Cooperative Technology for Virtual Enterprises: Learning from CSCW

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Abstract: In this paper the aspects of a Virtual Enterprise (VE) that are essential for the design of cooperation technology for a VE are identified. The explorative approach taken in Computer Supported Cooperative Work (CSCW) research is introduced and three CSCW topics are discussed that can be applied for the solution of problems inherent to a VE.

Cooperative Technology for Virtual Enterprises

Due to the accelerated speed of change on the global market and the options provided by state-of-the-art information and communication technology different new post-tayloristic forms of organizations have emerged in the recent years. One of the most promising of them is the "virtual enterprise" (VE).

No common understanding of what a VE is has yet been reached. Some references consider a VE to be a temporary network of independent companies linked by information technology to support their cooperation and lacking a central office and organization chart. Others would also define a globally acting enterprise whose local offices are linked and supported by extensive information and communication technology to be a VE (cf. [ArHä95] for different definitions).

In this paper we will not provide yet another definition but identify different aspects that can be found in existing definitions of VEs that are relevant for the usage of information, communication and cooperation technology for VEs and that may help to extract hints for the development and refinement of such technology:

- **information and communication technology vital for success**

  The feature of a VE that is most widely considered to be important is that information and communication technology vital for success. Extensive use of this technology is considered to be a core feature of VEs (cf. [ArHä95]), and may even serve as a feature distinguishing a virtual organization from a physical-real organization ([Scho94]). Klein ([Klei95]) associates a VE in a functional perspective with telework concepts by providing the example of a virtual office where a salesperson can access all relevant information by a portable computer thus enhancing the "classical" outwork by telecooperative features like access to an enterprise's database.

- **geographical distribution**

  Another aspect of VEs besides the importance of information and communication technology is that they are usually geographically distributed. Merkle ([Merk96]) explicitly considers a virtual organization to be not a spatial and organizational unit like a traditional organization but an electronic network. This is of particular relevance for cooperation since it implies the reduction of personal contact by face-to-face communication. Thus, it is very difficult to keep up the kind of informal communication that occurs when people meet each other by chance in the hallway and start to chat about how things are going. This form of exchanging work-related information is necessary for effective work to understand the context that the work is done in and to build a common understanding and mutual trust between the communicating parties.

- **no central control authority**

  Other than a traditional organization a VE does not have a central control authority and no hierarchical organization chart. It is in all aspects less rigid and must be open for processes of change (cf. [Scho94]). In such a setting leadership does no longer mean to tell people what to do and control the results but to coach a team and to create a framework for team-oriented participation (cf. [Ott96]). The lack of a central control authority thus implies that the implemented technology must support the cooperation of a network of team members rather than just information flow along a hierarchy chart and must be flexible to adapt to the ongoing change inherent to a VE.

- **different organizational cultures**

  Along with the change or even dissolution of organizational structure the organizational culture becomes more important (cf. [KaRo96]). Particularly with the spatial separation of team members in a VE the different organizational cultures in the different locations may make cooperation more difficult. While within one team at one location that takes part in the VE it might be common that all team members have access to all data in another team at another location access rights might be handled in a more restrictive way. Moreover, the different organizational cultures have a strong impact on the trust between the participants of the VE that is considered to be the basis of cooperation (cf. e.g. [Klei94]) but also difficult to establish (cf. [Sydo96]).

These features of a VE have various implications. Faisst ([Fais95]) considers different tools and techniques for the usage of information and communication systems for a VE. He suggests to support the flexibility necessary for technology in a VE by standardization and plug-and-play mechanisms realized by object oriented software and to use cooperative information systems, computer supported organization tools and groupware.

The point made in this paper is less on *what* technology can or must be used for a VE but on *how* this technology should look like. For the design of such technology particularly suited for VEs much can be learned from the experiences and discussions in the CSCW (Computer Supported Cooperative Work) area since CSCW already has a tradition of working on the advancement of insights and technologies for organizations depending on technically mediated communication and cooperation.

Learning from CSCW

CSCW is a research area dealing with the many aspects coming along when groups communicate and cooperate through computer software. This software is called groupware. In CSCW multiple different "classical" research areas including computer science, psychology, and sociology work together to cover the broad range of requirements posed by computer supported cooperative work.

A common approach to system design in the CSCW area is requirement analysis by an analysis of the actual work practice of an organization or a subunit since an organizational chart or other official written material is usually insufficient as a basis for system design and action is more often situated than planned (cf. [Such 87]). This does not only include observation of the work place but also active participation of the (future) end users in the process of understanding the current work practice and coming up with ideas to support desirable future work practices by groupware. The end users' participation can be ensured e.g. by leading interviews with them or by conducting common workshops with end users and system developers. Another promising way to combine the end users' knowledge of their work place with the developers' knowledge of the design of groupware systems is the institution of user advocates. They are located at the developers' site and visit the end users regularly serving as mediators between the two groups and performing small scale system support for the end users at the same time (cf. [MMPB96]).

Such a feedback with the organizational practice allows for the adequate definition of initial requirements and can be combined with an evolutionary approach where stepwise improvements of the groupware system are made by introducing a new version or adapting the configuration to changed needs (see section about tailorability). The improvements can be triggered by input of the end users or user advocates after the evaluation of the initial phase of use.

Thus, methods of user participation allow for initial requirements analysis as well as for the adaptation of the software specification and its realization in the next version of the software or prototype (cf. e.g. [Kahl96] for a case study) in an evolutionary process of system introduction and improvement. Since this is also true for a VE explorative studies in VEs would be helpful to better understand how they work and how group cooperation can be supported. The usually (but not necessarily: cf. [Scho94], [MeFa95]) limited time of the existence of a VE might not allow to perform the full range of evolutionary and participatory methods in one VE. Here, new ways to ensure user participation and stepwise improvement of software must be found. This might include software development and introduction for several consecutive VEs together if one or some of the constituent organizations of the VEs remain unchanged. Also measures for qualification must be taken so that the team members working in VEs not only learn to handle a specific software but also "learn how to learn" how to do so.

Awareness and Privacy

One important aspect of a VE is the mutual trust among its members. Klein ([Klei94]) suggests that information and communication systems allowing to monitor and understand the activities of a partner in the VE may replace and at the same time support trust building measures. The discussion about this topic is lead in the CSCW community under the label awareness.

Awareness can be defined to be the "understanding of the activities of others, which provides a context for you own activity" ([DoBe92]). Several studies have shown that it is crucial for cooperation to be aware of what others do. Bowers ([Bowe94]) presents a study on the enormous difficulties of introducing computer support of cooperative work in an organization and pleads for more sophisticated awareness mechanisms in CSCW applications. Heath and Luff ([HeLu91]) provide the example of cooperation in the Line Control Rooms on London Underground where two persons working together in a computerized setting use various forms of verbal and non-verbal communication to catch each others attention and coordinate different tasks and activities. E.g., they would raise their voices or snap their fingers while making a telephone call to encourage their co-worker to monitor the call. This is meant to ensure that both have the same working context to base their decisions on. Awareness mechanisms can be considered to be one way to compensate for the spatial separation of team members in a VE since they provide means to get to know what other team members are working on currently. This can include a sign on the screen that another team member is currently using his/her computer and may be available in the office or the ability to see a history of what documents another team member has worked on in the last week.

The counter part of awareness in the discussion of computer supported cooperative work is privacy. Similar to the ways people protect their privacy in paper based work settings there need to be ways for computer supported team members to protect their privacy. But since for a good cooperation access to others and information are crucial on first sight it remains open what the computer supported equivalent for closing the door in order not to be disturbed or putting objects from the publicly accessible desk into a drawer should be. Several suggestions and remarks on the privacy issue have been made. Wulf and Hartmann ([WuHa94]) have delivered empirical evidence for the core problem of privacy in computer supported cooperative work settings. They show that technical features supporting visibility of others' work and actions have ambivalent effects for the users in supporting cooperation on the one hand while on the other hand giving way for unwanted control and monitoring. They conclude that this ambiguity must be worked on by a process of participative tailoring the application (see section about tailorability). In order to not only draw experience from working practice but to put these experiences back into practice Bellotti and Sellen ([BeSe93]) have come up with design principles for privacy issues for computer supported cooperative work. They identify a set of criteria serving as a checklist for system evaluation including trustworthiness, appropriate timing, minimal intrusiveness, flexibility, and others.

The balance between awareness and privacy may be very delicate: While a team member might want to see what someone else has done the other person might not want to give this information away. Here, the groupware system must be able to handle different adjustments of awareness and privacy to allow for the support of an adequate level of trust between different teams and team members in a VE. Ideally, the groupware system helps to move up the "spiral of trust" (cf. [Sydo96]).

Access Policy

Generally a VE has no central control authority and teams are built and disestablished with the projects that a VE is involved in. Each of the teams constituting a VE is contributing knowledge and data to the common project. This requires a flexible policy for data access in the VE that takes into account the relation of the teams and the roles of the team members in the VE. At the beginning of a cooperation in a VE where teams from two companies cooperate they

will usually not be willing to give the other team broad access to their data. During the cooperation mutual trust and the need to access each others data will grow.

Researching access mechanisms in database management systems and operating systems Greif and Sarin ([GrSa86]) conclude that these might suffice for data modeling and administration of business processes but that they are not suitable for cooperative work processes. While traditional approaches rely on hierarchic access rights that usually can only be changed by a system administrator groupware systems particularly for a flexible organization like a VE need to provide means for teams and even individuals to grant access rights for data they "own" and change them themselves according to the changing needs of cooperation.

This requires the possibility to define different roles for users (e.g. a user is a team member both in team C in project X and in team D in project Y), to specify particular access rights for each operation, user, and object and to build access control lists (ACLs) to grant rights for users dynamically. For the case of a conflict between the "owner" of data and another person unsuccessfully trying to access these data the system should provide the possibility to negotiate about the access about an additional communication channel (cf. [Pfei95]).

One promising approach for teams and team members to define access rights for their objects is taken by Stiemerling ([Stie96]) who has system users set up rules for access (e.g. "For a member of team A it is allowed to read object MyExcelSheet.") and assign values to conflicting rules so that the rule with the highest value which is usually the most specific one is triggered.

Tailorability

Groupware that is meant to be used in a VE needs to be very flexible. Not only must it meet the needs of all the teams from different organizations that build a VE at one time but also be adequate for different VEs that an organization might contribute to at the same time or consecutively. Moreover, the requirements even within one VE can change over time and different subunits within one organization will also have different requirements. Thus, the groupware should be tailorable to the needs of a VE including the (possibly conflicting) needs of the different participating organizations, teams, and individuals.

Tailoring a software to the current needs can take place on different levels and can be performed by different persons. Henderson and Kyng ([HeKy91]) distinguish the three levels *choosing between alternative behavior*, *constructing new behavior from existing pieces*, and *altering the artifact*. To cover this range from simply picking an option to using an advanced scripting language or even programming different persons including end users and user and system support staff must be involved in tailoring. Much of the functionality to be tailored affects a whole group of persons: e.g. automatically forwarding a mail affects

- the sender who usually is not aware of the fact that other people than the intended recipient read the mail,
- the "original" recipient who changes the system behavior to forwarding the mail,
- the persons to whom the mail is forwarded and who receive a mail that was not written for them.

Therefore, tailoring groupware is not just an individual but also a team-related action. Some good experiences have been made with "translators" who support users and groups in tailoring

and sharing individual customization and at the same time "translating" between end users and system support or developers about how both groups can work together to reach a well-tailored system (cf. [Kahl95]).

Particularly for a flexible and fast-changing organization like a VE with possibly enormously different requirements from the participating teams tailorability is not only demanded from the groupware system but needs to be supported by the VE's organizational culture e.g. by providing tailoring staff or rewarding reasonable tailoring activities by teams or team members.

Conclusion

The geographical distribution, lack of central control, and difference of organizational cultures of the participating teams are the challenges that a VE poses to information, communication and cooperation technology. They result in the problems of many different and changing requirements for the cooperation software and the difficulty to build up a trust relationship between the teams due to the lack of casual meetings and informal communication.

Here, CSCW can provide help. Examples for this are the research discussions about awareness and privacy, access control and tailorability. They give hints on where to focus the endeavor and provide (partial) solution. While this paper sheds a light on only some selected CSCW topics we believe that the general CSCW approach of exploring concrete organizations and work settings and then design or improve and configure groupware applying end user participation and stepwise evolution of the groupware in use are adequate for VEs since they allow to deal with a VEs complexity and dynamics. This complexity and dynamics lets inevitably fail any attempt to put technology into an organization if it is based on the belief that the requirements and future needs can be anticipated.

Much of the intra- and inter-team dynamics are beyond the scope of technical support but cooperative technology is strongly affected by them and makes them visible. Therefore, the design, development and tailoring of groupware for a VE must be accompanied by organizational measures to overcome the difficulties inherent to a VE.

While, however, CSCW experiences provide a valuable basis still much work needs to be done on the concretization of methods and solutions for the particular requirements of a VE.

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