The Impact of Teleworking on Organisations and Human Resources

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1 Introduction

Today, organisations and enterprises are currently facing fundamental changes such as rapidly changing markets, global competition, dynamic modifications in the economical and political environment, introduction of information technology, and world-wide availability of information. Consequently, enterprises have started to reengineer their internal structures by decreasing the size of organisational units, increasing the local autonomy, decentralisation, networking, and cooperation in decision making. In nowadays organisations, there is an increasing demand for cooperation and learning that arises from the trend towards global markets and the rapid development of new knowledge skills required by workers. New organisational forms, such as virtual organisations, are being developed to address the needs for more flexible and effective production processes and services in the global economy.

A virtual organisation may be defined as an organisation without walls in which complementary resources of cooperating entities are left in place but are integrated to support a particular group endeavour, regardless of the geographically locations of people or resources. Virtual organisations include virtual laboratories [KMW96], virtual office processing systems, virtual environment for design and virtual manufacturing companies, virtual classrooms and virtual environments for training. New developments at the level of hardware, distributed operating systems and distributed databases have provided the means for developing the necessary infrastructure of virtual organisations.

In fact, as information technology, Intranet and Internets will become more and more an integral part of any organisation, the difference between traditional and virtual organisations will be blurred. It seems therefore that one of the keys of success in developing virtual organisations is the capacity of collaborative remote work trough computer networks, the possibility to access distributed data and knowledge trough the same networks, and the possibility of the members of a virtual organisations (both individuals and parts of the organisation) to be actively supported by NIT (New Information Technologies) tools in the learning on-demand process.

Several important characteristics can be identified for such emerging distributed organisations: effective cooperation and communication between different parts of the organisation to achieve common and individual goals, efficient storage, retrieval and utilisation of previous experiences, adaptation to the environment, and learning at individual, group and organisational level. To be able to achieve such characteristics in an organisation, new organisational concepts and NIT tools are and will have to be developed. Based on recent work of organisational researchers, the new concepts of organisational intelligence and learning organisation have emerged. They will be briefly presented in Section 3.

2 Teleworking

Computer-supported cooperative work (CSCW), or cooperative teleworking, refers to people working together on a product, research area, topic, or scholarly endeavour with help from computers [Gru94]. This field is also known as computer-supported collaboration, GroupWare, or Group Decision-Support Systems. Ellis [tele98] defines groupware as "computer-based systems that support groups of people engaged in a common task (or goal) and that provide an interface to a shared environment. While groupware refers to real computer-based systems, CSCW refers to the study of tools and techniques of groupware as well as their psychological, social and organisational effects. According to Wilson [tele98], "CSCW is a generic term which combines the understanding of the way people work in groups with enabling technologies of computer networking, and associated hardware, software, services, and techniques." Key issues of CSCW are group awareness, multi-user interfaces, concurrency control, communication and coordination within the group, shared information space and the support of a heterogeneous, open environment which integrates existing single-user applications.

Group interaction may take place in the same location or in geographically dispersed locations, in which case communication is either face to face or distributed. Interactions may also take place at the same time, namely in synchronous mode, or at different times, asynchronously. A combination of the time/place categorisation gives the basic ways in which people can work together supported by computers. For example, if the group activities take place at the same time but participants are located at different sites, they are working in distributed synchronous mode. CSCW applications also differ in the extent to which they structure human contact [GK90]. In contrast to e-mail and MUDs (Multiuser Dimensions), CSCW systems do not just use computing as a message channel; they also use computer processing to impose structure on the communication [GK94].

CSCW spans a wide area of applications. Typical applications refer to videoconferencing systems, synchronous Web exploration, collaborative authorship applications such as shared editing of a paper or collaborative design of a product, shared whiteboards or shared electronic notebooks, chatting, and electronic meeting rooms. Many applications, for example information-oriented, business conversations, require to visualise and collectively share information objects, such as documents, charts, etc. Other applications requires the manipulation of more sophisticated objects and the visualisation of the persons in the virtual group, and tele-immersion is the new direction of research that searches to find solutions for such situations.

A CSCW system relates functional features with social aspects of teamwork. Each functionality has an impact on the work behaviour and efficiency of the entire group using the system. These functionalities also influence the behaviour of individual group members. Therefore, the psychological, social, and cultural processes within groups of collaborators are important aspects to be taken into account in CSCW systems. Within a group of people working together, several types of relations are possible. Most common found ones are peer to peer, in which persons on the same level are involved in cooperative problem solving, coordinator-members of the group, in which a manager is conducting work over the network, or mentor-student, in which a professor or a senior scientist is guiding the work of the team members.

Computer-supported cooperative work applications offer a powerful technology to implement new learning environments and to make the best use of both collaborative and open-ended activities in learning. CSCW applications conceived for education can, on one side, make use of alternate styles of learning, including user-centred learning, and on the other, are able to free up learners from carrying some cumbersome and routine tasks and focus on the content of learning. Integrating CSCW learning with work may allow a smooth transition from work to learning on-demand and may encourage cooperative learning to lead to efficient knowledge transfer processes.

3 Integrated Working and Learning

For organisations, both classical and virtual, learning is very important. Through learning, organisations adapt to change, avoid the repetition of past mistakes, and continuously improve their performances and competitiveness. "In a time of drastic change, it is the learners who inherit the future. Those who have stopped learning find themselves equipped to live in a world that no longer exist" [Min94]. We are in an information society and knowledge workers constitute the primary means by which organisations compete. As knowledge becomes more central to competitiveness, the ability of individuals and organisations to learn becomes a primary means for winning. Nowadays, learning is frequently a part of the task itself. Learning and work have become almost synonymous terms. Rather than learn in preparation for work, personnel must learn their way out of the work problems they address. Learning is a new form of labour. Learning is not something that requires time out from being engaged in productive activity; learning is the hart of productive activity [Dix93]

A *learning organisation* is an organisation that focuses on the continuous improvement of its processes, products and/or services, that facilitates the learning of its members, both individually and independently and as groups and teams, that continuously transform itself in order to meet its strategic goals. Analogous to individual learning, organisational learning is defined as increasing an organisation's ability to take effective actions [Kim93].

Organisational learning is the outcome of three overlapping spheres of activity – individual, team and system learning. All three kinds of learning take place simultaneously. Individual learning takes place each time an individual reads a book, performs an experiment, or gets feedback from workmates or colleagues. Team learning takes place when two or more individuals both learn from the same experience or activity. Team learning may involve new ways to address the team's responsibilities, or it may involve some aspect of the interaction between members of the team themselves. System learning takes place when the organisation develops systemic processes to acquire, use, and communicate organisational knowledge.

As the capacity of learning of an organisation is such a strong demand nowadays, integrating working and learning in an IT based environment is one of the current focus of research and development in both traditional and virtual organisations. Several working and learning situations can be identified in an organisation: individual work, individual learning, cooperative work, and cooperative learning. These situations are not disjunctive but have overlaps referring to situations containing a mixture of work and learning and a mixture of individual activity and cooperation. Another meaning of the overlaps is to view them as transitions between different situations. Support for these situations requires not only the provision of support for each individual class of situations but also the support for the transitions between them. Furthermore, due to the mixture of these situations within work processes there is the need to support the integration of these situations as well. This integration will lead to reduced costs for learning in the organisation and to the potentially increased work quality due to better availability of knowledge. A CSCW environment may adequately support this new paradigm in which the traditional separation between work and learning will be blurred.

One of the ambitious project that tackle these requirements is CONCERT [Haa98], aimed at building an environment that supports cooperative work and cooperative learning as well as the integration of both activities, and the development of required tools and methods for the design and implementation of such an environment. CONCERT was created with the goal to develop a generic cooperation environment platform and methods and tools for building prototypes of integrated cooperation environments on top of the platform. Such a platform had to address integrated flexible coordination support that can deal with changing cooperation processes, making the environment situation-aware and adaptable to new usage situations, the integration of existing applications and information sources, and the provision of different cooperation modes.

Several current projects are under development in the scope of CONCERT. CHIPS (Cooperative Hypermedia Integrated with Processes Support) aims at supporting flexible coordination of team work with cooperative hypermedia. Flexible coordination includes the support for the whole spectrum of informal and formal coordination mechanisms, and the flexible adjustment of coordination mechanisms along this dimension. Methods on how to use cooperative hypermedia concepts to uniformly model all objects that represent coordination mediums and shared artefacts are developed. Clear (Cooperative Learning) designs learning scenarios integrating individual and cooperative, distributed and co-located learning, and develop methods and tools to support these scenarios. COAST (CoOperative Application Technology) aims at supporting groupware developers with toolkits and methodologies for the design and implementation of fully group-aware applications. In this project, the COAST framework is developed that consists of methodology, tools, and generic components for the construction of synchronous groupware based on shared dataspaces. POLIWORK (Telecooperation and Document Management at Personal Work Place) provides support for time and location independent cooperative work among people in distributed organisations, focussing on the application domain of the distributed German government.

Based on the novel approaches to conceive organisations, a new concept emerged: organisational intelligence, which originated from work of organisational researchers in Japan [Mat91] and the United States. *Organisational intelligence* integrates human and machine-based knowledge processing and problem-solving capabilities in which the "computerised" parts of the organisation must be able to cope with the aims, objectives, strategies, and operations of the company, as well as to contribute to the general organisation's "intellectual" capabilities. In such structures, information technology is not merely a tool for communication and data management but has started to play an active role in the design and implementation of organisational strategies.

Organisational intelligence can be divided into: organisational memory, organisational learning, organisational communication, and organisational reasoning. Organisational memory enables an enterprise to preserve, remember, and utilise its experience (information about successes and failures in the past) and, thus, to learn from or to apply its individual history. From the IT point of view, organisational memory may imply data bases and knowledge bases, model bases and case base reasoning, in the case of virtual organisations such resources being distributed and stored using different models. Organisational communication refers to the total amount of exchange of data, information, and knowledge which evolves among the human and machine-based actors within an organisation and between the enterprise and the environment. Organisational learning refers to an organisation capability to identify and store knowledge derived from both individual and organisational experiences, and to modify its own behaviour according to feed-back received from its environment. In the concept of organisational intelligence, organisational learning is performed at three different levels: individual learning, performed by individuals, micro-organisational learning performed by a group of people in the enterprise, and macro-organisational learning that evolves the organisational macrostructure. Organisational reasoning includes organisational problem-solving and strategies such as coordination of activities, cooperation to achieve a goal, coalition formation among processing units that temporarily share common goals, and problem encapsulation.

Following these recent trends, two important projects have recently started at "Politehnica" University: one to develop an multi-agent system environment to support the design and coordination of virtual organisations and the second to create a cooperative environment for open learning. The AGCOR project [Flo98, Flo99a] implies building a model and a programming environment that will allow the specification and design of flexible organisational structures, the simulation of organisation functioning, and the development of applications to coordinate the activities in a particular organisation. From a conceptual point of view, the project will show the mutual benefits of combining multi-agent technology with organisational theory, launching challenges at scientific research level. In the same time, the AGCOR system will try to support the concept of organisational intelligence, in particular organisational problem-solving and organisational learning. From a practical point of view, the main interest of the project is the development of a tool to show how multi-agent system technology may contribute to the enhancement of organisation functioning and to apply this paradigm to organisational coordination. The second project refers to an open learning system [Flo99b, Flo99c] based on a CSCW environment in which cooperative learning is achieved either between the student and the tutor/expert or inside a group of learners interacting with the tutor. The system comprises an artificial tutor that tries to partially replace the human one during the students' interactions with the system, personal agents to assist the students and to create the learner profile, and an information agent to search relevant information. The architecture of the system is a multi-agent one, human and artificial agents collaborating together to achieve the learning task.

4 Tele-Immersion

Recent advances in computer vision, computer graphics, networking and communication over computer networks offer opportunities for realising what was only a dream till recently, that is a realistic compelling experience for humans of tele-immersion. Tele-immersion, or Collaborative Virtual Reality, is the unification of Virtual Reality (VR) with CSCW in virtual environments to provide the "ultimate" sense of co-presence. Tele-immersion is an extension of the "human - computer interaction" paradigm with the computer providing real-time data in shared, collaborative environments, to enable scientists to interact with each other as well as their computational models, over distance. Current tele-immersion research focus on providing easy access to integrated heterogeneous distributed computing environments, whether supercomputers, remote instrumentation, networks, or mass storage devices, using advanced real-time 3D immersive interfaces. But tele-immersion is not aimed only to be used by scientists.

Tele-immersion will enable users in different locations to collaborate in a shared, simulated environment as if they were in the same physical room. It's the ultimate synthesis of networking and media technologies to enhance collaborative environments. In a tele-immersion environment, computers recognise the presence and movements of individuals and objects, track those images, and then permit them to be projected in realistic, multiple, geographically-distributed immersive environments where individuals can interact with each other and with computer-generated models. Andy Johnson from ImmersaDesk™ says: "There are some things that collaborative virtual environments will be better at facilitating than other means of communication. Video teleconferencing, phone calls, letters, email, and face-to-face discussions all have their strong and weak points. In areas of design, scientific visualisation, end education, sharing a virtual space with your work as well as your collaborators offers an incredible opportunity for discovery."

Tele-immersion implies high-intensive computations for image recognition, speech understanding, speech synthesis, real-time 3D visualisation of images and movements which are, on one side, those of the people participating in the immersive environment, and, on the other side, the results of the common work of the group of people in the environment. We can consider tele-immersion as one of the most provocative directions of investigation of today virtual spaces.

Several projects dedicated to the creation of tele-immersive environments are currently underway. The NCSA (National Computational Science Alliance) launched in 1997 a tele-immersion project coordinated by the Electronic Visualization Laboratory of the University of Illinois at Chicago [EVL99]. Among the aims of these project, it can be mentioned: collecting, maintaining, developing and evaluating tools of immersive virtual environments (e.g. visual, audio, tactile and movement-based displays), the large access of researchers to the specific equipment of such environments, and the promotion of computer-assisted artistic creation. For the time being, the project relies on the virtual reality platforms CAVE™ [EVL99] and ImmersaDesk™ [EVL99]. CAVE is a Virtual Reality Theatre conceived as a multi-person, room-sized, high-resolution 3D video and audio environment. To see the virtual environment in stereoscopic 3D, users wear Stereographics' CrystalEyes liquid crystal shutter glasses. To navigate and interact with the virtual environment, several Wands (3D mouse with a joystick and tree buttons) are available. CAVE monitors the position of the user's head and wand-holding hand. EVL has enhanced CAVE technology and created derivative projection-based collaborative virtual reality environments: the ImmersaDesk™ and the Infinity Wall. CAVE, ImmersaDesk and InfinityWall are used to elaborate several applications such as collaborative design of prototypes, interpretation of meteorological data, estethic experiments of virtual reality.

EVL and University of Tokyo's Intelligent Modeling Laboratory (IML) will study collaborative problem solving over advanced networks between EVL's CAVE and Tokyo's CABIN (Computer Augmented Booth for Image Navigation), a VR theatre with images projected on 3 walls, the floor, and the ceiling. This is main focus of the Networked Virtual Environments Collaborative Trans-Oceanic Research (N*VECTOR) between EVL and IML, whose goal is to better understand the requirements of multiple media flows among sophisticated virtual reality displays over great distance. This trans-Pacific tele-immersion effort is supported by Japan's Nippon Telegraph and Telephone Corporation (NTT) and managed by pacific Interface in Oakland, California.

5 Conclusions

Organisations and enterprises world-wide have begun to reengineer their activities and processes, and adapt their structures to a dynamically evolving environment. This has lead to a widespread decentralisation, which consists of autonomous organisational units globally distributed, committed to the distribution of tasks and resources and to virtualisation. Learning is an important aspect of such emerging new forms of labour organising, and concepts such as the learning organisation and organisational intelligence have started to play an important role in the development of today's and tomorrow's organisations. It is the role of NTIC to give adequate methodologies, tools, and techniques to support and implement these concepts. CSCW, teleworking and telelearning, intelligent agent technology and the future research direction of tele-immersion are able to create environments in which distances are blurred, the activity can be changed in a highly dynamic fashion, and in which artificial intelligence, artificial agents, and virtual reality techniques can actively support the working and learning processes as an important part of the design and implementation of organisational strategies

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