

# Complexity Factors in Networked and Virtual Working Environments

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## INTRODUCTION

Working environments are changing from the traditional model. An increasing amount of work takes place in networked and virtual environments which are not tied to one place and time. The work environment is defined “virtual,” when the employee uses information and communication technology (ICT) for collaboration (Vartiainen, 2006). The planning of working conditions becomes challenging task for managers and ICT tool developers, because there is a lack of understanding the consequences of emerging virtual work.

The capacity of workers to percept and process information is burdened with the complexity and high demands of working life. Knowledge of the complexity factors of the overall work system is essential for an in depth understanding of human working capabilities and limitations (Kleiner, 2006). The complexity of work is usually considered as a factor related to the task. At the one end the task is creative and demanding and at the other end it is simple and routine-like. The expanded complexity concept also takes into account the working environment that can be different combinations of physical, virtual, social and cultural spaces.

The purpose of this article is to present a framework to analyse the complexity factors in networked and virtual working environments. The approach developed in this article is intended to be generic in order to be applicable to various kinds of organisations and networks for the purpose of management. It is important that the working conditions of workers can be planned in advance to provide workers with appropriate ICT tools and data networks to enable efficient cooperation in networks in a way that the workload can be limited to a sustainable level. The described framework is assessed using the case of the Turku University of Applied Sciences (TUAS).

## BACKGROUND

### Organisational Context of the Study

Networked and virtual work are analysed by applying the complexity approach to the Turku University of Applied Sciences. The strategic plan of the TUAS is to react to the changes in a flexible way (Kettunen, 2006, 2007; Kettunen & Kantola, 2006). The interaction of the institution is close with its operational environment. The purpose of the institution is to react to the changes in its environment in a flexible way and to increase its external impact on the region.

TUAS is a multidisciplinary higher education institution founded in 1992. The City of Turku owns the institution, which has 800 full-time employees. The TUAS has six faculties and a Continuing Education Centre. ICT is an important field of education and is combined with business, biotechnology, mechanical engineering, health care, performing arts, communication and many other subjects. Cooperation with other universities is active. One reason is that the ICT education and research of the University of Turku and Åbo Akademi University are located in the same ICT Building.

The TUAS has 9,500 degree students. The institution offers tuition mainly in Finnish but there are also degree programmes, modules and courses in other languages. Internationalisation is one of the focus areas of the institution. The TUAS has wide international networks. The institution has cooperation with several higher education institutions in Europe, Asia and the Americas. Five entire programmes are taught in English. The objective is to improve the students' ability to work in a global environment.

### Networked and Virtual Environments

Figure 1 describes the dimensions of networked and virtual work. There are three modes for organising the communication and collaboration of work: traditional organisation,

network and virtual network. The concept of the virtual network includes networked and traditionally organised work. Mobility may take place within or outside the organisation. Networked and virtual work can be analysed using the various dimensions that come across the organisation and networked and virtual environments.

Information systems have been typically planned for the organisation, but an increasing amount of information systems have also been designed for the cooperation in networked and virtual environments. Virtual work environments increase the complexity of the work and therefore, various approaches are required to analyse and design the well-being of workers and the performance of the overall work system.

Data networks and ICT reflect the needs of working environments. The traditional organisation-centred work is extended with the mobile work, networked cooperation in diverse locations and virtual systems, which increase the complexity of working environments. Working in these environments requires not only traditional network but also an increasing amount of wireless data networks.

Ergonomics as a discipline is concerned with interactions with human-machine systems. Ergonomics has played a vital role, for example, in the reduction of occupational injuries, improved performance, increased health and safety of workers and end-products. Pheasant (1996) has concluded that the objective of ergonomics is to achieve the greatest possible harmony between the product and its users in the context of the task performed. With complex sociotechnical systems the above is not enough because various subsystems exist and the importance of interactions between them has a significant role. Kleiner (2006) emphasises that the larger work systems have to consider when there is a need to understand human-technology interaction, capabilities and limitations better. Macroergonomics as a subdiscipline of ergonomics is

concerned with human-organization interface technology and the optimisation of the overall work system, that is, design of the worker-job, worker-machine, and worker-software interfaces (Hendrick & Kleiner, 2001).

## ORGANIZATIONAL EXPANSION TOWARD THE VIRTUALITY

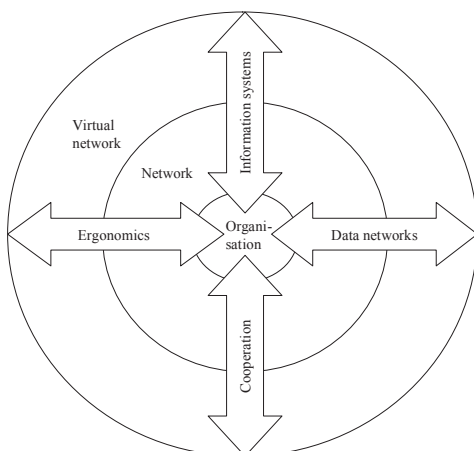
### Complexity Factors of Networked and Virtual Work

Vartiainen (2006) has described the complexity of working environments by following six dimensions: mobility, geographical dispersion of the workplaces, diversity of actors, asynchronous working time, temporary structure of the working groups and mediated interaction. These six dimensions form, in addition to task complexity, a set of requirements that can also be considered work load factors (Hyrkkänen, 2006). The complexity factors arise from the conjunction of a worker and the particular kind of working environment. We have further developed the complexity model of the networked and virtual work by exploring it taking into account the human and technology related enablers and limitations of virtual work.

Table 1 describes the general concepts of complexity factors for the traditionally organised, networked and virtual work. We suggest this classification as a framework, which can be used for example, as a framework for empirical studies, participatory design projects and consulting processes. The working environments are changing from the traditional model, where the place and time have an important role. An increasing amount of work takes place in networked and virtual environments which are not tied to one place and time. The planning of working conditions becomes challenging, because there is a lack of proper tools for analysing and managing sustainable and safe working conditions.

The information environments and systems can be classified as mechanical, organic and dynamic (Stähle & Grönroos, 2000; Stähle & Hong, 2002; Stähle, Stähle, & Poyhonen, 2003). The information systems in the mechanical information systems increase the efficiency of internal processes and include thoroughly controlled information systems, which are based, for example, on the automation of routines. The organic information system emphasises dialogue, communication and sharing of experience-based tacit knowledge (Kim, Chaudhury, & Rao, 2002; Takeuchi & Nonaka, 2004). The dynamic information systems include information systems which produce innovations and services by self-organisation. The virtual systems, networking, net casting and different portals, are often in connection with

Figure 1. Dimensions of networked and virtual work



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