easy communication, and the portion of electronic communication in this field rises quickly, which explains the great interest in electronic directories. The increasing use of electronic messaging is yet another factor and addresses like `Manager(Marketing)` are much more intuitive than `SmithP@dian.thor.acme.com`. Moreover in communication environments a vast variety of incompatible and partly paper based *directories* can be found and especially in a scenario where diverse partners get together in order to build a networked organization any of these assisting tools can be found: public telephone books and yellow pages, departmental telephone lists, personal computer software, pocket organizers, network user lists, human resource index card systems etc. Although any of these directories might carry valuable and possibly important information for the setting up of a VO, unfortunately these directories are bound to a distinctive locality and to a specific application software, they keep most likely redundant and inconsistent data and are administered by specific different but single persons in the same organization. This wide variety of information systems for organizational structure prevent from the quick use in VOs as information base on who can be helpful in a particular case in the business processes.

Within the subject of business communication the following changes can be recorded:

- organizations have to optimize business processes in order to reduce costs
- new types of organization layout with smaller independent units entail a growing external communication, i.e. communication across the borders of the own organizational unit
- trends to a growing interlocking of organizations require an increased inter-company communication
- an increasing portion of communication links (especially in virtual environments) is only short lived and is subject to permanent change of communication partners
- more and more communication partners are independent of place, which implies a need of information services on organization *structures*
- communication services are expected to be provided as complete services (rather than exclusive solutions for one application type)

#### 4.2.2 The GroupOrga Organization Database on a Groupware Platform

In order to implement and represent the data model described in chapter 4.1 we introduce a Groupware database which holds all information about the model's entities. Although the used Groupware platform itself does not dictate a relational data model, it seems to be adequate to stipulate a relational structure at least for the more common, hierarchical entities, such as departments, posts or persons. However, the use of a non-relational Groupware database enables for both, the design of strictly relational links and entities, as well as for a colloquial description of skills and knowledge. As chapter 4.1.2 showed, these less concrete assets of an organization will become more important for organization databases but they can hardly be squeezed into a rigid relational data model. **Figure 2** shows the user front-end from the prototype implementation of such an organization database.

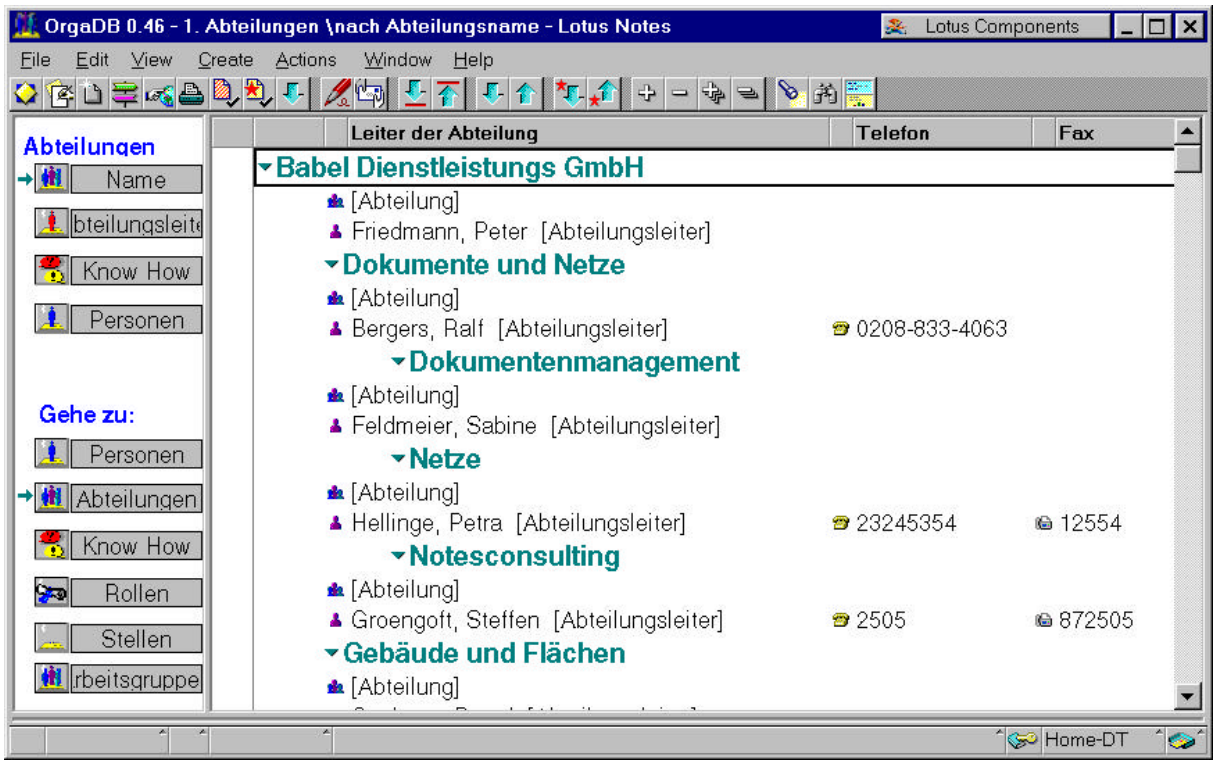


*Figure 2: User front-end of the organization directory (German prototype)*

Supporting distributed modeling of organizational structures requires scalability and the capability to share information from the directory. Thus confirming with the vision from chapter 3, a growing directory must be splittable into smaller, independent portions that can be administered separately. Nevertheless, this separation must be transparent for the user, i.e. a request that cannot be served by the local part of the directory must be handed over to the segment that contains the required information. The other way around, there must be an easy way to integrate several local directories into a large one. As outlined in the previous chapter, distributed organization modeling requires the option to delegate the administration of different parts of the directory to different authorities.

The organization database proposed in this paper is based on a Groupware platform, of which replication technology is an important feature for distribution of information. In order to realize the distributed organization handbook, identical replica copies of the same directory are held at different locations. This approach allows users to design and access information about the organization at several locations without being restricted to a central directory. The contents of replicas will be updated periodically due to a specific schedule or on request.

Protection of unauthorized access to distributed directory information is a feature which is supported by the access control management in the directory database. Likewise a secure, but yet flexible access control management ensures that only those contents can be modified, which a particular partner in the virtual network is allowed to change. I.e. layered authorization levels distinguish the right to read entries, to modify them, to add new entries and to delete existing ones. The setup of this distributed Groupware platform would specify the extend to which information is being replicated. Thus, a *central*[7] or main directory may store all available information and replicate specified parts to and from the partner's

[7] Since the term of a "center" does not exist for VOs, if at all, the broker or intermediary would administer such an all-embracing directory.

directories. Yet, this concept of centrality can be given up if wanted and the distributed directories would independently communicate with each other.

#### *4.2.3 Advantages and Application Fields of an Organization Directory in VOs*

Such a directory as proposed in the preceding chapters would be a standardized distributed information base for all possible entities within a VO. It would present a core component for the communication and the distributed workflow processes. In this respect it serves as an electronic information system or as an electronic navigator through the virtual entities of the respective organization, i.e. it provides with information about objects and potential partners in a distributed networked system. On the one hand, in technical terms such a directory is a data management system for a very large number of such information objects which are provided to all members involved in the virtually networked environment.

On the other hand it presents a "middleware layer" which is positioned between the actual task within a workflow and the respective task performer to be chosen from a number of potential members in a VO. Networks are less stable and more organic than functional hierarchies; during the process of accomplishing a shared purpose, workers in the network may change, and once a shared purpose is achieved, the network may be disbanded. New networks are regularly and instantaneously formed. In such an unsteady and unpredictable environment it is indispensable to be informed about who works with whom, since this is not prescribed by higher management. Instead, the partners seek out partners who have the relevant expertise and commitment to certain tasks with the support of a directory system. Thus the VO partners must know how to locate assets and skills, as through computerized organizational charts that contain information on workers' backgrounds and skills. They must also know who is available for how long, and under what terms. One could, for whatever job was to be done, quickly assemble a team by consulting this organization database of available skills and know-how. Although consulting and advertising firms do such things now, widespread networks will enable virtual teams to be assembled more quickly, for shorter projects, and from many different organizations. Additionally, as the next paragraph shows, this process of designating people to organization’s real tasks could also be automated to a certain extend.

Not only can such an organization database be used as a pure information system for the individuals involved in the VO, but it can also serve as the base for the execution of partially automated workflows between the partners of a VO. In the actual work-process, WfMS would combine organizational components with process types via defined interfaces from the commonly created organizational database as illustrated in **figure 3**.

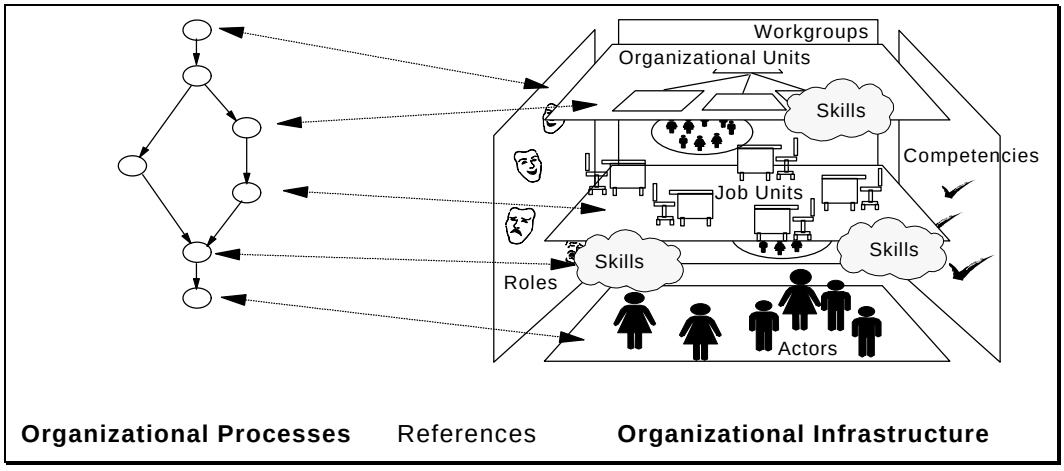


*Figure 3: Assigning process tasks in workflows to elements of VOs*

The current workflow management discussion stresses the ease-of-use of process management systems and demands flexibility and the possibility to perform ad-hoc changes in the process structure. As current approaches show[8], the formulation of these requirements is not restricted to workflow management systems for local environments. It is also true for distributed, wide area workflow concepts which can be used for the support of processes in VOs, as well. With flexible concepts in the area of workflow management[9] it is relatively easy to redraw the process diagrams and to change the way information flows between the collaborating partners. But unlike workflow support, organizational structure systems have been slow and difficult to change. In most applications for designing an organizational structure it is comparatively comfortable to rearrange the boxes in an organizational chart, but until the corresponding changes in information systems are carried out, a horde of specialized programmers working with large mainframe computers is required. By the time the information technology, such as workflow systems, is redesigned to reflect the altered underlying organizational structure, the latter has already been changed again, perhaps several times. A shared organization database architecture makes it possible for anyone who works with a workstation, to design and redesign the corresponding division of the VO.

Therefore, a necessity for the application and acceptance of a directory is its open interface to existing information systems such as WfMS. The directory service must offer an application programmers interface to enable office applications and WfMS to access directory information. This technology in combination with telecommunication networks permits to connect any individually generated process management system to the organizational database. Through this link each workflow will automatically base on always updated and optimized information about the organization's current structure and assets. With the availability of definitions of software resources, for example, WfMS may automatically use this information to launch an application or display a web page that is associated to a task.

Moreover, such an organization database can support a variety of applications since its advantage rises if it assists more than one application. Such a "multi-application" directory requires less resources and costs for its creation and maintenance and due to its common user interface, it can be used more easily than a single application directory. Two of these application fields, namely electronic know-how or skill directories and workflow processing, have previously been outlined in detail. Meyer proposes further important application fields of such directories [Meye93]:

- Office and telecommunication applications, such as e-mail or office automation packages
- Network and security management
- On-line information services such as yellow page services

### 4.3 GroupOrga Modeler - The Modeling Tool for Everybody

So far an abstract data model for design and administration of organization structures and its representation in a Groupware database has been introduced. In order to represent the organizational structure, however rigid or *soft* it may be, graphical on-screen illustrations are often more intuitive than the mere definition of it in any sort of programming language. Thus, we have developed an enduser environment which transforms the abstract definitions of entities and their relations into a visual illustration. The Groupware platform used in this

[8] Cp. [NR96]

[9] Cp. [NH95]

environment does not have any graphical user interface available, which is one reason why we have supplemented the graphical tool shown in **figure 4**. For each entity from the data model a dialogue-window for setting the respective attributes will be made available

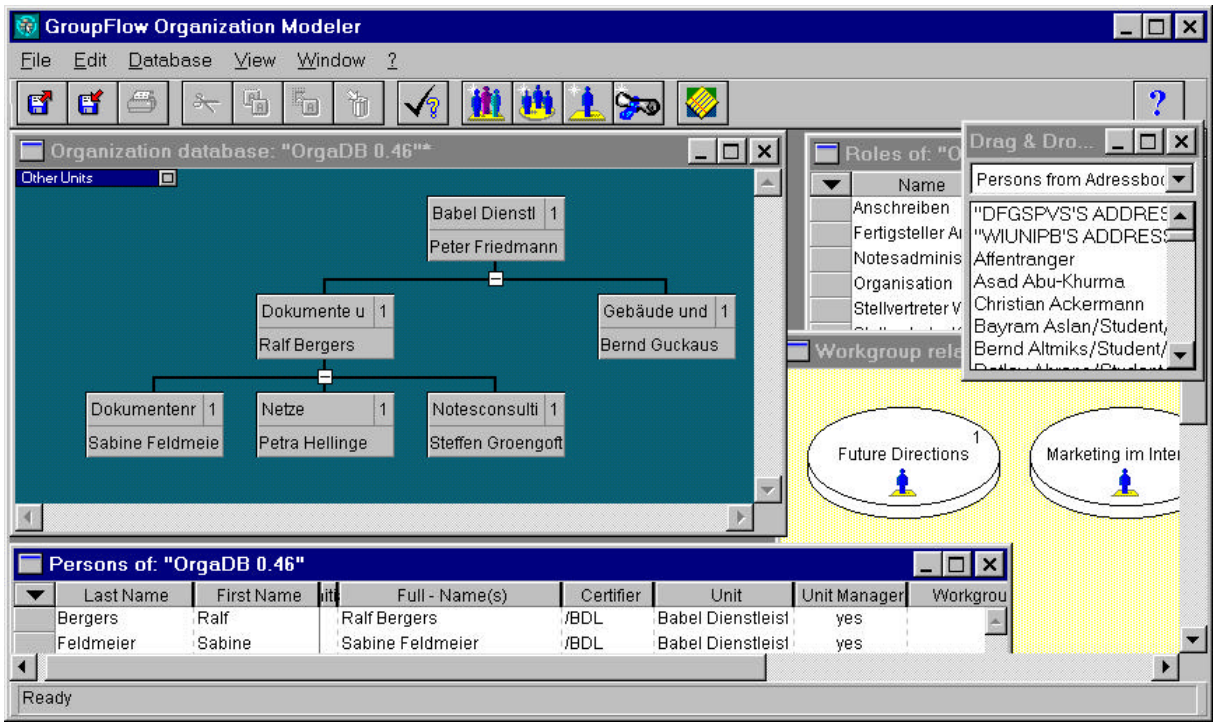


*Figure 4: The GroupOrga modeler user interface*

More importantly, we were forced to develop our own tool, since existing devices for graphical organization design do not support important features, such as API connectivity and distributed modeling; additionally, they rely on rather meager data models without innovative entities such as roles, workgroup, skills or know-how. Our prototype serves to discover improvements and additions for a final specification of a team-oriented graphical user interface.

The organization modeler assigns functionality to each object and thereby supports interactive linking of entities. Relations can be specified through a listed approach or through mouse-driven actions with ease-of-use and intuitiveness as two main design principles. After having designed the necessary organizational relations and structures between the VOs partners, the partial model will be stored in the background database and if necessary be replicated into the network. Naturally, all security options provided by the underlying Groupware platform remain existent and modification can only be made to those parts of the model with adequate access rights. In the conceptualization phase we attached great importance to a clear representation in order to address everybody in an organization for an independent and participate process, i.e. not only potential IT experts.

| *"Push-button" information needs* | *Occasional changes or adaptions* | *Regular departmental design and planning* | *Regular design, planning, analysis and reporting* |
|---|---|---|---|
| end-user | | | administrator |

*Table 3: Varying requirements by different user type classes*

**Table 3** shows that the target group of this organization design process are all members of the VO, i.e. it ranges from people who only want to get informed to those who actively and regularly participate in the design.

Navigation in the graphical representation can be performed by means of tabular retrieval functions, as well as by navigating in the graphical illustration itself.

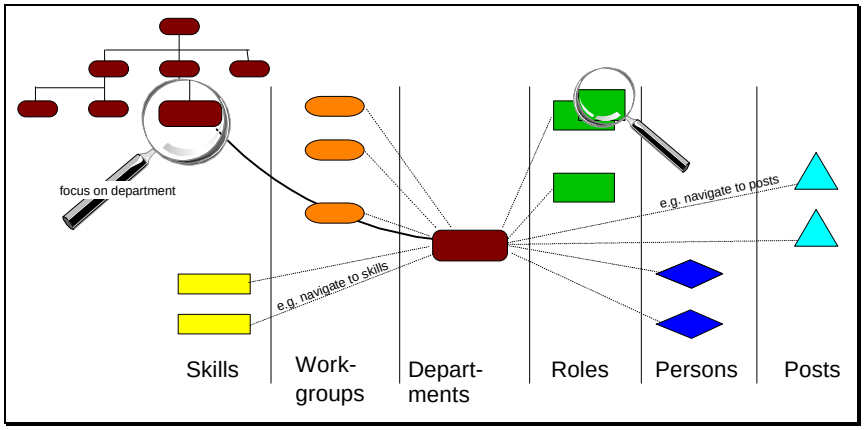


*Figure 5: Procedure of navigation with the graphical tool*

### 4.4 The Technical Perspective of the Current GroupOrga Architecture

Various technical requirements can be derived from these conceptional prerequisites. In the field of business *process* management there is first of all a great need for systems and platforms which deal with the actual control and management of workflows. A great number of concepts describe different approaches on a scale of workflow types, reaching from Groupware-based Workflow-Management[10] over to team-based Workgroup-Computing platforms in the area of Office Systems[11]. These concepts will not be closer examined here.

Considering the aspect of the underlying organizational directory, concepts for the administration of *structural data* and their transformation into the respective workflow management systems are required. A further step should also discuss the auditing of structural or organizational data when very large organizations are concerned.

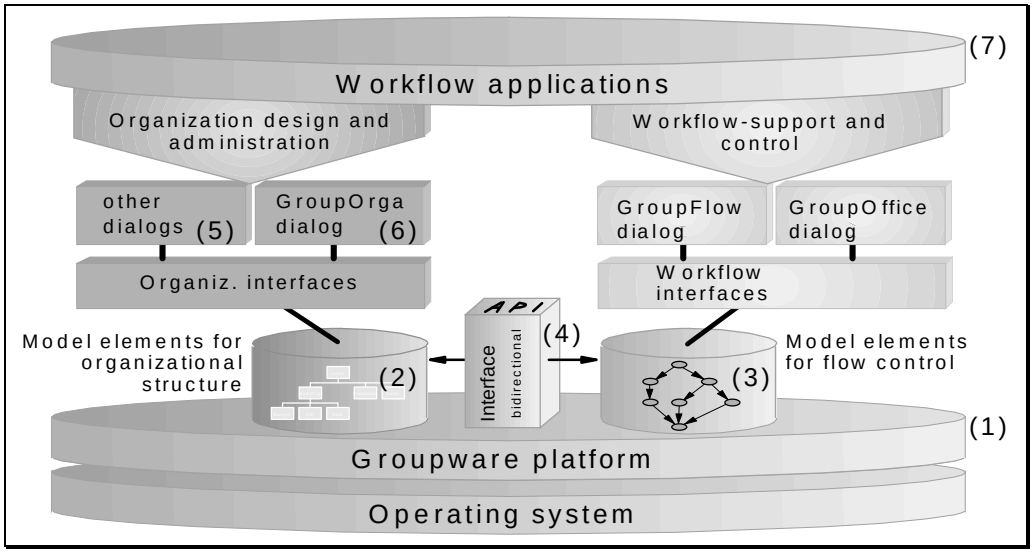


*Figure 6: Schematic GroupOrga architecture*

[10] Cp. [NH95]

[11] Cp. [NO96]

**Figure 6** shows how the integral parts of the introduced CSCW environment interact and summarizes the respective goals: The Groupware platform (1) allows to administer the organizational information in a distributed manner and to constantly define and check access and security rights. Furthermore, the architecture consists of mutually consistent information bases on the one hand for the structural or organizational data (2), i.e. the electronic organization handbook, and on the other hand for the workflow runtime system (3), which manages and controls the processes.

In-between the API interface (4) would be placed which allows to transport organizational information directly from the directory to any operational system, e.g. a workflow management system. Modifications and updates to the organizational data must are definable through the easy-to-use graphical administration tool (5). The GroupOrga database front-end (6) serves well for simple information retrieval tasks. On top of these applications which are mainly focused at administrative tasks, the workflow applications can be found (7).

### 4.5 The next Step: Publishing the Organizational Handbook into the World Wide Web

Quite recently the architecture shown in **figure 6** has been enlarged by its integration into the World Wide Web. The underlying Groupware platform allows to easily publish any database into the $W^3$ with the complete functionality available to the external user, as well. An open publication of information about an organization's assets, skills and know-how fosters the idea of a global virtual market where core competencies and main skills are offered by means of IT, and potential VOs would come into being for short periods, complete the joint task and dissolve, in order to rise again in a new structure and with changed partners. The more information is available about a potential partner, the better the outcome will hopefully be. Concluding, **figure 7** sketches the conception how such an organization directory would be seen and accessed from the $W^3$.

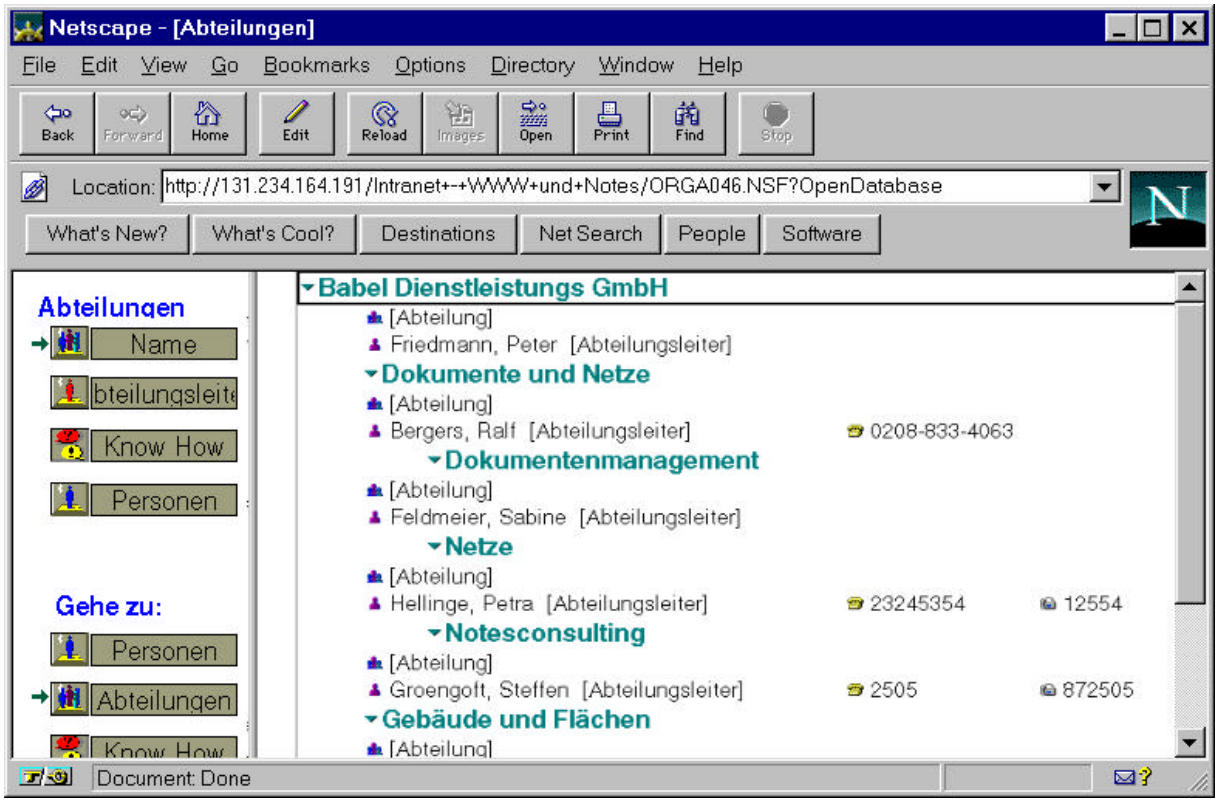


*Figure 7: The organization directory for web users*

# 5 Conclusion

Changes in technologies and market structures have shifted competition from a single organization's to a network scope, resulting in a need for new organizational strategies and structures. Traditional organizational designs, having evolved in response to a different set of competitive pressures, are generally not appropriate for these new strategies. New organizational structures, like those which are the main focus of this conference - the virtual organizations - need to achieve both flexibility and coordination among partner firms and their respective diverse activities in new international markets.

An evolutionary and distributed approach to design has been proposed. It has been shown that traditional design processes are no longer adequate for VOs and therefore a new multiple level team design process has been explained. Arguments have been given why such an advance serves today's requirements better than traditional procedures. Although we believe that both levels of design are necessary at present time, much current thinking argues that the hierarchical level might eventually be eliminated.

Furthermore, this paper has introduced a CSCW based environment for modeling the structures of these new organizational forms. It is a Groupware based organization concept which puts the conceptualized approach of distributed and intuitive structure design into action. This concept's base, a comprehensive data model for enterprises, has been delineated and its prototype implementation in a Groupware database has been described. Further, it has been shown that an organizational information base can be advantageous in various application fields. Concluding, a graphical tool for design support has been presented and the overall architecture has been pictured. An outlook on further conceptual ideas, such as an integration into the $W^3$ has been given.

The authors recognize that knowledge of designing effective virtual organizations is in an early state. This composition showed that much has been said about what VOs are and how they should be designed, but little is clear about how to operatively execute these ideas when it comes to the true and actual layout of a VO. The purpose of this paper is not to propose the way to design the virtual organization, but to put forward for consideration a first IT-supported design approach as an alternative to the traditional organizational design approach, which is proving to be inadequate to the task.

# 6 References


[AC93] Ang, J.S.K.; Conrath, D.W.: The ITHACA Office Object Model: Modeling and Implementation, in: Data Base, Bd. 24, H. 4, 1993, 5-14.

[AFHS95] Arnold, Oksana; Faisst, Wolfgang; Härtling, Martina; Sieber, Pascal: Virtuelle Unternehmen als Unternehmenstyp der Zukunft?, in: Handbuch der modernen Datenverabeitung, 32, 185, 1995, 8-23.

[BG89] Bartlett, Christopher A.; Ghoshal, Sumantra: Managing Across Borders, Harvard Business School Press, Boston, 1989.

[Blei91] Bleicher, Knut: Organisation, Formen und Modelle, Wiesbaden, 1991.

[Byrn93] Byrne, J.: The Virtual Corporation, in: Business Week, 08.02.1993, 1993, 37-41.

[CR92] Clemons, Eric K.; Row, Michael C.: Rosenbluth International Alliance: Information Technology and the Global Virtual Corporation, in: IEEE, USA, 1/92, 1992, 678-685.

[DM92] Davidow, William H.; Malone, Michael S.: The Virtual Corporation, Structuring and Revitalizing the Corporation for the 21st Century, Harper Business, NY, 1992.

[DM93] Davidow, William H.; Malone, Michael S.: Das virtuelle Unternehmen, Der Kunde als Co-Produzent, Frankfurt - New York, 1993.

[Dutt93] Dutton, James E.: Commonsense Approach to Process Modelling, in: IEEE Software, 10/4., 1993, 56-64.

[EN93] Eccles, Robert G.; Nolan, Richard L.: A Framework for the Design of the Emerging Global Organizational Structure, in: Bradles, Stephen P., Hausmann, Jerry A., Nolan, Richard L. (eds.): Globalization, Technology, and Competition, The Fusuion of Computers and Telecommunications in the 1990s, Harvard Business School Press, Boston, Massachusetts, 1993, 57-80.

[Essw93] Esswein, Werner: Das Rollenmodell der Organisation: Die Berücksichtigung aufbauorganisatorischer Regelungen in Unternehmensmodellen, in: Wirtschaftsinformatik, Vieweg, Wiesbaden, 6, 1993, 551-561.

[Galb77] Galbraith, J. R.: Organization Design, Addison-Wesley, Reading, MA, 1977.

[GW91] Gurbaxani, V.; Whang, S.: The Impact of Information Systems on Organizations and Markets, in: Communications of the ACM, 34, 1991, 59-73.

[Klei94] Klein, Stefan: Virtuelle Organisation, Informations- und kommunikationstechnische Infrastrukturen ermöglichen neue Formen der Zusammenarbeit, in: WiSt, 23, 6, 1994, 309-311.

[Mert94] Mertens, Peter: Virtuelle Unternehmen, in: Wirtschaftsinformatik, Vol. 36, No. 2, 1994, 169-172.

[Meye93] Meyer, T.H.: Electronic directories: a speculative look ahead, EEMA Autumn Conference, Maastrichts, The Netherlands, 1993.

[MF95] Mertens, Peter; Faisst, Wolfgang: Virtuelle Unternehmen - eine Organisationsstruktur für die Zukunft?, in: technologie & management, vol 44, 1995, no. 2, 1995, 61 -68.

[Moad94] Moad, Jeff: Welcome To The Virtual IS Organization, in: Datamation, February 1, 1994, 32-35.

[NH95] Nastansky, Ludwig; Hilpert, Wolfgang: Das GroupFlow System für Workflow-Management, Balance zwischen Struktur und Flexibilität, in: Business Computing, Vogel-Verlag , Würzburg, Nr. 7, July 1995, 30-31.

[NO96] Nastansky, Ludwig; Ott, Marcus: Office Management im Team zwischen Struktur und Flexibilität (GroupOffice), GroupOffice-Infrastruktur für das Informationsmanagement, in: Uellner, Stefan (Hrsg.): Computer Supported Coorperative Work (CSCW) in großen Unternehmungen, Proceedings Workshop "Gesellschaft für Informatik (Fachgruppe 5.5.1)" and "Technologiezentrum der Deutschen Telekom AG", Darmstadt, 9./10. May, 1996, 39-53.

[NR96] Nastansky, Ludwig; Riempp, Gerold: Workflow Management zwischen verteilten Groupware-basierten Büros (Wide Area OfficeFlow), Die WideOffice-Infrastruktur zur Interaktion vernetzter Teams, In: Proceedings of "CSCW in großen Unternehmungen", Ed.: Uellner, St., Telekom AG, Darmstadt, February, 1996, 193-207.

[NN94] N.N.: Neue Technologien für virtuelle Organisationen. Groupware als Katalysator für das virtuelle Unternehmen, in: Gablers Magazin, 6-7, 1994, 28-30.

[NPW88] Nolan, Richard L.; Pollock, Alex J.; Ware, James P.: Creating the 21st Century Organization, in: Stage by Stage, no. 4, July-August, 1988, 1-11.

[ON96] Ott, Marcus; Nastansky, Ludwig: Verteilung und Kooperation bei der Modellierung von Workflow Management, Zukünftige Entwicklungen der Organisationsmodellierung als verteilte, kooperative Gruppenaufgabe, in: Lehner, F., Dustdar, S. (Hrsg.): Telekooperation in Organisationen, In Preperation, Gabler Verlag, Linz, March, 1997.

[ON97] Ott, Marcus; Nastansky, Ludwig: Groupware Based Organization Design for dynamic Workflow Management and Office Systems, Future development of organization design as a (tele-)cooperative, distributed team-task, in: Proceedings Business Information Systems ’97 (BIS'97), In Preperation, Poznañ, Polen, April 9.-11., 1997.

[Ott96] Ott, Marcus: The Enterprise Model Underlying GroupFlow, Working Paper, University of Paderborn, Business Computing 2, Unpublished, 1996.

[PH90] Prahalad, C.K.; Hamel, G.: The Core Competence of the Corporation, in: Harvard Business Review, Vol. 68, No. 5/6, 1990, 79-91.

[Rei92] Rein, Gail Louise: Organization Design Viewed as a Group Process Using Coordination Technology, MCC Technical Report Number CT-039-92, Dissertation, University of Texas, Austin, February, 1992.

[Rupi92] Rupietta, Walter: Organisationsmodellierung zur Unterstützung kooperativer Vorgangsbearbeitung, in: Wirtschaftsinformatik, February 1992, 26-37.

[Sieb95] Sieber, Pascal: Annotated Bibliography zum Thema Virtuelle Unternehmen, Arbeitsbericht Nr. 73, Arbeitspapier der Reihe "Informations und Kommunikationssysteme als Gestaltungselement Virtueller Unternehmen", Bern Leipzig Nürnberg, 4, 1995.

[WP96] Wüthrich, Hans A.; Philipp, Andreas: Das Grenzenlose Unternehmen, Virtuelle Netzwerkstrukturen - organisatorischer Trend für das 21. Jahrhundert?, in: zfo, Schäffer Poeschel, Stuttgart, 6, 1996, 383-384.