

Pervasive forces such as increasing globalisation and competition, demographic changes such as an ageing population, the European enlargement, and the emergence of networked forms of organisation are affecting the nature of work and the adequacy of existing forms of work organisation. A diversity of work environments is developing, ranging from the creative environment of networked professionals using the Internet for a variety of activities to environments characterised by standardised work processes at physical places. Technologies such as the Internet and broadband networks, mobile and wireless services, collaborative and shared workspaces and software infrastructures allowing distributed working clearly play an important role in enabling creative and productive workplaces where people can work together efficiently and effectively while being more independent from time and place. However, the outcomes in terms of workplace innovations that will succeed or fail depend primarily on how we are able to cope with the human, organisational and social aspects of work. New problems are showing up in attempting to use the new technologies. Among them are distortions in work-life balance, difficulty to cope with different styles of working and organising, management and leadership issues in coordinating distant working, long working times and stress due to the blurring of boundaries between private and working life, poor capabilities of time management, the rise of work-related chronic diseases, and an apparent stagnation in skills development (Dublin Foundation, 2004). Additionally, the interrelations between employment, work environment and health imply an increased risk for workers who are not able to enforce healthy work environments.

Starting with a categorisation of mobile workplaces, this chapter highlights some of the trends shaping the future of work, sketches out their implications at the sector level, and reflects on the way systemic innovations could succeed. We also present the results of our survey into future mobile workspaces.

2.1 THE IMPACT OF MOBILITY ON COLLABORATIVE WORKING

Our initial focus is on the role of mobility in collaborative working and on the transition between traditional ways of working and mobile collaborative workplaces. Collaboration clearly is the key to most of current work practice. However, effective collaboration is difficult to achieve and depends on a number of interdependent factors. In case of mobile working, new factors come into play. Access to mobile technology is not enough on its own, and to be truly effective, organisational structure and support as well as effective collaborative behaviours are equally important. Figure 2-1 gives an idea of some of the factors that will need to be considered to have a good chance of success.

The new ways of working are within the context of virtual organisations. These organisations are often formed for the duration of projects and are then dismantled. Particular challenges for engineering are characterised by access to large databases such as product breakdown structures and geometries, product data management systems and workflow, analysis and modelling tools. This has driven the development of new collaborative and mobile technologies to allow work to be done in this way and to capitalise on the significant technological developments made in other domains, for example in mobile and wireless technology, GRID computing, and collaborative workspaces.



Figure 2-1: Factors affecting collaboration in dispersed teams of mobile workers (Carver and Leggatt, 2002)

The transition between traditional ways of working to mobile and multi-location ways of working presents risks as well as opportunities to do things that could not be done before. It is necessary to understand the requirements for working in a more traditional environment to understand what the impact will be when elements of the working environment are changed. Even the challenges of collaborating when people are co-located are still not fully addressed, especially in a climate of competition. When teams become dispersed and mobile it is even more difficult. How can the technology replace the cues that are lost or how can new behaviours be trained if important elements are lost?

One way to cope with this challenge is to look at where the failure modes might be. For example there are many failure modes for e-mail, and e-mail is the most common form of communication for remote collaboration. Currently there are technologies supporting collaboration to varying degrees: for example voice and video links, e-mail access and use, shared working spaces, conferencing tools, document repositories, tools for presence and situation awareness, calendaring tools. However, a holistic and integrative approach to the impacts of mobile working is required in order to understand the risks and failure modes of the new ways of working, to and to understand the requirements for collaboration in the context of a changing environment and informal networks. There is a significant challenge in managing the transition between static and mobile ways of working and the various hybrid working scenarios that are particularly prevalent at the early phases of new technologies. In order to introduce mobile and collaborative working.

2.2 MOVING TOWARDS MOBILE AND COLLABORATIVE WORKING

What is mobile working, and what is a mobile organisation? What are the key issues in introducing new forms of mobile working? A mobile organisation could be described as an organisation “...where people, processes, technology and management support work (are) done anyplace/anytime” (Neal, 2004). This is a good description but does not indicate the variety of options that are possible particularly with respect to groups and teams of people who need to collaborate with each other and to access data, information and tools to support their activities.

The mobile organisation has to support not only individuals but also groups and teams who need to collaborate. In Figure 2-2, the true mobile organisation is described as highly collaborative, but acknowledges that co-located high performance teams are also important for success. A flexibility of approach is required that aims to support the collaboration process, to reduce unnecessary travel without creating further challenges for individuals, to enable people who are away from their 'home base' to carry on being effective and to allow individuals to make the best use of the time available to them to carry out both work and home commitments.

Mobile	Collection of mobile individuals	The mobile organisation
Static	Collection of static individuals	A high performance team
	Not collaborative	Highly collaborative

Figure 2-2: Collaboration and mobility

Ideally, the mobile organisation from an ICT perspective can be seen to have the following attributes:

- **No fixed working space.** Working in the office is just another place for the worker to work and access to the network is available wherever he or she happens to be. Moreover, instead of the architect being in charge of creating a collaborative environment, the applications architect is now responsible. However, since 'office' spaces are now 'shared' spaces, and may be used for many different activities, considerable care still needs to be taken in designing workspaces in buildings. If the home becomes a workplace too, equal attention should be paid to the design of that environment. There may also be running cost implications for workers working in places other than the traditional 'office', for example Internet connections, dial-in facilities or additional printers.
- **Internet-based processes.** Processes are designed to be useful and accessible by both mobile workers and co-located workers, and administrative forms and procedures are available in electronic form, with applications using the HTML-based browser.
- **Mobile technology.** Technology is used seamlessly to enable anyplace/anytime work. Different sorts of mobile devices can be used, and the choice of device is driven by user requirements rather than an organisation wide decision. Mobile devices are always on, are always connected, have rapid response rates and reliable connectivity, are light, small and non-intrusive, and most of all are not prohibitively expensive. Diversity of devices will incur costs, both in the hardware itself and in maintaining the skills and knowledge to support different systems and of course in the provision of 24hr support. The business plan needs to consider these elements and elaborate how the provision of technology will save costs and improve effectiveness. The positive aspects include more effective use of time, reduced down time, high levels of availability and employee satisfaction if they can be in better control of the way in which they achieve their goals. It is also important to consider some of the

potential negative aspects too – these might include time clock changes - for example the time taken to reach decisions or complete processes, there is additional pressure to ensure that contributions have been made and views considered, and not least the challenge of ensuring that there is understanding across the team, adequate situation awareness of the activities and requirements of the team, and no isolation of individuals.

- **Management of mobility and mobile working culture.** The organisation recognizes that mobile teams have different requirements and train their managers to motivate and manage mobile teams. Additionally, the organisation appreciates issues of privacy and accessibility and develops protocols to help workers maintain a work-life balance. One step further would be the acceptance of a mobility culture: mobility being the norm, not exception.

Many of the principles for a mobile organisation make sense for a more static or at least a mixed organisation too. But a mobile organisation is not just a collection of people with laptops, cell phones and pagers allowing people to take their office home after the “normal” working day. It is also not just a group of mobile workers bolted on to the standard organisation. However many organisations will not see a requirement to be entirely mobile and people may not work exclusively in one way all the time – this can be driven by individual preference, work life balance, or driven by project or task requirements. The role of the organisation and the type of work undertaken will also affect the type of choices of working environments open to an individual. The degree of choice is extremely variable across different industries, from engineering to telecommunications, and across domains from service industry e.g. health, consultancy, finance and insurance, to farming and other rural occupations.

Mobility leads to changes in working practices - as well as new terms and conditions. These might include expense account changes i.e. mobile phone charges, remote connection charges, teleconferencing costs, video conferencing costs, attribution of cost to project versus overhead, costs for IT support 24 hours per day, additional costs where IT devices are not all standardized, and potential health and safety considerations where employees are working outside the ‘normal’ working environment. In offering the flexibility to work at home or wherever is appropriate for the individual, the organisation also needs to address the risk of making team members feel isolated, unaware and not engaged in the process. Co-located team members may also exhibit virtual characteristics, for example, people using e-mail to talk to someone in the next room, or sending texts to someone in the same room.

One often cited business goal is to 'improve productivity by leveraging knowledge'. This is potentially even more difficult if the organisation is virtual and its employees mobile. However the challenge is realizing this and using the very mobility to create social networks and to build rich knowledge and information flows across the organisation. Leveraging knowledge across a dispersed organisation is often difficult if not impossible - not only because of the technical difficulties but also because of the politics and negative sharing ethos where knowledge still represents power rather than the other way round – i.e. sharing the knowledge creates the power.

The socialization of knowledge, that is, the direct exchange of ideas in conversations and other interactions, both planned and unplanned, speeds up the exchange of knowledge allowing organisations to get more value from it. However, this takes place most readily when people are located in the same physical environment. With more mobile communities, it is still important to consider this requirement in the physical design of work spaces and to acknowledge different spaces are required for different types of work (Duffy, 1997). Spontaneous interaction and ad-hoc

meetings decrease as distance between people increases but these spontaneous meetings have significant value. It is often only when we perceive a colleague that we think of issues that they can help us to solve, or even help us to frame the right questions to ask. Ambient intelligent systems bringing computing power everywhere, but in the “background”, may be one way of trying to support and facilitate these spontaneous interactions, but there may need to be cultural changes and training to enable individuals to succeed. Changes to the physical working environment and solutions linking the virtual world with the physical show promise but are as yet immature in their implementation. We need to think now about the impacts of these new environments and to consider how they might be integrated into new processes and organisational structures.

2.3 CATEGORISATION OF MOBILE WORKING

As there is a lot of innovation in work environments going on, any categorisation is limited. Are we describing current forms of mobile working based on worker mobility, or future ones based on the ability to work anywhere and anytime? Are we talking about (physical) workplaces, or about (virtual) workspaces? Current working environments and new technologies show that that we are on a transition point towards the future. In order to be able explore strategic research and innovation issues, we must confront current mobile working practice with the now apparent future trends in order to explore the diversity of aspects in mobile work and workplace mobility.

We distinguish between four types of working environments, using the dimensions of mobility (frequency of changes in location) and work location (Figure 2-2), and discuss shortly the impact of ICTs and the implications for collaboration and mobility.

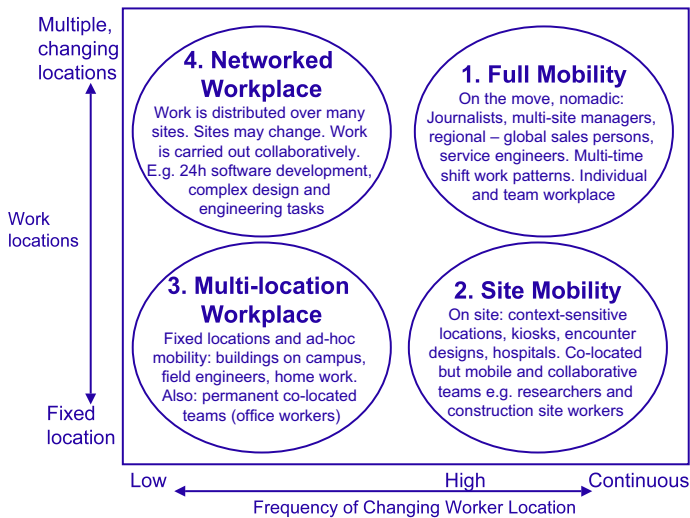


Figure 2-2: Mobile working environments categorisation (Schaffers, 2005)

1. The “full mobility workplace” describes a situation of mobility-intensive jobs, in terms of worker mobility and in terms of changes in work location, for activities such as maintenance, sales or consulting. Its widespread introduction may be more constrained in the future because of limits to physical infrastructure and also for work-life balance reasons. Collaboration is limited to bilateral communication-oriented tasks of short duration.

2. The site mobility or “micro-mobility” workplace denotes mobile workers in geographically restricted areas like hospitals, schools, offices and campuses where individual work locations. Collaboration is characterised by frequent face-to-face contacts in different settings (individuals, groups) in combination with bilateral electronic communication and group conferencing.
3. The multi-location workplace covers a situation where work is carried out at fixed locations, synchronous or asynchronous. The worker is travelling to such a location or a location is the home base of the worker. An example is distributed design review in aerospace engineering, supporting multi-functional teamwork and bringing in multiple competences in judgment and evaluation.
4. The networked workplace is characterised by limited physical mobility and at the same time the ability to work at many different locations. It might be a valid model for the future collaborative workspace and is not yet fully realised in practice. Current forms are diverse, covering working in hotspots and working distributed over many sites e.g. for collaborative R&D and software development.

This categorisation covers many of the current forms of mobile work, such as working away from a fixed location in temporary workplaces (e.g. the field worker), or teleworking as working in two different but fixed locations, or working at constantly changing places like hotels, train stations and airports (See Lilischkis, 2003).

2.4 TOWARDS FUTURE WORKSPACES: DRIVERS OF INNOVATION AND CHANGE

The realisation of more flexible, networked working environments termed “future workspaces” presents complex challenges in terms of new technologies, organisational arrangements, working behaviours, the nature and functioning of organisations, and societal structures and policies. Because of the many interlinked aspects involved, such innovations can be termed “systems innovations” and in order to succeed and to be absorbed in practice they require “systems changes”. Mobile working has not only to do with worker mobility, but also with mobility and/or flexibility of the work, the workplace and the organisation. Increasingly, it is the adaptive and networked organisational form, responding to a continuously changing business and societal environment, which becomes the future workspace that should provide the proper level of flexibility.

The EUFORIA Delphi (Popper, 2003) suggests that dominant trends in the knowledge society such as new forms of business organisation, the use of electronic networks for remote supervision, and increasing family stress and conflict affect negatively important aspects of working life resulting into loss of social cohesion, increasing social exclusion and deteriorating work-life balance. Workplace innovation requires us to face transition issues and uncertainties inherent in the development towards new working environments, such as the acceptance of particular styles of work, the quality and health aspects of work, and the networked forms of organisation and managing.

MOSAIC perceives three strands of drivers with critical influence on the future of work organisations. They relate to a set of interrelated developments: technological progress, economic and business trends, as well as behavioural and societal trends.

Technology factors and decreasing cost of usage

Several technological trends are affecting the future of mobility and mobile working (see Brugnoli, Davide and Slagter, 2005). Moore's law, stating that the computing power available for a given price doubles every 18 months, is expected to hold at least for the next ten years. At the same time, battery life is expected to increase in a rapid pace. The telecommunication technologies that are expected to be dominant in the next ten years are mobile telephony (GPRS, UMTS) and various generations of WiFi. The existence of roaming contracts between many European mobile operators is an important enabler for mobile access to business services from anywhere in Europe. The various mobile access technologies will be available at competitive prices and offer the user an increasing amount of bandwidth and different Quality of Service levels. At the same time, the current heterogeneity of access technologies is likely to exist for the coming period of time as different access technologies have different advantages, such as high bandwidth or large coverage.

Another relevant trend is the migration towards all-IP networks: the current mix of IP (Internet Protocol) networks and circuit-switched networks, such as the current (fixed) telephone network, is likely to converge into multi-purpose all-IP networks. The availability of such networks facilitates the convergence of services, for instance allowing voice-over-IP calls to be placed to a mobile phone.

The next generation mobile technology will establish 'always-on connectivity' in combination with flat rates offered by operators. This will greatly stimulate the usage of new types of information applications like anytime-anyplace communication. Increasing mobile bandwidth and processing power are expected to support the development of more secure and user-centric work applications. Mobile applications will be coupled in a secure way according to the user's profiles, work context and availability to produce smart applications. Fuelled by the expected cost reduction in devices and network usage, presence awareness (ambient intelligence), instant messaging and audiovisual communication will be important drivers for convenience of real-time mobile groupware applications. Mobile Voice over IP (VoIP) applications will allow users to communicate with others using their handheld devices while sharing information. A current example is Skype going to launch specific new kind of mobile phones that will use VoIP.

A viable trend, which is also enabled by the increasing computing power, refers to the fact that devices like notebooks, cellular phones and Personal Digital Assistants (PDAs) together with position detection sensors converge to one integrated smart tool. Key actors in this area will be, first, the device manufacturers; second, the network operators installing hybrid networks including necessary gateways; and third, the operating system developers as mobile applications will become part of the operating system of mobile devices.

An open question is left how the end-to-end security with respect to mobile support applications will be enforced. Due to the limitations in current security solutions, organisations still are very reluctant to open their cooperation environments to others. Solutions will be based on secure access to information archives and databases, semantic-based knowledge repositories and other advanced functions in order to protect vulnerable infrastructures by sufficient trust and security. We expect a trend towards support for secure, ad-hoc collaborative mobile workspaces. The challenge here is to integrate trust and security into an architecture as well as into a middleware to facilitate trustworthy interactions between mobile workers and systems. Current R&D projects are working on improving security mechanisms based on more applicable algorithms and better functionalities, new approaches to meet computational demands

(e.g. Grid computing), more powerful hardware and software, delegation of tasks to dedicated servers, and trusted mobile platforms.

Increasingly sophisticated value adding networks

Looking at the economic drivers affecting mobility, the future of mobile working seems to depend to a large extent on costs of transportation and travel. Although the steadily decrease of transportation costs has been a long-term trend, an increase in oil prices and costs associated with security measures and growing importance of sustainable development will probably result in an increase. There are many indications that in the long term scenarios (>5 years) fuel prices will increase due to oil price development, rapidly increasing demand from Asian countries and political instability of many of the world's largest oil producing areas. In other scenarios the cost of fuel could be increased by environmental concerns. In the specific case of air transport, the effects of increased fuel costs could be compounded by security costs (anti-terrorism), cancellation or reduction of the state subsidies, and taxation of transport organisations (e.g. carbon tax). In these scenarios, the increase in costs will be long term and is likely to provoke a major reduction both in long and medium range mobility (by air) and in short range mobility (by road). This is likely to lead to a reduction of business travel, leading to a potential increase in virtual collaboration and mobilisation of work.

Closely related to the technical advances mentioned earlier, we are witnessing the continuing sophistication of value adding networks. Value creation no longer happens in sequential chains but in multi-nodal and increasingly global value networks. As a consequence, network relations become tighter, the number and sizes of virtually collaborating teams increases and the mobilisation of work grows as well as the number of individual knowledge workers, often named eProfessionals. For individual knowledge workers this often means a more process oriented task structure, an increase of contact points and of roles to fulfil as they could be involved in different projects while being members of communities of professionals, communities of knowledge or communities of practices.

In the past, Enterprise Resource Planning (ERP) has focused on codifying processes such as sales, order processing and fulfilment, production and material planning, financial planning, logistics, and implementing them into ICT applications. Future ERP applications will increase flexibility to improve the integration of company spanning value chain activities and to extend the systems to mobile collaborative workspaces.

While the majority of interfaces today reach suppliers and customers, future structures will also involve public players as well as the wider stakeholder environment on e-enabled processes. The networked organisations will have to take into account local as well as global process requirements to become a seamlessly working “real-time enterprise” (Österle, 2000).

Behavioural and societal trends

Unless the rise of teleworking and working on the move, most of the work today is still carried out in fixed locations, and during fixed time periods¹. The more information-intensive, the better chances for work being carried out on a distance or mobile, and in collaboration with others. The decreasing cost of communication of remote information and increasing value of using remote information has stimulated the development towards decentralisation and networked

¹ See the Collaboration@Work 2005 report, European Commission Directorate-General Information Society and Media (2005) for an overview of new working environments and practices in EU member states.

organisations to a considerable degree (Malone et al, 2003, and Malone, 2004). In increasing the opportunities for interaction, mobile and wireless technologies are providing a new generation of possibilities. But practical bottlenecks are many, and further innovation towards mobile workspaces requires new ways of working and time management, new ways of decentralised organising, new collaborative and information sharing behaviour of the worker, and also new styles of coordination, leadership, motivation and trust-building, and even new regulations at the societal level. As Table 2-1 shows, the actual work setting will be the result of a balance of forces operating at different levels: the work requirements, the worker needs, organisational factors, industry developments, societal policies, and technological opportunities and bottlenecks.

Table 2-1: Forces affecting work settings at various levels

Forces Levels of analysis	Forces promoting mobile workplaces	Forces hindering mobile workplaces
Nature of work	Task at hand requires more decentralization, e.g. distributed problem solving	Task requires more centralization of information and key experts
Human worker	Willingness for more flexibility, freedom, better work-life balance	Fear for more stress, more control, less human contact, trust issues
Team	Key experts are located at very different places	Key experts are located at same location
Organisation	Need for more flexibility and decentralization, complexity	Control and management procedures, leadership styles, culture
Industry	Globalisation of business activities due to worldwide operating competitive forces	Concentration of business activities to particular regions
Society	Offensive economic policies e.g. deregulation and liberalisation	Worker protection regarding working times, health and stress
Technology	Decreasing cost of communication, broadband networks, groupware, security	Problems in security and access management issues

Mobile collaborative work, enabling flexible working, could considerably increase productivity due to the fact that knowledge workers will have less need to travel every day to and from their office. This will allow to save many travelling hours that will be used for value added work, social networking, continuous learning and for private life as well. However, travelling to professional events will not disappear at once, especially because face-to-face meetings are often a prerequisite for ensuring a good level of relationships and trust among collaborative workers. Nevertheless, the potential reduction of daily travels to work office could have a positive impact on city environmental situation on both car traffic and air pollution. The other positive impact is that workers will not be any longer tired by spending hours in transportation systems, nor so much stressed by transportation period and depressed by transportation strikes.

The growing connectivity and information ubiquity in new work environments implies an increase of work complexity. The number of organisational interfaces, the globalisation of business relationships, and the digitalisation of information will increase the burden for knowledge workers. They will be required to accomplish additional roles and fulfil changing job profiles in a more process oriented business environment. This will increase complexity, besides the already existing information overload. Future ICT collaboration and business platforms will need to be designed in a more user friendly and automating way in order to reduce search and transaction cost. The improved usability design can evolve as another key driver for increasing adoption of new work technology (Gates, 2005).

On the one hand, complexity will undoubtedly increase whereas new technologies will considerably increase potential connections among people sharing common interests, especially when thinking about connecting people through the concepts they use and share. This will clearly lead, as shown by the actual trends, to an exponential increase of the development of on-line communities and social networks where everyone will need to spend part of his time, probably in replacement of the tiring transportation.

An additional phenomenon, that is not only relevant to less-developed countries but also to, for example, the new member states of the European Union and even to the relatively more prosperous Western society is the digital divide which also applies to emerging work environments. In many cases, digital divides equal social divides as well. In order to generate sustainable new work environments on a global scale, the requirements of elderly and handicapped as well as the ambitions and needs of new EU member states need to be considered.

2.5 IMPLICATIONS ON INDUSTRY SECTOR LEVEL

It is instructive to look at different industry sectors to identify the critical factors in a sector affecting the mobility of the workplace and prospects for mobile working. MOSAIC has carried out analyses of the conditions and prospects for mobile working in several sectors, and circumstances are different. In particular we must take a look at the inherent mobility of production assets (in design, engineering, production, maintenance environments), knowledge assets (skills, experts), and the work it serves (including the subject of work, which could be people like in healthcare, or material goods).

Electronics and automotive industry

In manufacturing sectors such as electronics and automotive, shorter product life cycle require new capabilities to deal with a situation of faster product development and rapid switching between product families. Forces of global competition are increasing the pressure on OEMs and their suppliers to become more cost effective and flexible. As a result suppliers become more cost effective and more collaborative and are eager to gain positions in global collaborative value networks. Overall, the complexity of the product and of its handling has enormously increased compared to a few years ago. To cope with this situation, the organisation of the product development process is changing. To be able to handle the holistic view of the product development process and the geographic dispersion of actors involved, companies are experimenting with distributed forms of the design and engineering process. The organisational implications are a trend towards ad-hoc collaboration processes, robust control and supervision system (with corresponding workspaces) and adequate inter-related workspaces for each type of engineering activity.

Aerospace industry

The aerospace industry to a growing extent is organised as a distributed virtual organisation, which has complex characteristics compared to other sectors. Such characteristics include number of partners (i.e. Airbus network), complexity of the product (number of components and related disciplines), size of the organisation (OEM, risk-sharing partners, suppliers, sub-contractors, etc), long lead times, and huge capital sums for developing products. For example, Airbus has about 150 sites throughout the world with distributed manufacturing facilities in France, Germany, UK and Spain. As a result, this sector needs efficient collaborative tools and processes to work as a distributed virtual organisation. In the aerospace sector the situation is different from automotive as operation and maintenance is a crucial business

process and mobility its natural characteristic because of the inherent mobility of aerospace assets. Mobile applications for ground personnel involved in servicing and supporting aircrafts are not just communication oriented but are related to the primary processes of diagnosis and repair. As regards design and engineering the same situation as in automotive exists and mobile applications could enable networked teams to work on digital mock-ups.

Building and construction

For the building and construction industry, mobile technologies can play a crucial role in order to increase communication among workers, organize work more efficiently and reduce process cost. This industry is characterised by dispersed teams that jointly work on the development of a new site, sometimes not belonging to one and the same company, without being able to use fixed line infrastructure and having high mobility/travelling requirements on site and between sites. This provides substantial opportunity for mobile communication. In the mobile data arena, mobile field applications are becoming crucial in this industry whereas the machine-to-machine applications are a further strand of development. Machines like elevators, heating systems and security systems will be equipped for ongoing communication with central surveillance systems, ensuring continuous controlling and monitoring and data availability for maintenance and security reasons. Although the industry has started in the mid nineties to centralise the development and standardisation of e- and m-technologies, the current state of the industry still needs to overcome structural challenges in order to allow stronger penetration with mobile technologies.

Health and wellbeing

Finally in a service-oriented sector such as the healthcare sector there are pressures for change from the inside (continuing innovation expanding the available methods and tools, increasing organisational complexity) and from the outside (increasing demand for citizen empowerment, need for cost reduction, evolving implications of demographic changes like ageing). These changes in the framework conditions have led the healthcare organisations to look into new ways to organising and delivering health services. Information technology has a central role to play in the reorganisation of the healthcare service delivery environment by facilitating and enabling new trusted and secure ways of working, collaborating and sharing of knowledge. For example, IT-supported work processes enable virtual workspaces for health teams, provide healthcare professionals with access to relevant case data and knowledge in order to identify issues and therapies, and enable patients and healthcare professionals to discuss second opinion by making available patient multimedia data. The healthcare sector also provides a challenging validation environment for mobile applications.

From this overview it can be concluded that circumstances are quite different as regards the key factors determining success of mobile workplaces (Table 2-2). Mobility of production assets, of knowledge assets (workers), of the work it selves (and of the subject or subjects of work) are different across industry sectors. In aerospace the key assets, aeroplanes, which are also the subjects of work, are mobile thus requiring mobility in the knowledge assets (workers) in particular those related to maintenance and operations. In fact the work it selves is mobile by nature and the workplace (including knowledge assets) must follow the work. In healthcare, the subjects –patients – are to some extent mobile (while travelling) but more important they are highly distributed over different locations sometimes concentrated in areas (villages, cities) whereas the healthcare assets (hospitals, equipment) are fixed in buildings and whereas the healthcare workforce in particular in crowded areas is available near the patients. In building and construction, production assets are mobile and workers must be mobile at the workplace.

Construction work procedures are required to be replicated at very different locations but predominantly within a geographical area.

Table 2-2: Mobility-related factors determining potential success of mobile workplaces

Sectors	Mobility demands	Implications for mobile workplaces
Automotive	<ul style="list-style-type: none"> Design and engineering skills are scarce and costly Production assets are concentrated, maintenance assets are distributed Cars are mobile and distributed 	<ul style="list-style-type: none"> Mobile workplaces add value in maintenance processes (on travelling) Distributed workplaces add value in design and engineering process
Aerospace	<ul style="list-style-type: none"> Key business assets are also subject of work and are mobile in nature (the work is by nature mobile) Design and engineering skills are scarce and costly 	<ul style="list-style-type: none"> Mobile and distributed workplaces for maintenance and operations are critical for business success Distributed workplaces add value in design and engineering process
Building and construction	<ul style="list-style-type: none"> Production assets are mobile Workers must be mobile at the workplace Skills are mobile and location-independently available 	<ul style="list-style-type: none"> Mobile workplaces add value where the mobile worker is supported at the workplace location Distributed workplaces add value in design and engineering process
Healthcare	<ul style="list-style-type: none"> Subjects (patients) are mobile and distributed over many and changing locations Skills partly are available near patients, partly available at fixed locations. Experts are relatively mobile. Assets are fixed at particular locations 	<ul style="list-style-type: none"> Mobile and distributed workplaces are critical as the subjects of healthcare are inherently mobile and distributed Distributed workplaces add value in those cases where assets (equipment, critical skills) are relatively scarce and bound to locations

2.6 PROSPECTS FOR INNOVATION

From mobility support to networked and virtual workplaces

The introduction of new mobile collaborative work environments in practice attracted the attention of scientific researchers from various research disciplines, such as information systems research, management research as well as social theory and architecture and design. So far, research on mobile work is in its early stages and definitions and concepts of mobility are still emerging. Early work has focused on the geographical or spatial mobility of workers (Lilischkis 2003, and Perry 2001), which is criticised for being a too narrow focus (Sherry and Salvador, 2002). Andriessen and Vartiainen (2005) extended the concept of mobility to virtual mobility, which includes stationary actors moving "with the help of ICTs in a virtual working space". This is much related to the MOSAIC concept of networked, person-centric workspaces. Kakahara and Sørensen (2004) postulate three interrelated aspects of worker mobility: location mobility concerned with the workers' extensive geographical movement, operational mobility in relation to flexible operation as an independent unit of business, and interaction mobility associated with their intense and fluid interaction with a wide range of people. As such, aspects of collaboration can also widely change due to new qualities of ICT.

Gartner and MIT (2001) support the multi-mobility notion, speaking of the "agile workplace". For them "agile workplaces" represent the next important step in workplace evolution. The basic finding is that a workplace that is distributed and connected and that facilitates work anytime

and anyplace in a face-to-face or a virtual environment is a prerequisite of organizational success and survival. Additionally, the workplace agility means constantly improving work and the underlying infrastructure, involving both infrastructure flexibility and a focus on the work characteristics itself. The virtual mobility of work will support work processes to be carried out whenever and wherever needed. This will accommodate the need for more controlled work time usage and reduced travelling due to increasing transportation cost.

Breaking down the observation of increasing numbers of networked organisations to the workplace level reveals the need for collaboration support for teams and individuals. A networked organisation can be studied from different perspectives. Whereas the top-down oriented business transactions perspective is focusing on business processes within and across its constituting organisations and their result in terms of transactions, the bottom-up perspective is that of the human worker who is a member of temporary teams and projects. Both perspectives are valuable and complementary, but result in different approaches for developing process and organisational improvements and IT support. MOSAIC approaches the networked organisation by emphasizing the people-centric “networked workplace” and the “we-centric” services that will form the core of modern workplace support.

From a workplace confined to particular locations and fixed working times mostly, we now are accustomed to more flexible forms of working, allowing more flexibility in choice of where and when to work. However, current collaboration and teamwork applications have changed the way we carry out tasks. This leads to a flexible workplace model enabling a diversity of new forms of people collaboration that are more independent from location and time. The flexible workplace model is enabled by information technologies, which - if combined with new organisational and management processes - affect the structuring of tasks and collaboration and their dependence on context parameters in a number of ways.

- *Context independence.* The balance between tasks that can be carried out independent or dependent of task context parameters (time, place) is changing. Tasks increasingly can be carried out independent of time and place. In the extreme, tasks are carried out “anywhere anytime”.
- *Context awareness.* Tasks can be carried out context-independent and context-aware. This contributes strongly to opportunities for optimizing task execution. An example is the use of location information and personal profiles for mobile salespersons, or the use of presence information for organising real-time collaboration meetings.
- *Context switching.* Collaboration is supported in more diverse context settings, ranging from “same time and same place” to “different time and different place” settings, and even including unpredictable places and times (Grudin, 1994).

Table 2-4 categorises different types of workplace support according to the dimensions of time and place. Working in networked organisations requires the possibility to switch between different contexts and different applications. It should be noted that applications intended for a certain context are often unexpectedly (mis-) used in other contexts. An example is the chat-like use of email for the frequent communication between local users.

Table 2-4: Workplace support categorisation (adapted from Grudin, 1994)

Place	Time	Same	Different, predictable	Different, Unpredictable	Aware of Time
Same		Electronic meeting and brainstorming support	Newsgroups, notice boards Electronic project room	Room infrastructure	Electronic project meeting
Distributed, predictable		Video/audio-conferencing; Co-authoring, Co-designing	Group scheduling E-mail Co-authoring	Shared workspace Virtual community	Co-authoring Shared workspace
Different, Un-predictable		Presence-based audio-conferencing Distributed work flow / task flow management	Distributed asynchronous collaboration (e.g. mobile E-mail)	Process coordination	Wearable computing /PAN
Aware of place		Mobile audio-Conferencing	Presence and instant messaging	Mobile document access	Context awareness services

As regards current work practice, still most work activities are being carried out at fixed locations and fixed working times, combined with traditional forms of teleworking and working on the move. Current mobile working applications are largely limited to supporting mobile individuals such as sales representatives and managers. The element of collaboration is still lacking as it is subsumed under the practice of mobile communication. Essentially these are solutions for mobile workers, supporting mobility by enabling new and mobile forms of communication in combination with presence and location awareness information.

Mobile work can be interpreted in an even more challenging way by applying the dimension of “mobility” to work and to the workplace. Following this view, a workplace could be envisaged allowing work to be carried out anywhere and anytime. Such a concept would include the use of context information beyond location and time, enabling new forms of cooperative interaction and workspace contextualization (Schaffers, Ribak and Tschammer, 2004). This concept also emphasizes emerging new structures of collaboration. The “virtual team” consists of a project team of geographically distributed members who temporarily cooperate to accomplish a common goal. Such global virtual teams provide an opportunity whose challenges require organisational skills and sophisticated ICT support. However, the “team” as the entity of work activity, as assumed by most CSCW (Computer Supported Cooperative Work) models, may decrease in importance giving rise to so-called “intensional networks” (Nardi, Whittaker and Schwarz, 2002). In such a way, mobile and location-aware technologies together with broadband networks and groupware applications and embedded in new collaborative structures and processes provide much scope for exploiting the potential of decreasing cost of communication in enabling new forms of decentralisation and networked organisations (Malone, 2004).

Systemic character of innovation in mobile working

Many aspects in the way we are working, and in our workplace infrastructure, are changing rapidly and continuously. The pace of change in wireless and mobile technologies is enormous, and there is no single trajectory. The change is not simply about technology; it includes social change, changes in economic structure, and demographic changes. We are seeing a move from vertically structured organisations in a hierarchical steering society, with fixed workplaces, to horizontal communication between people participating in network organisations, with only a few layers of management. This means that conventional approaches to management and organisation, and their associated technologies and processes, are being replaced.

Change can go in a number of different directions. At the European level, commitment to a set of European policy objectives is shared, and principles such as participatory democracy and democratic dialogue are crucial for realising change. Our tasks are complicated by the multifaceted nature of social change. We must recognize that the pace of change brings attendant problems, in the form of cognitive dissonance and stress, with widespread implications for economy and society.

Even the set of European assumptions is increasingly challenged, for example through the current debate on a Single market in Service Industries, and Enlargement policies. New information technologies, including mobile and wireless, have a central strategic role because of their impact on business models, workplace regulation and employment.

We must be aware of the complexity of issues surrounding innovation, once the dimension of social change is considered. The challenge is to engage the technologically driven perspective with discourses in, for example, quality of work, work organisation, healthy work, regional development and lifelong learning. Each of these should be understood as reflexive characteristics of societal change.

Work environments and work practice comprise a complexity of interacting aspects that together form systems: technology, skills, learning, worker behaviour, organisational processes and structures, societal conditions of legal and regulatory nature. If we wish to understand and influence the patterns of workplace innovation, the success and failure factors and the strategies of designing successful innovations, we should capture all aspects in a holistic, systemic way and address the different interests and capabilities of actors. We also need to find out what the instruments are that are capable to create systemic innovation. Here we need to find out what can be left to the market mechanism, and what the type of policy interventions and coordinated forms of innovation and implementation are. In short, what are the environments in which systemic innovation may succeed? As regards innovations in information-technology based applications, one of the key instruments that arise is the large-scale validation environment where all actors and interests come together to establish networks for experimentation and learning.

2.7 SURVEY ON FUTURE MOBILE WORKPLACES

We conclude this chapter with the results of a survey of “Future Mobile Workplaces”. This survey² has been conducted in an innovative way of consulting the members of the MOSAIC project network and AMI@Work communities about their opinions concerning future mobile workplaces through the combination of complementary polls posted on the MOSAIC website (*see www.mosaic-network.org*). Looking at the resulting figures of this survey and more particularly to the social perspective, it appears very clearly that most of the respondents, close to 90%, are already convinced about the implementation of flexible work arrangements before 2010. In fact, it has already started based often on the motivation of costs cutting and increases of productivity (less wasted time with for example no need to travel everyday to the office as the knowledge worker could decide to carry on his tasks from his home office, customers or suppliers’ premises) as a benefit for the organisation and on gaining more freedom for employees in becoming self-organised. Surprisingly, a majority, close to 70%, do believe that

¹ More details about this survey are available within the MOSAIC newsletter issue n°4 article entitled “Vision Survey and Workplace Effectiveness”, which is also available on the Library articles section of the MOSAIC website.

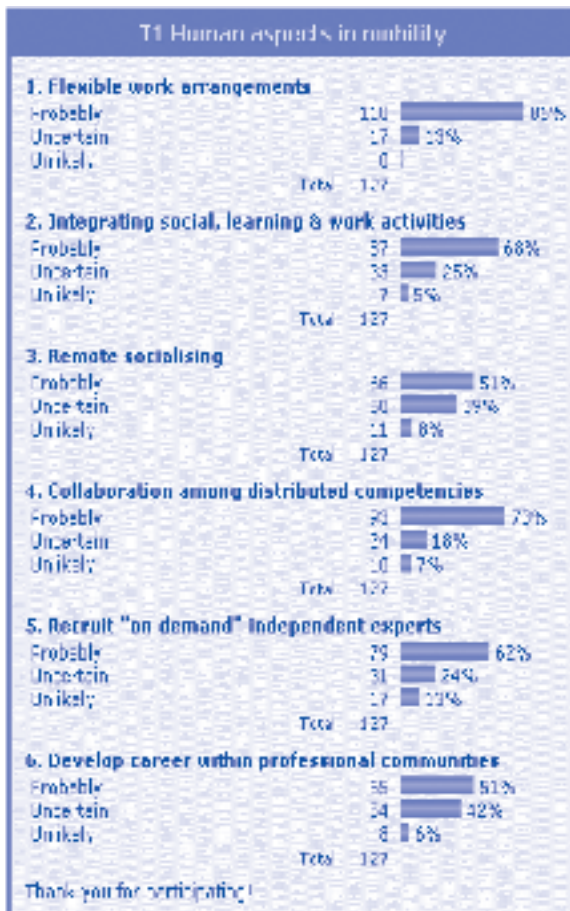
future mobile workspaces will better integrate social, learning and work activities. Especially because of the flexible working time, which allow the knowledge worker to decide to go, for social activities or learning breaks over the Internet whenever he needs it. Even more surprisingly, remote socialising is seen, by 51% of the respondents, as something that could happen before 2010. It seems there is a strong wish to get some kind of conviviality space, like the informal on-line discussion (coffee machine) area shared with his social networks colleagues, where they could have unplanned public or private discussions.

Collaboration among distributed competencies is also predicted, by 73%, as something that will happen while it is already becoming a reality. Recruit 'on demand' independent experts is gaining 62%, as part of the heavily required flexibility by organisations. This is something that could considerably reduce recruitment headache, as the contracted worker is not really recruited on basis of a fixed contract but rather for a short or medium duration depending on the needs.

Developing careers within professional communities has also reached the majority with 51% of respondents thinking it will happen before 2010 as means to increase employability. It is interesting to notice that only 6% do believe it will not happen at all. It means certainly that

people are seeing communities are a new motivating and stimulating form of organisation that is going to replace the traditional hierarchical management by control inherited from the army organisation. It is clear that communities' colleagues could be seen as an excellent support when searching for a job, especially because they know each other expertise and capabilities.

Nowadays, a traditional approach of workplace organisational models corresponding to different work styles is still appropriate. Nevertheless, there are new emerging practices introducing a new work style that could be named the "networked" work style, where knowledge workers are more or less permanently wireless connected with their peers and belong to several communities of practice or knowledge communities or even communities of professionals to serve either business or social purposes. They could be working from their home, from a customer or supplier's site, on the move in the plane, in the train, at their hotel, at the station, at the airport or anywhere else.



Actually, the foreseen main problem, beside organisational and social aspects, is to carry on various heavy equipments while network connection is not ensured anywhere. The Future

Mobile Workplaces survey did reflect perfectly these different points. About 90% of respondents are willing to get a new wearable computing device that integrates multimedia, telephony and computing in consumer's applications. More than 70% predict convergence of networks and IP connectivity anywhere at anytime as well as collaborative and context-aware applications, and "on-demand" collaborative workspaces. A large majority requires more interactions among multidisciplinary competencies and plug&play capabilities as well as mobile access to experts. More than 80% of respondents predict the implementation of flexible working and the integration of social, learning and work activities.

In terms of a workplace organisational model, the emerging signal is on "External Global Model" which means that individual workplaces are hosted by a service provider ensuring and guarantying permanent wireless connection to the network and shared applications anywhere at anytime. It is also quite clear that soon or later knowledge workers will be walking their hands in their pockets without to have to worry that much about their workplace and working environment as their workspace will follow them wherever they have to go and whenever they need it.

As a conclusion, a possible mobile workplace approach could be based on three main capacities: inclusiveness, innovation, and interconnection. Inclusiveness implies a flat and open structure of communities, allowing the inclusion of new comers at any time when needed. Innovation and creativity will be enhanced through stimulating multiple interactions among multidisciplinary competencies at the crossroads of experiences. Interconnectedness on basis of permanent wireless connections established anywhere at anytime will provide much more flexibility and adaptability to any situation.

Another concluding remark is that there is not any "universal" mobile workplace organisational model so far, due to the diversity of various legacy situations. Prediction is always a very difficult task because one needs to foresee the "weak" signals. But we can predict for sure, due to cost-to-use and time-to-market pressure, that soon or later "the network will become the collaborative workplace" for all knowledge workers.