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An Empirical Study on Human and Information Technology Aspects in Collaborative Enterprise Networks

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Abstract: Small and Medium Enterprises (SMEs) face new challenges in the global market as customers require more complete and flexible solutions and continue to drastically reduce the number of suppliers. SMEs are trying to address these challenges through cooperation within collaborative enterprise networks (CENs). Human aspects constitute a fundamental issue in these networks as people, as opposed to organizations or Information Technology (IT) systems, cooperate. Since there is a lack of empirical studies on the role of human factors in IT-supported collaborative enterprise networks, this paper addresses the major human aspects encountered in this type of organization. These human aspects include trust issues, knowledge and know-how sharing, coordination and planning activities, and communication and mutual understanding, as well as their influence on the business processes of CENs supported by IT tools. This paper empirically proves that these aspects constitute key factors for the success or the failure of CENs. Two case studies performed on two different CENs in Switzerland are presented and the roles of human factors are identified with respect to the IT support systems. Results show that specific human factors, namely trust and communication and mutual understanding have to be well addressed in order to design and develop adequate software solutions for CENs.

Keywords: Collaborative enterprise networks, human aspects, trust issues, communication, ICT support
Categories: M.4, M.9, L.3.1, .L.6

1 Introduction

Enterprises today are aware of the potential benefits related to their membership in collaborative enterprise networks (CENs). The CEN consists of a variety of autonomous entities (e.g. organizations and people), geographically distributed, and heterogeneous in terms of their operating environment, culture, social capital, and business goals [Camarinha-Matos and Afsarmanesh, 05]. Although different objectives can be pursued, most of the companies are interested in cost reduction and market penetration as the main objectives of joining a network ([Gruber et al., 05], [Warner and Witzel, 04]). A collaborative enterprise network evolves dynamically over time, depending on the different business opportunities proposed by the customers. This means that the selected enterprises may differ from one business opportunity to another in order to react correctly and efficiently to the evolution of the exact needs of customers. Two particular networks can be identified: horizontal and vertical CEN. As opposed to vertical CENs, in which the competences of the enterprises are complementary to address a business opportunity, the companies belonging to horizontal CENs have similar competencies and are mainly interested in increasing their capacities (inventory, production, human resources, etc.).

Many of those companies that have joined or built a network with the help of governmental funding do not survive after the funding agencies stop their financial help. The failure is mainly due to the inadequacy of the IT tools and softwares to the business processes, in particular those integrating human and organisational factors [Pouly et al., 05]. Furthermore, human aspects are recognized as a fundamental issue to consider in CENs as neither organizations nor IT systems, but rather people cooperate. This paper addresses the main human aspects encountered in this form of organization which are:

- trust issues,
- knowledge sharing,
- coordination activities,
- communication and mutual understanding

and their relative influences on the business processes and the corresponding supporting IT tools.

Several researches in the area of technical and organisational enablers of CENs have been carried out to identify the benefits, from a company point of view, of an IT-supported network and the advantages of taking part in CENs [Camarinha-Matos et al., 08]. On one side, some works focus either on the logistical performance evaluation or on the financial aspects of business (see [Chituc and Nof, 07], [Cheikhrouhou et al., 10] and [Gomes-Casseres, 03]). Furthermore, several works focus on the design, development or implementation of IT software for global CENs frameworks (see for example [Rabelo at al., 09], [Chituc et al., 09] and [Nami and Tavangarian, 07]). On the other side, [Rocha et al., 05] presented a series of IT tools and methodologies that may be of help in supporting the design and the establishment of CENs. Similarly, several researches address trust issues and consider it as a technical attribute of security requirement for IT systems supporting the management of virtual organisations [Luo and Ni, 09]. However, all these works are mainly focussed on the

IT systems and do not consider the human factors that may have changed the technical requirements and specification in designing and developing such systems.

[Forzi and Peters, 05] developed a global methodology integrating technical, organisational and human factors to design a knowledge management system for CENs. However, the human factor has been limited to the know-how frame of knowledge management software. In addition, [Lugger and Kraus, 01] argued that knowledge management does not seem to attach enough importance to the issue of communication, in particular, to internal communication which is one of the four factors considered under study. In addition to human and organisational transfer barriers identified, they find that the communication media can also contribute to create problems and barriers in knowledge transfer. In their paper, [Volpentesta and Ammirato, 07] focuses on knowledge sharing and transfer within technological districts. A technological district is a specific kind of CENs in a limited geographical area, where a variety of economic entities (enterprises, research centres, public administrations) are involved in highly intensive research activities and distributed scientific and technological processes. They introduce a breeding environment framework for technological districts that aim to realize innovation projects. However, they do not discuss the issues of knowledge sharing between enterprises belonging to the same technological district for the management of business processes.

Generally, abovementioned reviewed literatures either partially address some of the identified human aspects or consider business processes exclusively from the IT point of view in designing, developing and implementing IT systems to support creation or operation of CENs. Although very few works address the human factors in real CENs, however, they were only considered from a theoretical point of view [Loss et al., 10].

Therefore, this paper attempts to close the gap identified in the literature review, in identifying the human factors and contributing to the business processes of IT-supported CENs. Furthermore, this work addresses the main roles of these factors in the daily business with respect to the different roles of the IT systems that enable business processes and proposes, on this basis, new guidelines for the development of future human-centred enterprise software. Our findings are supported by the empirical study of 2 real CENs in Switzerland, a horizontal CEN: *The Virtuelle Fabrik Northwestern Switzerland (VF)* and a vertical CEN: *Swiss Microtech (SMT)*.

This paper is organised as follows. Section 2 explains the proposed methodology for the empirical study. Section 3 provides detailed description of the two CEN participating in the study. This section also highlights their business processes, the role of human actors as well as the IT systems. Section 4 presents the methodological design of the empirical studies and the interviews. Furthermore, sections 5-8 address and discuss different identified human aspects with respect to the situation of the CENs, namely trust issues, knowledge and know-how sharing, coordination and collaborative planning activities and communication mutual understanding. Section 9 discusses the requirements for the future generation of enterprise software dedicated to CENs. Finally, conclusion and future research directions are discussed in section 10.

2 Proposed methodology

The research methodology is based on an empirical study on 2 CENs, a horizontal one *the Virtuelle Fabrik Northwestern Switzerland (VF)* and a vertical one: *Swiss Microtech (SMT).* A complementary approach is chosen for the analysis of the networks. Complementary means taking explicitly into account that the human and the technical sub-systems. It is argued that the combination of these two can achieve better quality, through their interaction, than a quality that neither the human nor the technical sub-systems can reach alone [Grote et al., 00]. This complementary approach makes possible highlighting the behavioural factors as well as the organisational concepts related to the implemented IT systems in the companies belonging to a network. The objective of the socio-technical analysis is to identify the main human factors considered by the enterprises in efficiently running the CEN and their relative impacts on the network as well as enterprise business processes. For each network, the analyses are conducted in the form of multi-run semi-structured interviews with representatives from the enterprises belonging to the CEN as well as with the coach of the network (see section 4). Indeed, since the number of sample is not sufficient to rely upon a statistical analysis, semi-structured interviews are chosen to identify the most important human factors and their relations with the business processes. In addition, we did not use hypothesis testing since there is a need to first identify these elements.

Each interview has duration of about one hour, in which we explicitly asked the respondents to think about the main human factors that they consider or would like consider. They have also been asked about their implications on the business, the inter-organizational and the intra-organizational aspects. We conducted a content analysis using thematic units for coding the interviews [Strijbos et al., 06]. Sufficient delays between the interviews have been ensured in order to take into account different situations of the enterprises and the network. This guarantees the maximum objectivity in the representatives' answers. After this step, the main tasks and roles of the human actors as well as the technical features of the supporting software are identified and then discussed with the respective coach in order to avoid generating results in specific situations and to ensure a generalization of our findings.

3 Description of the networks

3.1 Introduction of the industrial CENs

Two industrial networks are involved in this study:
- *The Virtuelle Fabrik Northwestern Switzerland (VF)* is a horizontal CEN, founded in 1999 and consisting of 20 SMEs covering a large spectrum of activities (industrial design, engineering, metal working, electronics etc.). Its main business objective is to develop new products that are beyond the capabilities of each isolated member in terms of technical competences in a partnership environment (see [Cheikhrouhou et al., 10]). New products have been already developed within the network in the fields of urban furniture and mechatronics.

- *Swiss Microtech (SMT)* is a vertical CEN of 7 subcontracting enterprises active in the production of high precision mechanical parts (see [Pouly et al., 02]). Its main business objective is to provide a large palette of parts and services that are also beyond the possibilities of each member in terms of production and inventory capacities and develop jointly products in the medical sector.

Both networks are based on the following elements (see Figure 1):

- the industrial cluster
- the virtual enterprises

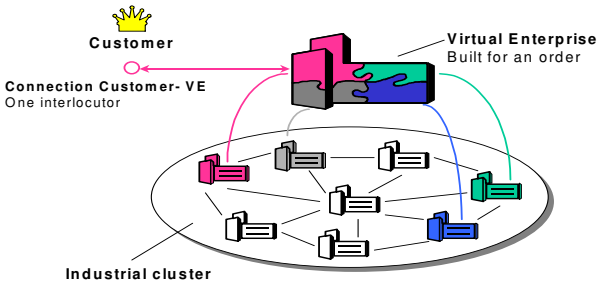

Figure 1: The constituting elements of a collaborative enterprise network

3.2 Industrial cluster

The industrial cluster is the stable basis of a network consisting of independent enterprises, which are and will remain independent within their own markets but will also be partners to enter new markets or develop new products or new services which they would not have been able to address if they were alone.

Selecting the members of the cluster is a key process during the creation of such a network (cf. [Flores and Molina, 00], [Cheikhrouhou et al., 10]). These members should:

- bring a certain amount of complementarities at the technical (machinery resources, technological know-how, etc.) and economical (markets, products, etc.) levels; the alliance is then better suited to fulfil the customer needs than any individual partner alone would have been able to,
- have a similar level of quality, for instance an ISO 9000 certification,
- share a common approach of doing business with customers, suppliers, partners and competitors (common business ethic),
- be deeply convinced that an alliance is a solution for the future and be ready to invest before collecting gains.

3.3 Virtual enterprises based on the cluster

Virtual enterprises will be set up with cluster members from the CEN to fulfil a customer need or address a business opportunity in an optimal way. The best suited

enterprises based on the technical competences as well as on their availability and response capacities will join efforts to fulfil the order or develop a new product for the most optimised costs and within the requested time. Once the project is completed, the corresponding virtual enterprise can be dissolved if the warranty and after sales issues have been finalised. Table 1 shows the different competences identified in VF that could belong to one enterprise or more. These competences are taken into account in order to find the best configuration of the virtual enterprise for a given business opportunity. Table 2 presents the different competences offered by some enterprises of VF in the frame of an answer to a given business opportunity.

Abbreviation	*Competence*
C_1	Design
C_2	Computer Aided Design
C_3	Milling
C_4	Turning
C_5	Assembly
C_6	Automation
C_7	Moulding
C_8	Coaching
C_9	Firm financing
C_{10}	Laser cutting
C_{11}	Painting
C_{12}	Metal sheet working
C_{13}	Washing

Table 1: Competence list for the The Virtuelle Fabrik Northwestern Switzerland

Comp. / Firm	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}
F_2		x	x	x									
F_3							x						
F_4								x	x				
F_5		x	x	x	x					x	x	x	x
F_6		x	x	x	x								
F_7			x	x						x			
F_8							x						
F_9										x			
F_{10}						x							
F_{11}		x											
F_{12}		x	x	x	x						x		
F_{14}	x												
F_{18}			x	x									

Table 2: Identification of enterprises competences for the Virtuelle Fabrik Northwestern Switzerland

3.4 Structure and roles

Even a light framework like a CEN needs a minimal structure to run a business. The used structure is based on *roles* ([Schuh et al., 98]). A role is a function, which can be fulfilled by one or more persons and takes place in a business or technical process in the CEN. Four main roles have been identified (see Figure 2): In/Out-sourcing managers, coach, order manager and broker.

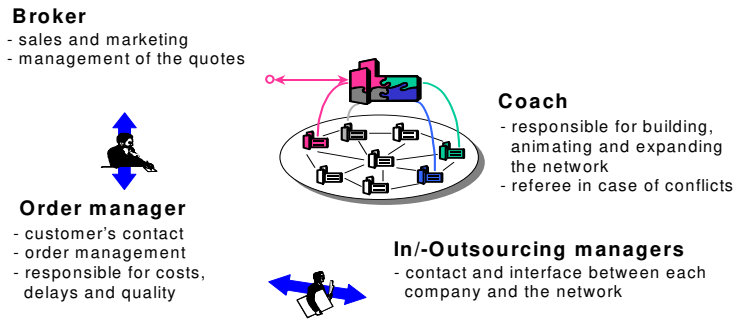

Figure 2: The human and enterprise roles within the virtual enterprise

In-/Outsourcing Managers
Each enterprise belonging to the cluster must appoint an In-/Out-sourcing (I/O) Manager responsible for the contacts within the network. The I/O manager receives the requests for quotation from the brokers and prepares the bids in case of interest.

Since reaction time is important for a customer, he/she is responsible for a timely answer. He/she is also the contact person for the order manager within a virtual enterprise in which his/her company is participating. Finally, he/she represents his/her company within the cluster and acts as a contact person.

Coach
The responsibility of the coach is the animation of the network. He/she will prospect and evaluate new possible cluster members, organize the information and knowledge transfer and also be the arbitration instance in case problem/conflict between cluster members or within a virtual enterprise occurs.

Broker
The broker « sells » the network to the potential customers and manages the requests for quotations. He/she is also responsible for preparing and following-up the quotations until their transformation into a real order. Many people can play the broker role, i.e. salesmen from the member companies, independent sales agents, etc.

Order Manager
Once a quotation is validated and transformed into an order, the Order Manager will take over the responsibility up to the delivery and beyond. He/she will be the single point of contact for the customer and must set up and pilot the virtual enterprise built for this particular job. He/she is accountable for the delays, costs and quality of the order as well as for the commercial part (internal and external invoices). A collaborator working for the company that has the biggest share of the order will normally be appointed as Order Manager.

Working groups
In addition to the abovementioned four roles, working groups can also be created to address particular problems in a smaller circle and propose solutions for the cluster without being a pillar for the setting-up of CENs. Possible working groups are: common purchases, IT solutions, etc.

4 Insights from the interviews

Relying upon the interview process described in section 2, in the case of SMT, the participants to the interviews are:
- The coach of the network,
- Four CEOs representatives of four SMEs out of the seven members of SMT,
- One purchaser from each company, member of SMT.

In the case of the VF, the interviewed persons are:
-The coach of the network,
-The order managers of a former specific project, called the 'Abfallhai' project where the network produced dustbins based on the competences of its members (see [Cheikhrouhou et al., 10]).

The semi-structured interviews deal with the way the network and the corresponding enterprises consider, identify and manage the human factors for running efficiently the business processes within the network with respect to the projects managed. Based on a content analysis of the interviews, the identified categories and sub-categories of human factors are represented in the two first columns of table 3. The main human and organizational categories identified as having a large importance in a CEN are:

- trust issues,
- knowledge and know-how sharing,
- coordination and collaborative planning activities,
- communication and mutual understanding.

Furthermore, open statements relating the human factors, considered or that need to be considered, are grouped and represented in the last column of the table by the frequency of occurrence during the interviews. This information suggests the importance of the different categories and sub-categories with respect to the total statements. In this regard, we assume that more often an issue is discussed, more likely it is important for the respondents. Percentages are also indicated in brackets in order

to give a relative representation of each category and sub-category with respect to each others.

Category	***Sub-category***	***Number of open statements***
Trust	Trust between network members	22
	Trust between the network and the customers	15
	Trust between the network and the suppliers	10
	Trust between the coach and the network members	12
Sub-total		*59 (39%)*
Knowledge and know-how sharing	Technical knowledge and know-how sharing between members	15
	Common training programs	2
	Information sharing in cross functional working teams	9
Sub-total		*26 (17%)*
Coordination and collaborative planning activities	Alignment of working standards	2
	Roles and competences of the actors	11
	Alignment of the different business processes with each others	15
Sub-total		*28 (18%)*
Communication and mutual understanding	Information/ visibility about the business opportunity /project	12
	Tracking and managing orders	16
	Negotiation and discussion	6
	Technical information and drawings repository	5
Sub-total		*39 (25%)*
Total		***152(100%)***

Table 3: Content analysis results of the interview process

As shown in table 3, the most important category cited by the respondents is related to trust issues (39%), either between different members within the CENs or between the latter and external actors such as suppliers or customers. This result highlights the importance of trust in CENs for all situations and processes. In particular, it has been noticed that trust between the members takes the highest importance as a sub-category (22%) from the point of view of the decision-makers. The second most important issue, namely communication and mutual understanding mainly shows that there is a need to communicate efficiently and regularly share information within the network about the status of customer orders, potential business opportunity and materials and information flow tracking. Indeed, 28 statements relating these sub-categories during the interviews have been considered. It is also noticed that the respondents give concrete examples fostering the importance of

electronic and oral communication related to the business. The main focus is put on visibility and product/project tracking (28% in all). On the other hand, knowledge and know-how sharing and coordination and collaborative planning activities take similar importance (respectively 17% and 18%). Even if they are linked to information sharing, these sub-categories address a different point of view. In fact, learning from others is the general issue discussed in case of knowledge and know-how sharing, whereas the relationship between business processes, actors, IT systems and their alignment are the major topics that was discussed.

5 Trust issues

Three main forms of trust are identified and classified in the studied CENs according to their nature:

§ *Path trust*
Path trust is based on an individual's understanding of how another person will act in a given situation. The feeling of having a common "path" and values intensifies the relation between each others and creates trust. As it is strongly linked to individuals, it only lasts between companies as long as the corresponding people are still present. The path trust can be asymmetric as the trustor and trustee have divergent opinions on each other's trust relationship, or can be mutual if the trust relationship is symmetric.

§ *Situation trust*
Situation trust is formed when people perform an activity based on common interest, hobby or habit. During this activity, the involved people shape a shared psychology, which is the foundation of trust among individuals.

§ *Family trust*
Family trust is a strong trust among extended family relatives, which is tied by blood and is strengthened by mutual social connections. It is a very valuable and efficient trust system in the early development stage of enterprises and networks. It facilitates the common interests among company members and helps them to reach an agreement on management goals. In comparison with previous findings, it is by far the main trust system in China's small and medium size companies [Pouly et al., 08]. This form of trust at the community level is also the base of the Italian industrial districts and can be found in some areas in Switzerland too.

In this manner, it is found that the trust is a key element to foster sharing know-how and experience between the members and to boost the business within the network. At the very beginning, trust building within a CEN is supported by formally adhering to a common chart defining:

- The goals of the new network and the limits of the collaboration,
- The member related processes: rights, duties, acceptance of new members, exclusion of members,
- The funding schemes for common activities, and
- Conflict management.

A major step to consolidate trust is to reach a first common success in riskless and simple to start activities like common supply and purchasing. Common activities

including social ones, regular meetings and common events also help building trustful relationships. The respondents argue that although the notion of trust is very important, it is difficult to (1) assess it objectively, (2) separate between inter-organizational and interpersonal trust, and (3) link it to the performance of the network and particularly to the evolution of the business. The interviewed people agreed on the fact that there is a lack of tools and software helping to design, manage and control the business processes with respect to trust. More particularly, there is still a need for IT support and software that would help to:

- assess inter-organization (inter-firm) trust independently from the user perception,
- control the level of trust and provide alerts in cases where the level is not sufficient to achieve some operations shared by the actors in an efficient manner,
- reinforce the trust between partners in acting on a specific direct lever of action (such as information exchange) or an indirect process (such as Marketing actions and common participation to exhibitions).

6 Knowledge and know-how sharing

Acting as one of the industrial pilots in charge of testing and evaluating the methodologies and tools developed in the frame of ECOLEAD, a major European research project in the area of collaborative networked organization, SMT introduced the *Bag of Assets Management System* (BAMS) developed with the support of the University of Bremen ([Afsarmanesh et al., 08]). This web-based tool consists of a repository of small modules that a member or actor could use to publish and share information with other members of the network. The information supported is related to experience and best practice exchanges, different types of guidelines, business, institutions and historical performances. Different formats of file are allowed to be stored in the BAMS, such as PDF files, MS-Word files and graphical files. Since the system designed allows sharing knowledge, know-how and data, one of its important functions is to provide a common understanding of the concepts related to the assets and their representations in the BAMS.

BAMS mainly covers the following functions:

- *Information publishing:* lessons learned, technical and commercial items, know-how assets and general information of interest can be published using an embedded rich text editor and made available to the other members of the network depending on their access privileges.
- *Bag of Assets information viewing*: the access to the information in a rapid manner through displaying the list of asset items and providing different ways of criteria-based search.
- *Items evaluation*: allowing the network administrator to classify, accept or refuse items and assign a value to them.
- *Database administration:* allowing the network administrator to update and clean the items database.
- *Support of network member rewarding process*: the rewarding mechanism is a specific process that characterizes CENs and represents a way to share benefits and to promote cooperation in the network. The function is mainly supported by a set of

both textual information and data, allowing the representation of human judgments and the assessment of operations by the actors.

The results show that a simple and rapid possibility to publish information contributes to motivate the collaborators of the enterprises to share not only general information but also the technical know-how, which is of high value for the achievement of a business opportunity. Nevertheless, know-how and knowledge still represent a specific power that could be exercised and reflect the value of a collaborator in his/her organization, as they are the main elements composing the competence concept. The actors remain reluctant to share their knowledge if:

- they feel that their value for their company will be reduced and their job jeopardized,
- the goals and the reasons for their company to be member of a collaborative enterprise network have not been clearly explained at all levels of the hierarchy,
- no effort has been made to present to the other members their products and their collaborators. This aspect is more reinforced in the horizontal CEN where the enterprise competences differ from a company to the other.

In this manner, it has been noticed that the value of shared information can vary from a company to the other, particularly in the vertical CEN, without being able to objectively estimate the value of this information. Further research is still needed to develop methods and tools to evaluate the economical value of each shared know-how item with the other members of the network and to better exploit the accumulated thesaurus of know-how.

7 Coordination and collaborative planning activities

Participation in a CEN induces new business processes for enterprises that can be different from those found in classical enterprises. Table 3 shows that the respondents consider coordination and collaborative planning activities as part of the human factors in CENs, since they address the alignment of working standards, the roles and competences of the actors and the alignment of the different business processes with each others. The latter is the most critical issue (15 times cited) and consists of ensuring coherence and efficiency of the business processes related to the CEN and to the actors and their corresponding competencies. Indeed, the main identified processes in a CEN are: quotation, order processing and order delivery and warranty. In figure 3, the standard processes are shown in white rectangles, whereas the additional sub-processes, corresponding to the new activities within the CEN, are represented in grey colour.

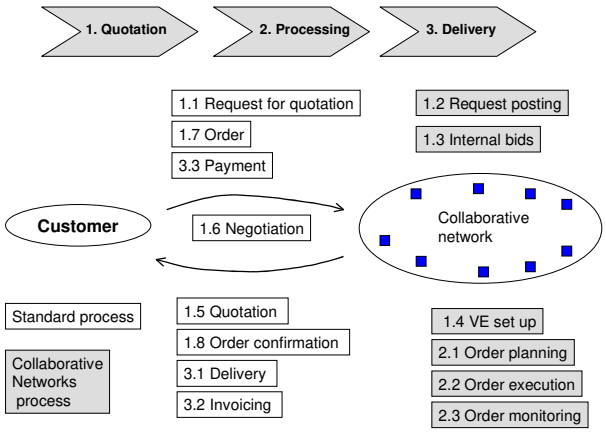

Figure 3: The business processes identified in CENs and their relationships

7.1 Quotation process

First of all a virtual enterprise must be built to prepare a quotation if different enterprises are involved in capturing the business opportunity. The main actions at this step are:

- posting the customer request for quotation or the project idea to inform the network members
- getting internal quotations and the expression of interests for participation by the members
- selecting the best fitting constellation to handle the quotation and realize the project
- coordinating the preparation of the quotation and plan the new project development
- technical and commercial negotiations with the external customer

7.2 Order processing

In case of an order acceptance, the virtual enterprise must process the order and coordinates the activities of the participating members as follows:

- order planning
- progress monitoring
- cost monitoring
- quality monitoring
- problems solving

7.3 Order delivery and warranty

This classical business process that one may find in a manufacturing company could be extrapolated from enterprises to the CEN. It includes the following processes:

- final order delivery
- invoicing

- sharing the benefits or losses between the members
- warranty and after sales services

8 Communication and mutual understanding

Webcorp2 is a second generation Internet-based collaboration platform developed to support collaborative work and virtual teams. Following different standard functions are developed as briefly shown in figure 4:

- MyDesk, personalised view of all relevant information and actions
- Community and organisation picture
- Document management and Web-Content handling
- Agenda, tasks, news
- Messaging like forums, mail, chat
- Project management (planning and controlling)

New functions have been added for the VF to support specific communication, cooperation and coordination requirements of the enterprise network:

- Competence database
- Internal order management system
- Customer Relations Management (CRM)
- Net2Net communication (overlapping the collaboration network)

8.1 Competence database

The competence database is used to efficiently search for the required competences (expertise), technologies and production resources within the network. Intelligent searching mechanisms allow a fast search process relying on the input information as shown in table 1 and table 2. Furthermore, the competence database is made public and can be used by all interested persons (sales agents or potential customers) via the VF homepage to identify if the network has already acquired the needed competences to realise a given project.

8.2 Internal order management system

The internal order management system (IAMS) is the heart of the collaboration platform and is used to handle and post inquiries mainly during the quotation coordination and preparation phase. This module creates transparency about the customer activities, the participation of the partners to the orders and the realized results. A customer inquiry goes through a 3-stage process: inquiry, quotation and finally order. Inquiries are directly uploaded to the platform by the customers or the network brokers and the different consequent processes are systematically monitored.

A new generation of collaboration platform based on the most recent programming and web technologies is developed in the frame of the European project eCoSPACE (eProfessionals Collaboration space) [Ecospace, 10]. The target is to improve commercial processes in CENs through the development and implementation of the following features:

- Easy integration and data exchange between different commercial business software, thus making the cross-enterprise processes efficient and effective
- Real time functions like audio and video conferences, desktop and file sharing allowing every employee to cooperate online anytime and anywhere
- A multi-project management and controlling system
- New process oriented user interface allowing inexperienced collaborators to use the platform with minimal training and without going through a knowledge management system.

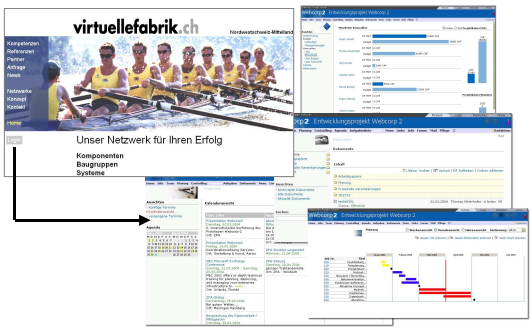

Figure 4: The collaborative software "Webcorp2" screen snapshots

8.3 Discussion and negotiation tool

Industrial companies, including those studied within SMT and VF, normally use drawings as the main source of technical information and data. Unfortunately, different legacy CAD systems are used and a full interconnection between these software and the manual drawings is hardly possible. Nevertheless, the recent versions of standard PDF browsers allow the exchange of 2D or 3D CAD drawings in PDF format. Today, many different commercial programs exist to allow technical discussions on the Internet. A powerful and easy to use 'desktop sharing' tool. The software GoToMeeting® [Citrix, 10] is used for e-discussions between the members. This software has following features:

- "Software-as-a- Service" tool, i.e. no local installation or maintenance required
- no high-speed connection required
- only the "host" of the discussion needs a software license
- very easy and intuitive handling
- low price
- good technical performance

The software "GoToMeeting®" allows people to show attendees any application or file-like documents, drawings, etc. on their own computer screen using the Internet. In combination with the voice over IP function, the discussions can be conducted as if the meeting attendees are sitting together in front of the same computer. The control of the keyboard and mouse, or the facility to use the "pen-function", can be given to any

attendee just by clicking on the corresponding name in the participant's list. These functions allow them to draw directly on a document uploaded on the host's screen, visible for everybody, and independently from any running software at that time. This feature is used during technical discussions to highlight details directly on drawings or add other information related to an order or a business opportunity as shown in figure 5.

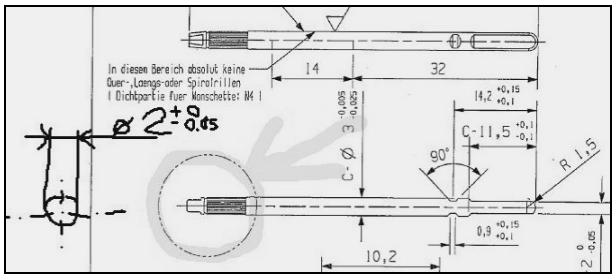

Figure 5: Illustration of the use of the "pen function" in discussing technical drawings between enterprises

8.4 Common understanding tools

Technical misunderstandings appear between the members of a network if they work in different cultural and industrial environments and do not communicate regularly. Notions, symbols or terms, which are obvious for one side and are normally not explicitly described, could be unclear for the other side and reciprocally. The consequences of these misunderstandings considerably disturb the business processes and add additional costly delays. This kind of problem can be avoided through the use of ontology. The Ontology Discovery and Management System tool ODMS developed within the European ECOLEAD project (see [Ermilova and Afsarmanesh, 07]) supports ontology functions at different levels of abstraction:

- the *meta* level represents meta-concepts like the abbreviations or acronyms used to define other concepts,
- the *core* level used to define common concepts, notions and terms related to the CEN,
- the *domain* level used to define common concepts, notions and terms related to a specific activity such as metal working or tourism, and
- the *application* level used to define usual concepts, notions and terms related to a particular network like SMT for instance.

At the application level, terms or notions such as the commonly used norms and standards (ISO, DIN, etc.), definition of particular machining operations and surface finishing or specifications for raw material (for instance, SMT uses the definitions of the so called German "Stahlschlüssel" handbook to specify steel) can be introduced in the corresponding ontology database and viewed through a web browser. The concepts, symbols and terms introduced in ODMS do not have to be explicitly defined again during the clarification phase of the request for quotation process, thus considerably reducing the risk of misunderstanding between people as well as between

partners.

9 Discussion

Beyond identifying the main human factors, this work shows the way these factors are perceived and managed in the companies belonging to a CEN and their relations with the IT systems. Either in horizontal CEN (VF) or vertical CEN (SMT), the importance of these factors is emphasized by the respondents and highlighted during the interviews. Indeed, new insights about the perception of human factors in CENs are given. Addressing them by supporting software or IT systems is also needed. Current IT systems are dedicated to support organizational structures and business processes rather than assisting in shaping the human factors to comply with the requirements of efficient and agile networks. There is a class of software, namely social business software that intends to create a human/social perspective of communication and coordination. But this class of software forces business users to adopt narrow social visions imagined by the developers. Social business software does not solve business problems either in a CEN or in its constituting enterprises. They exaggerate the real problems of managing business processes by creating distractions and support more disconnected data, information and applications. As a conclusion, separated and isolated pockets of socialization bring little value to a CEN. Even if there are software and tools aiming at developing the human factors in CENs and in their members, they are still at the early stage of a new era.

Therefore, there is a need to create and design new classes of enterprise business software integrating human aspects and to provide social tools for creating efficient communications and valuable interactions within a CEN. To reach this ambitious objective, some recommendations could be provided for software developers as well as for users.

- Addressing human and social aspects as a sole interest is not worthwhile. Ensuring coherence around the contextual information and data is the main concern for the new enterprise business software. Managing transversal information along the business processes in a network is an important requirement.
- Any software enabling human and social aspects should focus on the user not only as an individual but also as a group of individuals or network members.
- Not only the level of trust has to be monitored and controlled, but the corresponding tools should be able to propose the adequate levers of action able to solve critical or conflicting situations. Additional elements could be found in [Ayadi et al. 11].
- The current situation of the two studied CENs show that the tools should be able to address priory trust and communication and mutual understanding categories. This may change in the future depending on the context of the network. Consequently, these tools should also be able to address the human aspects related to knowledge and know-how sharing as well as coordination and collaborative planning activities.

10 Conclusions

Considering the huge potential for CENs in all sectors of economy, only very few examples are really operational. Furthermore, a very high percentage of newly created networks disappear in the first two years of their life cycle. Different hypotheses could explain these facts:

- Some networks are not market-oriented and do not bring significant competitive advantages to the customers
- The collaboration domain is not clearly defined and therefore conflict of interest arises
- Collaboration is not necessarily the common way of working for companies that have been working isolated for a long time. Changing the mentalities of the employees could take time.

Since people and neither organizations nor IT systems collaborate, the human aspects are and will remain crucial to successfully set up and run CENs. So far, research efforts have been concentrated on the theoretical organization and on the design, development and implementation of IT systems. The current paper addresses the question of the identification and the role of the human factors within IT-supported CENs. These aspects namely trust issues, knowledge and know-how sharing; coordination and collaborative planning activities and communication mutual understanding have been considered as highly important by the two CEN participating in this study. It is noticed that there are some differences between a horizontal and vertical CEN in organisation of the business processes and in the roles played by the human aspects with respect to the IT support systems. In addition, the perception of human aspects is mainly related to trust and communication and mutual understanding rather than coordination and collaborative planning and knowledge and know-how sharing. These differences, addressed in this work, have to be taken into account when designing new methods and tools for CENs. Furthermore, we provide insights about the future enterprise business software to cope with the needs of CENs, in particular the efficient integration of human and social aspects. The main focus is then put on the software for groups rather than individuals.

The main limitation of this work is the lack of statistical evidence for the analysis, since the number of answers did not allow a generalisation of our findings. As a consequence, the validity of this analysis should be complemented with additional case studies.

Future research directions concentrate on topics like trust building and assessment since it constitutes a major element in setting up and running efficiently collaborative enterprise networks. Concerning the IT side, the “Software-as-a-Service” approach particularly fits the needs of SMEs, in addressing human aspects, since they have scarce IT resources. Accessing these services on the Web and using a Pay per Use scheme would be a major way to promote IT support for human and social aspects in collaborative networks of SMEs.

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