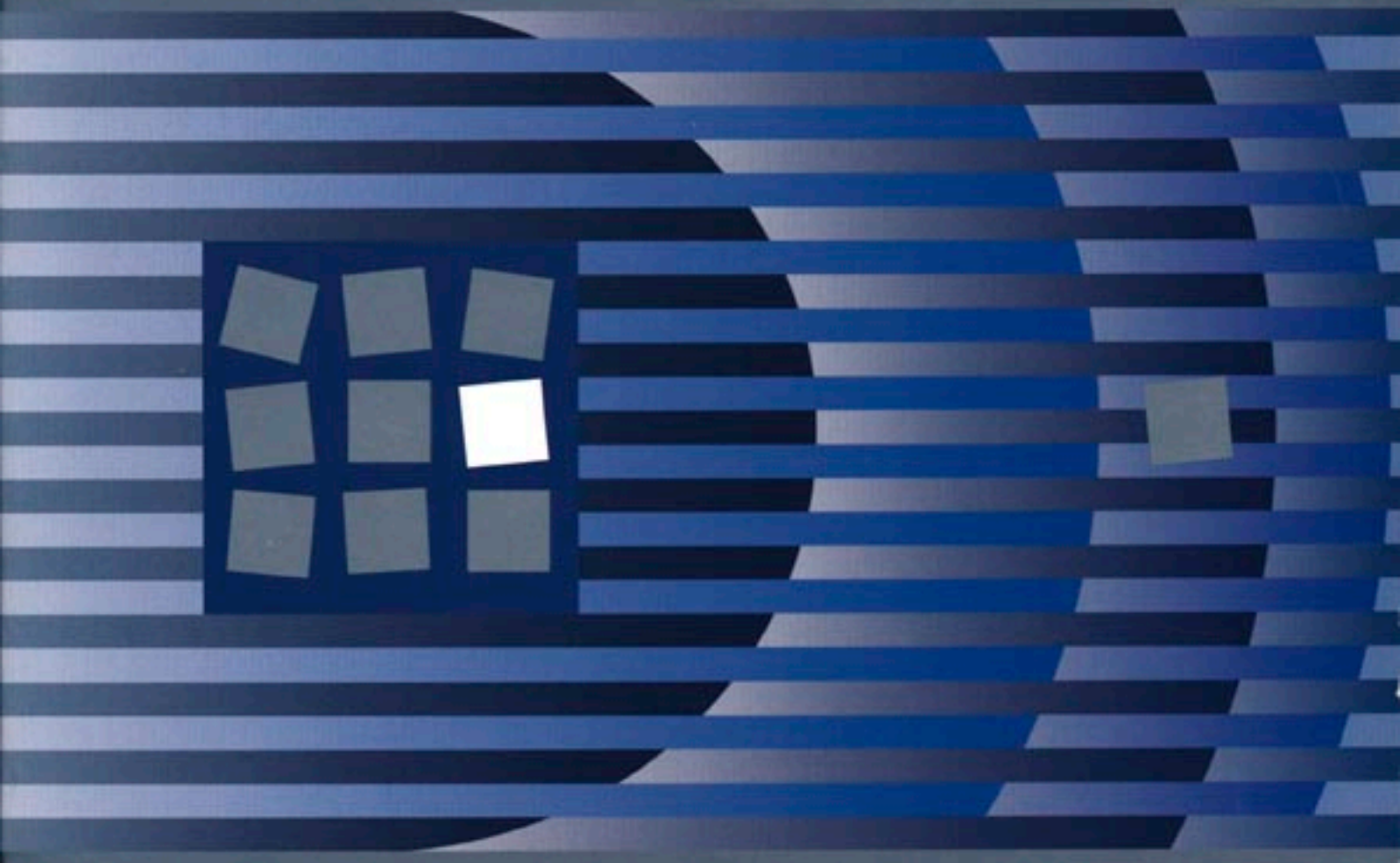
Telektronikk 4.99
95 YEARS ANNIVERSARY

Telework



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At the age of 95 and into year 2000

Ola Espvik, Editor

For 95 years *Telektronikk* has presented developments within telecommunication. Exciting years I am sure they have been to all professionals involved.

Since long ago the global telecommunication networks became the most intricate and large-scale human inventions ever. And the complexity continues to grow! The objective has always been to make any user able to communicate with any other user no matter the location in the world. Be it war or peace, diverse equipment and networks, procedures, or age of equipment, cultural or political divisions – communication should make its way over the globe, space, oceans and land masses. Co-operation has always been a key issue.

Amazingly, it always worked! Because highly skilled professionals did their job in a visionary and responsible manner.

Such people write the articles you find in *Telektronikk*.

Telecommunication developments have always made great impact to the way we organise our way of living – be it work or private family life. Looking back – and summing up – I dare conclude that the telecommunication progress has contributed to a better world. Let it be so – also in the future. *Telektronikk* will continue to explain to you the telecommunication basics of that future.

Telektronikk portrays the achievements of Norwegian professionals and their international co-operative partners. Our idea of presenting their material with an educational approach has caught on. In fact, from all over the world! Outside demands for some feature editions have occasionally reached unparalleled heights. Although such feedback has given those of us working with *Telektronikk* a good feeling, not everybody out there could possibly receive a paper copy.

To our readers: I hope you have benefited from reading features addressing your personal area of specialisation, and enjoyed looking into other areas that are – believe me – as interesting as yours.

To our authors and guest editors: Thank you for producing enlightening features and articles that educate us and everybody else interested in the fascinating principles, structures, and developments of telecommunications.

To our editorial board and Telenor: Thank you for a mature philosophy and strategy behind the production of this publication – together with the necessary funding – all vital components in making *Telektronikk* one of the few stable 'rocks' to hold on to for professionals busily providing the world with new developments.

To our editorial staff: Thank you for an extremely efficient way of producing this publication over the years.

And to new contributors to future issues: Welcome to our long list of skilled professionals who experienced the feeling of making really difficult concepts understandable to others. The feeling was good!

Enjoy the rest of 1999 with this issue of *Telektronikk*, and happy new year 2000.

Guest editorial

TOM ERIK JULSRUD

Telework has gradually been implemented in the language as a term describing work conducted at a distance (from Greek: tele = distance) to the employee or regular workplace, supported with information and communication technologies (ICT). The concept has its corresponding word in most languages, and in the Anglo-American language *telework* is used together with terms like "distance work", "telecommuting" or "remote work".

Although the term telework has turned out to be difficult to define in a precise way, the *idea* of working at a distance with the help of telecommunication tools is not new, but has actually been a recurring theme at least since the beginning of the century. In 1889 the popular science fiction author Jules Verne described the collaboration between a newspaper editor situated in Paris, and one of his journalists located in USA in the book "One Day in the Life of an American Journalist" (1889). As a communication tool, they used a "screen medium" to talk to each other and to distribute written information.

Approximately fifty years later the famous mathematician Norbert Wiener in his book "The Human Use of Human Beings: Cybernetics and Society" (1954), speculated on how progress in the science of the information technologies could make the transportation of the bodies redundant, as more work could be managed by distribution of information instead of matter. He envisioned how an architect could instruct the building of a house on the other side of the Atlantic Sea, using an "Ultrafax", a device that "communicated information alone". Wiener actually stole a march on Nicholas Negropontes famous slogan of "being digital" when he stated that: "the bodily transmission of the architect and his documents may be replaced very effectively by the message transmission of communications transmissions that do not entail the moving of a particular matter".

Jules Verne and Norbert Wiener's ideas sprung out of fascination for the new technology of their time. But as the 21st century came of age, there were several social scientists and futuristic writers who recognized how the information element seemed to move in the forefront in the labor process, giving new opportunities for conducting work at a distance. It also became more and more obvious that computers and telecommunications were going to be absolutely central for the future work life, as well as almost every other area of life. During the 1960s, 70s and 80s, the visions of a future society closely connected to the development of information and telecommunication technologies, was more thoroughly described by authors such as Daniel Bell, John Naisbit, Yoneji Masuda, Jack Nilles and Alvin Toffler.

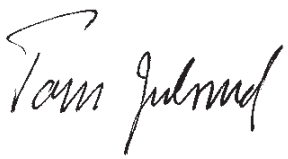
In the early 1980s Alvin Toffler presented the probably best known scenario of a more telework-oriented society, in the book "The Third Wave" (1980). In his view the home would soon appear as the place to work for most of us, due to the new communication technologies and networks. In the 1980s his term of an 'electronic cottage' became the symbol of the way telecommunications would restructure the work-life, and our private lives as well.

These glimpses illustrate how "working at a distance with communication devices" for a long time has been a fascinating idea in the borderline between popular culture and more scientific writings. The idea of moving work to people, instead of people to work, has been a recurring theme in this vision.

However, during the last 20 – 30 years there has been a major change in this picture: As late as the 1980s telework appeared as a rather vague vision, associated with the futuristic movement of its time. Now, 20 years later, telework no longer represents an abstract idea or a vague vision. On the contrary; to conduct work in other places than the traditional head office, with the support of communication tools, has become a daily habit for millions of employees in Europe, USA and other industrialized parts of the world. The typical jet-set journalist of our time, sending and receiving information back and forth to their editor with the help of a lap-top and a modem, is in fact a materialization of Jules Verne's early vision.

For the telecom businesses this has of course meant a new and fast evolving group of customers, situated partly in the residential and partly in the business markets. Meeting the demand of this group is clearly a significant challenge for all telecommunication operators. For the researcher in this area, however, this has meant that it has at last been possible to conduct empirical investigations of larger groups of teleworkers, not only stand-alone case studies, theoretical discussions, and predictions. The impact of telework on the individual or implications for the larger society can now be studied with a new set of real life evidences.

The articles presented in this volume reflect this important change, as they are all based on empirical research on teleworkers and their organizations. Analyzing the evolution of telework from a multitude of angles, the authors provide exciting insights and reflections on how telework affects the individual and society, and vice versa. But even if the contributors are relating their writings to genuine empirical findings, they are also giving hints on what the future workplace might look like. To me, this balance between present situation and future possibilities, appear as a fruitful and exciting approach to getting an understanding of the phenomenon of telework.



Telework research: Setting the scene

JOHN WILLY BAKKE AND TOM ERIK JULSRUD

Telework has become a common element in the public debate on the future of work over the last two decades. A brief look at the literature shows that telework has been proposed as a potential solution to a long list of societal, commercial and individual challenges and needs, including:

- To make firms more attractive and 'family-friendly';
- To reduce traffic congestion;
- To give individuals more flexibility in their work;
- To reduce stress related to commuting;
- To strengthen local communities and families;
- To provide work for employees in rural areas;
- To give disabled people better possibilities to join the labour market;
- To give enterprises access to employees from other geographical areas;
- To reduce office expenditure;
- To reduce fuel expenses;
- To reduce air pollution;
- To facilitate concentration work.

This list is not comprehensive, but it illustrates how the topic of teleworking relates to different causes, interest groups, and political camps. As there are arguments making telework interesting – or threatening – for individual employees, organisational developers, environmentalist, transport planners, self-employed and even unemployed, it is clearly misleading to assume there is *one* telework debate. On the contrary, there are *several* debates with different participants, problematics, and measures for what makes telework relevant, interesting, successful or even harmful.

In this introductory article we will give an outline of telework debates as well as factors that have been central to the interest for this field, and some important challenges ahead. We will however first pay some attention to the concept itself.

1 Coming to terms with telework

The heterogeneity of the discussions explains to some extent the large number of *concepts* that are used to describe the phenomenon. In addition to telework, terms like 'telecommute', 'flexible work', 'home office', 'distance work' are often used in a synonymous way, even though they may also refer to particular ways of doing telework.[1)] Much effort has been put into finding a single, unifying definition of telework (or whatever one prefers to call it), while others have argued that it probably would be better to introduce and strengthen a conceptual differentiation. In general it is recognised that it is probably impossible to agree upon one single, precise definition. We are still in the same situation as described in a review some twenty years ago, which stated that the concept is fuzzy, and that it is even doubtful whether it is possible to construct a definition, based on existing conceptual and statistical categories (see Huws et al., 1990).

The fruitfulness of gathering such varied research themes under one definition will depend on the chosen research questions. For a number of purposes, there are good arguments for bundling together somewhat varied work practices under one overarching concept like 'telework' since it is necessary to establish some common understanding of the field before introducing conceptual differences. In this collection of articles we take a pragmatic approach to the question, recognising firstly that telework is a very broad concept, covering multiple ways of organising work, and for several motives. Secondly, we find that there are good reasons for establishing a general understanding of the "core elements" in the discussion. We will discuss this a little bit further later on in this article. Thirdly, we argue that being explicit in a substantial sense when talking and writing about telework, is more important than a specific chosen concept. This can prevent typical quasi-discussions where, for instance, one party criticises home-based work dictated by the employer, while the other party defends voluntary telework one or two days a week.

What are the "core elements" in the concept? A central characteristic of telework, as we apply it here, is that it refers to work tasks performed on a distance from the premises of the employer. The chosen work location may be the (tele)-worker's home, or other places like a telework centre, a hotel room, a public place, a car, or combinations thereof. Thus, the geographical distance is the most important aspect, not the particular location of work.

Bearing in mind that 'telework' refers to the execution of work tasks is helpful for distinguishing telework from related phenomena like 'distance education', 'electronic commerce' and 'teleshopping'. However, the borders between these concepts are not absolute. For instance, the much debated merging of private and work life makes it sometimes hard to tell if one is working or doing leisure activities. In a similar way modern education and working will often be intertwined in the modern 'learning organisation'. The focus on telework as 'work' should not make one neglect the connections and intersections between work, education and leisure.

The use of *information and communication technologies (ICT)* like computers, modems and telephone-lines is often included in definitions of telework. In our view ICT are important devices and tools helping the employee perform work tasks and communicate with employer, colleagues and customers, irrespective of their location. However, one should be aware of the fact that there are also non-technological solutions to this problem, like physical meetings, carrying books, papers and diskettes, and using the mail. Further, there may be periods when ICT tools are not used at all, or when there is a shift between old and new tools. In our opinion one should be careful to hold too strictly on to the criteria of using some specific type of technology.

2 Why is telework (still) on the agenda?

What are the driving forces behind the strong interest for telework? Firstly it is clear that developments within information and communication technologies have been crucial for the interest, making it possible to perform work tasks at almost any chosen location, with communication technologies bridging geographical distances. At least four recent improvements should be highlighted in this respect:

- Development of mobile communications;
- Development of the Internet;
- Development of ISDN;

[1)] *Norwegian concepts include* fjernarbeid, telependling, telearbeid, mobilt arbeid *and* distansearbeid.

- Development of broadband telecommunication networks.

'Communication' refers no longer primarily to audio-based communication, but includes communicating with electronic documents, and with visual media like videoconferencing. The rapid merging of telecommunication and computer technology during the last 20 years has made exchange and storage of electronic files a common characteristic of modern work life. It is difficult to over-estimate the importance of the shift from paper-based correspondence and archives in traditional organisations. If you are working on the computer at your ordinary work place, and if you are using e-mail to exchange information, the options for performing work activities outside a central office are good.

Of course, some occupations and work tasks depend on physical contact with customers and clients, for instance employees in hotels, hospitals, restaurants, etc. However, the general trend seems to be that in a number of occupations, more and more work tasks may be performed at a distance from the premises of the employer. A much cited author stated in the early eighties that telework is particularly suited for those with a "low need for communication towards colleagues and managers" (Olson, 1989). As electronic mail and access to the Internet have become almost omnipresent for most white-collar work, this criterion is hardly that relevant anymore.

Technological development is but one aspect that explains the renewed interest for telework. A general change within organisational practises that support more flexible types of work is probably equally important. This includes firstly management 'paradigms' focusing on results and mutual trust more than detailed work process control and work process location. Prominent examples are project-based organisations and other organisational forms emphasising autonomy for the participants, and management philosophies like Management by Objectives. Similarly, organisations that work in a global environment with a high degree of co-operation between dispersed departments tend to be positive toward telework. This points to a more general shift in the structure of the workforce where information-based work and knowledge-production becomes more important than traditional industry (cf. Bell, 1973; Lyon, 1988; Webster, 1995). This shift towards a knowledge economy is in itself a central motivating factor for the increased use of telework. As more work becomes centred on the gathering, production or distribution of information, location becomes more irrelevant.

In addition to the organisational factors, aspects related to workers' private lives have also propelled the increasing interest for teleworking arrangements. A major change in many western societies, including Norway, is the growth of female employers in the work force. The double-income household has become the most common household structure during the last 10 years, causing a need for more flexible options at work. The increasing interest for more flexible work alternatives has been supported by household surveys over the last years. Further, there are studies that stress the importance of looking at work efficiency in a broader context which includes the employees' total 'quality of life' (Van Sell, Jacobs, 1994; Dixon, Webster, 1998). Thus, some enterprises have been advocates for less stressful working environments, with more time for family activities.

Finally, it should be mentioned that telework has been promoted strongly by commercial interests like ICT dealers, furniture dealers, and others. During the last years there has been a strong technology-push through a series of marketing campaigns selling solutions for the home-office, both to the residential and the business market. This has probably increased the interest for trying out telework among enterprises and employees alike.

3 Telework traditions – an overview[2)]

Turning to the academic discussions, the theme of working at a distance has been approached with a multitude of perspectives and methodologies. The first systematical studies were conducted in the early seventies by researchers in California. In a now classic study of the "telecommunication-transportation trade-off" (Nilles et al., 1976), *telecommuting* was proposed as one solution for the oil-dependent western economies. Aided by communications technologies, the argument went, one might reduce road-based commuting by working one or more days per week at home, or in a neighbourhood telework centre, thereby reducing travel and traffic congestion, in particular in urban areas. The focus here was on developing predictions based on economic models. Later on, several pilot projects were launched where work-related travel and fuel savings were investigated empirically (cf. JALA, 1990; Hamer et al., 1991; Kitamura et al., 1990; Mokhtarian, 1991). The approach of seeing telework as a substitute for travelling is still an active and important field. As a result, telework has been implemented in travel regulation plans in The Netherlands and in several states in USA (cf. Balepur et al., 1997; Mokhtarian et al., 1995; Henderson et al., 1996). Here, the economic savings from a travel reduction will also be supplemented by other advantages, such as environmental benefits.

The travel-reduction approach to teleworking was soon supplemented by other perspectives. During the 1970s, the question of re-locating work into the homes was discussed as a major social innovation. Best-selling books like *The Third Wave* (1980) by Alvin Toffler forecast that the home would become the workplace of the future. The motivation for establishing teleworking schemes was here linked to the "reunification" of the nuclear family and the development of more lively local communities. A number of psychologists and sociologists were now drawn into the field, making theoretical contributions and conducting case studies. Most of these studies proved to be rather sceptical, either towards the iedea, or towards the alleged benefits of teleworking (cf. Renfro, 1985; Forrester, 1989). Some studies have also indicated that female teleworkers had lower levels of education, lower general income and less flexibility in their work than men (cf. Lie, 1986; Christensen, 1987), and several feministically oriented social researchers formulated warnings about how telework could represent a "female trap".

The teleworkers' social situation remains an important issue, and much research still aims at exploring how telework influences the 'life quality' of the employee and his/her family (Büssing, 1998; Dixon & Webster, 1998; Van Sell & Jacobs, 1994), and how the boundaries between work and leisure are affected (cf. Haddon & Silverstone, 1994; Nippert-Eng, 1996).

[2)] *This section builds on Bakke, 1997; and Julsrud, 1996.*

During the 1990s the focus was increasingly put on *the organisations* that were implementing telework. Recognising that telework is a question of organisational design, the focus of many studies was on how telework could (or should) be implemented in different organisations. Research in this field has also included studies on barriers to implementation, managerial styles, effect on workers' efficiency, and evaluations of proper and improper ways of using the technologies.[3)]

The organisational approach has produced a large number of handbooks, intended to guide managers and employees on technological as well as more organisational questions for introducing telework on a larger scale (see Gray et al., 1993; Nilles, 1998; Bakke et al., 1998). Viewing telework as part of an organisational strategy has also introduced a whole new set of theoretical perspectives. Contingency theory, action research, media choice theory, social network theory, actor-network theory, as well as general system theory are among the theoretical approaches that has been applied (cf. Qvortrup, 1998; Limburg, 1998; Salaff et al., 1998; Julsrud & Ling, 1997; among other sources).

Another set of studies, connected to the organisational approach, has focused on co-operation within and between groups consisting of one or more teleworkers. Within the broad field of computer supported co-operative work (CSCW) a number of studies have explored technologies and applications that support telework or influence the workgroup. Telework has in this respect also been regarded as an element in "virtual organisations" or new production regimes, based on the exploitation of digital networks and computers (cf. Igbara & Tan, 1998; Harris, 1998).

A recent approach in studies of teleworking has been the "workplace design-approach". Authors like Becker and Steele (1994) regard telework as one part of a reorganisation of office work through the reorganisation of the physical space. While some see flexible office design as a way of working more rationally and increasing co-operation, others tend to regard it as simply a way of cutting costs (Becker & Steele, 1994; Duffy et al., 1993). A related theme is the ergonomic challenges raised by this new way of organising work (see Bakke, 1997).

This brief overview of approaches to studying telework shows that the theoretical perspectives have been broadened in scope. Today, scholars in academic disciplines like economy, psychology, management studies, sociology, architecture, media studies, transportation, geography and informatics are all familiar with the term telework, and they all give contributions to the field. The subject is truly multidisciplinary, and this has also been reflected in variations in methodological preferences and use of empirical results within the various traditions.

It should be mentioned that the subject in question – telework – has been changing during the last decades. In the study of the telecommunications-transportation trade-off (Nilles et al., 1976), teleworking centres, or 'business centers', was given a prominent place, whereas home-based teleworking got less attention – although the authors referred to the media awareness of home-based work. Alvin Toffler (1980) forcefully formulated the ideal of home-based teleworking in what he called the electronic cottage. In later studies, home-based teleworking comes to the forefront, alone, or in combinations with office-based work and mobile teleworking (see Nilles, 1998; among other sources). The initial focus on full-time homework has also faded in favour of more focus on teleworking some days a week. Thus, the term has gradually been 'adjusted' to the way telework actually is performed in today's organisations.

From its early beginnings, the discourse on teleworking has had an international orientation. The initial studies were done in the United States, but very soon the idea spread to other countries as well, while deploying the US, and later the British and Swedish experiences as inspirations (see Huws et al., 1990; Hetland et al., 1989). Now, information policy documents like "the Bangemann Report" promote teleworking, and the goal has been formulated to reach two million teleworkers in the European Union by the turn of the century (Club de Bruxelles, 1994). While being internationally inspired, one also finds national characteristic traits. For instance, local teleworking centres, or 'telecottages' have been proclaimed as a Scandinavian solution, retaining the positive aspects of teleworking, like short commuting travels and presence in the local community, while avoiding perils like isolation or an unfavourable bargaining position relative to the employer (see NOU, 1983:32; Holloway, 1994).

4 The contributions in this volume

The motivation behind this current issue of *Telektronikk* has been to collect a number of recent empirical and theoretical studies of telework from authors based in several different countries. The present papers demonstrate a variety of focuses, methods and goals. Based on well-developed theoretical frameworks and on thorough empirical studies, they demonstrate the necessity and fruitfulness of building a mosaic of focused studies. Some articles studies individual experiences, others networks of co-workers or larger organisational units. What they all have in common, however, is that they use empirical trials and experiences as a starting point for the discussion of the potentials and limitations of telework as a future way of work. Unlike much of what is written on this topic during the last decades, these contributions are exploring new flexible work forms in a systematic and critical way. They also share a concern for the human aspects related to teleworking. Even if the importance of the new information and communication technologies is not neglected, the target interest is on the user, not the technology *per se*.

Section one in this volume includes two articles founded on Norwegian experiences with telework. *Tom E. Julsrud* discusses the development of home-based telework in Norway in the period from 1995 to 1998, based on household surveys conducted by Telenor Research & Development. The article reveals that there has been a growing interest for telework, measured both by the number of articles in the daily newspapers and by various official initiatives during the early 1990s. This interest has however not been reflected by a growing number of home-based teleworkers. The most salient change during the period is the rapid growth in the teleworkers media use, towards intensive use of electronic communication media. Based on the findings, the author discusses factors that seem to stimulate and counteract the development of telework.

[3)] *For an overview, see Huws et al., 1990; Jackson et al., 1998.*

In the second article in this section *John Willy Bakke* discusses the importance of regulatory mechanisms for the practice of telework, lacunae in existing laws and agreements, and the corresponding need to develop local telework agreements. To stimulate the further development of telework as an attractive way of organising work, he argues, national and international regulatory frameworks have to be brought forward. In the article, a Norwegian telework development project is presented, where the development of regulatory mechanisms has been central.

In the second section of this volume, *general issues*, we leave the national level and present a set of articles that cover central themes in the debate on telework in society.

Leslie Haddon starts his article "Approaches to understanding telework" by presenting some major approaches to the field, as well as issues usually considered when defining telework. Based on interviews with 20 UK households, he then shows how the experience of telework is shaped by motivation, status of telework in the home, and the use of information and communication technologies. Looking at the dynamics of telework over time, he points to a number of different 'trajectories' that lead employees and self-employed into – and out of – teleworking arrangements.

The experience of being a teleworker is further explored by *Birgitte Yttri* in her article "Homework and boundary work". Using sociological cognitive theory, she analyses how 10 Norwegian teleworkers actively construct their private boundaries between home and work. Applying the conceptual framework of Christina Nippert-Eng, she shows how the teleworkers can be considered as being either 'integrators' or 'segmentators', depending on how they organise their private and work life. Much like the former article, she points at the dynamics involved in the personal experience of teleworking over time, indicating that the boundaries are not static, but an issue that is constantly being reworked by the individuals.

As flexible work forms becomes a more common and accepted way of working, an important task is to explore how this might affect the employees' health. In the article "Telework and health" *Erik Bergersen* shows how a range of studies have documented a clear connection between psycho-social factors, such as control over work-tasks and social support and observed health effects. Based on these findings, he discusses how telework in the future should be developed to avoid negative health effects for the individual employee.

Turning to the characteristics of the working group, *Dima Dimitrova* explores work situations and work relations that appear more or less suitable for telework. Based on a larger qualitative study of Canadian teleworkers, she contrasts highly interconnected groups of workers, with more loosely connected networks. Applying social network analysis, she discusses differences in communication patterns and working style among the different 'networks', focusing on the possibilities for teleworking. To understand the future development of telework, she argues, it is important to understand the combinations of these different types of network within organisations and enterprises.

In the last article in this section, we move our focus from the organisation to the strategic use of telework to develop regional labour markets. In the early 1980s the first trials with telework centres were launched in rural parts of Sweden. In the article "Telecottages and other telework experiences" *Walter Paavonen* analyses the pioneering work that took part in the first telework centre in Nykvarn, as well as other initiatives. As newcomers to the field of teleworking, we today face new initiatives in areas like resort offices and office sharing. There are several lessons to learn from these early trials, he argues.

The final section of this volume – *outlooks and opportunities* – focuses on the potential implications of telework, if applied more systematically and on a larger scale in society.

Lars Qvortrup regards telework as a strategy applied by modern organisations to handle high levels of complexity, as well as a tool for private families to handle their complex daily routines. Drawing on results from trials in the private and public sectors in Denmark, Qvortrup divides the teleworkers into three subgroups (electronic homework, telecommuting and flexiwork) which, he argues, roughly correspond to different life forms. According to his investigations, the typical teleworker seems to display a 'career life-form', more than 'the wage earner', or 'the self-employed'. In the last part of the article, Qvortrup uses this theoretical framework to discuss how telework will appear in future 'hypercomplex organisations'.

The virtual organisation is the subject for next article, "Distributed teams and the individual" by *Sigmund Akselsen*. Analysing some of the typical challenges for network-based organisations and distributed work teams, he argues that different technologies and applications can be applied to meet new demands. User trials with electronic teamrooms and other applications indicate that the core problems of higher thresholds to communication and lesser visibility of work can be handled successfully by creating a 'virtual proximity'.

As telework becomes a more common opportunity among employees, the potential for substituting traditional road-based commuting with telecommuting increases. In the article "Telework and reduction of travel: Analysis of potential in two Norwegian conurbations" by *Tom E. Julsrud*, two scenarios for the year 2010 are presented, where the number of regular homeworkers reaches 10 and 20 percent respectively. Based on these scenarios, the potential reduction of work travel in two Norwegian conurbations is estimated, and the role of telework as a general strategy for traffic reduction is discussed.

The epilogue is written by *Lars Helljesen*, an advisor who has experienced the pros and cons of home-based work for a period of time. From a personal point of view he contemplates the differences between telework theory and practice, when the home office constantly is being invaded by his 3-year old son.

5 Implications for further research

A central theme in this introduction is that telework constitutes a part of several agendas, both political, private and strategic ones, making telework an interesting and challenging field of research. This is also the reason why telework research cannot be expected to follow a single line of development, based on a unifying scientific framework. Thus, developments in the area of telework research point in different directions. Telework is introduced for several reasons, and sometimes for reasons that may

be internally conflicting. However, some general objects appear as important, and in the conclusion of this introduction we will point at some major challenges in the years ahead.

First, there is a need to systematise and *integrate research* that has been and is done on a national and an international level. Further, telework is a part of the general trend towards globalisation of the labour markets. National economies, laws and regulations are challenged by multinational and international companies, employing workers from all parts of the world. In this respect it is important to try to analyse the impact of the emergent globalism on working practices, as well as similarities and differences regarding how telework is implemented and utilised in different settings and cultures. During the last years, important initiatives have been taken to measure the distribution of telework in large-scale European surveys (Korte, Wynne, 1996; European Commission, 1998). The integration of present studies and the establishing of international research should clearly be further developed.

Secondly, there is still a lack of theories that help to explain and synthetise research findings. Telework is a field of research with a lot of separate studies, with only few references to each other. On the one hand, future research should try to see how telework fits into existing bodies of theories on eg. technological changes at the workplace, structural changes, organisational developments, media choice, etc. On the other hand, it would be helpful to develop genuine theories of telework to understand more of the dynamics in the development of telework. Some recent publications have started this work, trying to incorporate telework into more general frameworks of social sciences and theories of work (Jackson & van der Wielen, 1998; Jackson, 1999).

There is a large literature on teleworking, both paper-based and on the Internet. To a large extent, this literature has a pro-teleworking bias, often in mixtures of descriptions and prescriptions, the majority being simple assertions of the possibility of teleworking. The lack of studies according to academic standards motivates the continued need for theoretical and empirical studies. We hope that the contributions in this volume represent steps ahead for this exciting field.

Literature

Bakke, J W. 1997. The ergonomics of teleworking. *Telektronikk*, 93 (3/4), 78–89.

Bakke, J W et al. 1998. *Håndbok i fjernarbeid*. Oslo, Arbeidsmiljøforlaget.

Balepur, P N, Varma, K V, Mokhtarian, P L. 1997. Transportation impacts of center-based telecommuting: Interim findings from the neighbourhood Telecenters Project. *Transportation*, 25, 287–306.

Becker, F, Steele, F. 1994. *Workplace by design. Mapping the high-performance workscape*. San Fransisco, Jossey-Bass Publ.

Bell, D. 1973. *The coming of post-industrial society.* New York, Basic Books.

Büssing, A. 1998. Telework and quality of life. In: *Teleworking: International perspectives.* Jackson, P, VanVielen (eds.). London, Routledge, 144–165.

Christensen, K. 1987. Impacts of computer-mediated home-based work on women and their families. *Office: Technology and people,* 3, 211–230.

Dixon, T L, Webster, J. 1998. Family structure and the telecommuters quality of life. *Journal of End User Computing,* Fall 1998, 42–49.

European Commission. 1998. *Status report on European telework.* Luxembourg, Office of the official publications of the European communities.

Duffy, F et al. 1993. *The responsible workplace.* Oxford, Butterworth Architecture.

Forester, T. 1989. The myth of the electronic cottage. In: *Computers in the human context.* Forester, T (ed.). London, Basil Blackwell.

Garrison, W L, Deakin, E. 1988. Travel, work, and telecommunications : A view of the electronics revolution and its potential impacts. T*ransportation Research,* 22A (4), 239–245.

Graham, S, Marvin, S. 1996. *Telecommunications and the city.* London, Routledge.

Gray, M et al. 1993. *Teleworking explained.* Chichester, John Wiley & Sons.

Haddon, L, Silverstone, R. 1994. *Teleworking in the 1990s : A view from the home.* University of Sussex. (SPRU/ CICT Report Series, No. 10.)

Hamer, R, Kroes, E, van Oostroom, H. 1991. Teleworking in Netherlands : an evaluation of changes in travel behaviour. *Transportation*, 18, 365–382.

Harris, M. 1998. Rethinking the virtual organisation. In: *Teleworking: International perspectives.* Jackson, P, VanVielen (eds.). London, Routledge, 74–92.

Henderson, D K, Koenig, B E, Mokhtarian, P L. 1996. Using travel diary data to estimate the emission impacts of transportation strategies: The Puget Sound Telecommuting Demonstratuion Project. *Journal of the Air & Waste Management Association,* 46, 47–57.

Hetland, P et al. 1989. *Nært, men likevel fjernt. Telematikk og lokal utvikling.* Stavanger, Rogalandsforskning. (RF-rapport 123/1989.)

Holloway, L. 1994. *Telecottages, teleworking and telelearning.* Stockholm, Teldok. (Teldok Report 90E.)

Huws, U. 1988. Remote possibilities: Some difficulties in the analysis and quantification of telework in the UK. In: *Telework : Present situation and future development of a new form of work organization.* Korte, W B et al. (eds.). North-Holland, Elsevier Science Publishers BV.

Huws, U, Korte, W B, Robinson, S. 1990. *Telework : Towards the elusive office.* West Sussex, Wiley.

Jackson, P, van der Wielen, J (eds.). 1998. *Teleworking : International perspectives.* London Routledge.

Jackson, P (ed.). 1999. *Virtual working*. London, Routledge.

JALA Associates. 1990. *The California Pilot Project, final report.* Los Angeles, JALA Associates.

Julsrud, T. 1996. Teleworking : The vision. An historical view of theories and trends. *Telektronikk*, 92 (1), 16–25.

Julsrud, T, Ling, R. 1997. *The Goretex principle : The 'hytte' and mobile tele-*

phones in Norway. Kjeller, Telenor R&D. (R&D report R 7/97.)

Kitamura, R et al. 1990. *Telecommuting as a transportation planning measure : Initial results of California Pilot Project.* Washington DC, Transportation Research Board, National Research Council. (Transportation research record 1285.)

Korte, W B, Wynne, R. 1996. *Telework. Penetration, potential and practice in Europe.* Amsterdam, IOS Press/Ohmsha.

Lie, M. 1986. Er ny teknologi veien til likestilling? In: *Revolusjonen som forsvant?* Sørensen, K H, Schiefloe P M (eds.). Oslo, Universitetsforlaget, 134–146.

Limburg, D. 1998. Teleworking in a managerial context. In: *Proceedings of the third international Workshop on Telework,* Turku, September 1998, 93–106. (TUCS General Publications.)

Lyon, D. 1988. *The information society.* Cambridge, Polity Press.

Mokhtarian, P. 1991. Telecommuting and travel : state of the practice, state of the art. *Transportation*, 18, 319–342.

Mokhtarian, P, Handy, S, Salomon, I. 1995. Methodological issues in the estimation of the travel, energy, and air quality impacts of telecommuting. *Transportation Research,* 29, (4), 282–302.

Nilles, J et al. 1976. *The telecommunications-transportation tradeoff.* New York, John Wiley.

Nilles, J. 1998. *Managing telework.* New York, John Wiley & Son.

Nippert-Eng, C. 1996. *Home and work. Negotiating boundaries through everyday life.* Chicago, The University of Chicago Press.

NOU. 1983. *Telematikk. Teleutvalgets utredning nr. 2.* Oslo, Ministry of Transport. (Norges offentlige utredninger; 1983:32.)

Olson, M H. 1989. Telework : Effects of changing work patterns in space and time. In: *Information Society and Spatial Structure.* Ernste, H, Jaeger, C (eds.). London, Belhaven Press.

Qvortrup, L. 1998. From teleworking to networking : definitions and trends. In: *Teleworking: International Perspectives.* Jackson, P J, van der Wielen, J M (eds.). London, Routledge, 21–39.

Renfro, W L. 1985. Second thoughts on moving the office home. In: *The Information Technology Revolution.* Forester, T (ed.). London, Blackwell.

Salaff, J W, Wellman, B, Dimitrova, D. 1998. There is a time and place to telework. In: *Proceedings of the third international Workshop on Telework,* Turku September 1998, 11–30. (TUCS General Publications.)

Toffler, A. 1980. *The third wave.* New York, Pan Books.

Van Sell, M, Jacobs, S M. 1994. Telecommuting and quality of life : A review of the literature and a model for research. *Telematics and Informatics,* 11 (2), 81–95.

Webster, F. 1995. *Theories of the information society.* London, Routledge.

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The silent transformation of the workplace
Distribution of Norwegian teleworkers 1995 – 1998

TOM ERIK JULSRUD

1 The tracing of a social innovation

Telework is often presented as a consequence of rapid diffusion of new communication technologies at the workplace, in the homes, or – more recently – due to the fast development of the Internet. It is true that technological progress is at the core of the concept, and also provides an important driving force behind the development of homework and other types of telework. As argued in a typical commercial by an ISDN supplier: "With an ISDN connection you don't have to go to the office every time you need to work".[1)]

However, several researchers have during the last 30 years or so, warned us against a strong belief in technology as a deterministic force in social change (see Williams, 1974; Winner, 1985; Feenberg, 1991; Mackay, 1995). The broad field labeled "social shaping of technology" stresses on the contrary that social forces are crucial in the development of a new technology and how it is adopted by the users. This last point is highly relevant to the discussion on telework: Use of information- and communication technology (ICT) is – at least in most cases – not an end in itself for the employees who decide to work at a distance, but something that helps them reach one or more goals. A decision to work at home could, for instance, be made as a response to a long commuting distance, or a need to work in more peaceful surroundings. This insight, as simple as it might be, underpins a human centered approach towards telework, where it is treated as a social, rather than a technical innovation.

The aim of this paper is to give an updated overview of telework and teleworkers in Norway. The empirical core of this work is a small survey of the Norwegian households conducted by Telenor R&D during the years 1995, 1997 and 1998. This statistical analysis includes a sample of 29 full time homeworkers, 180 part time homeworkers and 443 mobile workers, and it provides exciting information on how Norwegians use their domestic technologies and how they tend to organize their work and leisure activities. The issue I will put forward in this article, however, is not only *who* the Norwegian teleworkers are, but I will also try to shed some light on *how* the phenomenon of telework has developed, and what have been the central factors behind the development. Even if the data only cover a small time span, from 1995 to 1998, it is nevertheless a rare opportunity to trace the development of telework over time. The intention is that observations here should relate to a more general discussion on how we might understand the phenomenon of telework as a social innovation, and thus how it is developing in modern societies.

Since telework is a social innovation, it is also a cultural phenomenon, driven by the common understandings and ideas of a community of people. Thus, telework should be studied with reference to the specific social environment it is applied to. In this article I will first outline the way telework has been presented in Norway since the concept caught the interest of the social researchers. It is important to note that this is a very brief and also highly subjective presentation. The idea is however that this brief history-line will provide me with a starting point, and help raise some "guiding hypotheses". These hypotheses raise the framework for the discussion of the core results from the three small surveys. My focus here will be different types of homework and to some degree mobile work. In the last section, I will discuss how the results from the surveys can be related to the way it has been treated in public discussions, and what we can expect of telework in the years ahead.

2 Teleworking the Norwegian way

The modern vision of telework was born on the west coast of the United States in the early 1970s, when the western nations were forced to cut their oil consumption due to the oil crisis in the Middle East. Prominent researchers, such as Jack Nilles and John Harkness conducted estimates of the potential savings possible by giving way to teleworking for parts of the labor force. It was stated that for every percent of the workforce who became teleworkers, the US saved 5.4 billion barrels of oil per day (Nilles et al., 1976; Huws et al, 1990). In this early vision, the primal advantage of teleworking was the reductions in money spent on oil and gas. When the idea of teleworking reached Norway in the early 1980s it had, somewhere on the way, undergone an interesting transformation: The essence of the concept was more or less the same; people were going to work at a distance with the support of telecommunication and information technology, but the central objective was no longer the reduction of oil and gas, but the development of regional labor markets. In a report from the Norwegian government published in the early eighties outlining the future consequences of telecommunications in the society, teleworking is for the first time discussed in an official document (NOU, 1983). Here, homework and local neighborhood offices ("telematikksentra") are viewed as the two contrasting types of telework. While the report is sceptical towards homework for its potential deterioriation of the individual workspace and lack of contact with colleagues, regionally based neighborhood offices are highly recommended:

> *"Local neighborhood offices of varying size may be considered. Such offices could be placed in the regions and could serve as a means for regional and employment policies (...) There may be great potential in co-localizing groups of similar work or whole organizational units in local neighborhood offices which are physically separate and have a geographical distance to the rest of the company or organization they are part of."* (page 71)

The point is further elaborated in a later chapter describing "teleworking in the year 1998" in two futuristic scenarios. While the home-office is concerned with constraints on the individual, the neighborhood office is described in a more positive scenario, marked by renewal of local industries. In general, telework is perceived as a way of moving the jobs from the cities to the regional areas. This is combined with a focus on local neighborhood offices instead of home-working. Thus, in the Norwegian discussion, telework on the one hand shifted its *content* from homework to neighborhood offices in the regions. On the other hand, it changed its *purpose* from fuel savings to regional employment.

This shift of focus illustrates a more general point to be made on the introduction of telework as a social innovation: the idea itself seems to be closely connected to the present historical and political context. While the crisis in the Middle East triggered the initial research in USA, there was another political agenda in Norway in the early 1980s. The *regional dimension* has solid roots in several political parties in Norway since the begin-

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[1)] *Advertisement for Alcatel STK,* Telekom revy*, 19/97. (My translation.)*

ning of the century and it became a central element in how telework was "framed" in the Norwegian discussion (Rokkan, 1967).[2] Much like popular trends in organisaional development, the idea of telework seemed to have travelled around the world and been implemented in accordance with local political agendas and 'mental frameworks'.[3]

Since the 1980s the regional dimension of the telework discussion in Norway has been supplemented by several others. After a period of remarkable silence on the topic, the interest for teleworking blossomed during the 1990s. The discussion of the potential impact of information and communication technology (ICT) on society was suddenly more sound. European initiatives were made to promote teleworking, and the Clinton-Gore initiative for an information superhighway opened the way to a broader discussion on the topic of telework. An important national statement from the Norwegian government came with the report "Den norske IT-veien bit for bit" which appeared to be inspired by the European Bangemann report (cf. Bakke et al., 1997). Telework was here recommended as a way of building the IT networks to provide benefits for business and industry (Ministry of Communication and Transportation, 1996). This document was followed up in 1998 in the report "Norge – en utkant i forkant" from the Ministry of Trade and Industry. In this report we meet a slightly more business oriented and careful approach:

> *"Whenever required, businesses should in a good and secure manner be able to establish telecommuting as an appropriate form of work."* (Ministry of Trade and Industry, 1998.)

The underlying point is the common view in the political milieu that the Norwegian economy had become too dependent on oil resources. The traditional onshore business lacked initiative, and the development of IT-related business appeared as a major source for economic renewal. In this context, telework appeared as a way to make efficient use of the investment in technological equipment and infrastructure. From a political point of view, it seemed like teleworking had shifted its orientation from the regional dimension, towards the more general economic interests. Probably due to the lack of any successful implementation of local neighborhood centers, the content was now undoubtedly in the direction of working from home.

2.1 The public interest

An increasing interest for the theme brought new groups into the discussion during the early 1990s. The discussion of telework was little by little lifted out of the universities and research institutions and adopted by organizations and interest groups in the labor marked. The Norwegian Federation of Trade Unions (LO) published a leaflet on the topic, other unions produced statements that supported – or banned – teleworking among their members. PC dealers and telecom businesses marketed their product as solutions for the homeworkers, and local seminars were held to discuss the pros and cons of telework. A small and enthusiastic guide to homebased teleworkers was published, promoting homework for the growing segment of self-employed (Hoksnes et al., 1991).

Obviously, the general distribution of PCs, ISDN connections and the Internet in the population acted as an important driving force behind the general interest for alternative work forms. The Norwegians have, after all, a tradition for choosing the high-end solutions when they buy their domestic technologies, and the household income has increased during the period.[4] Partly as a spin-off from the interests for technological applica-

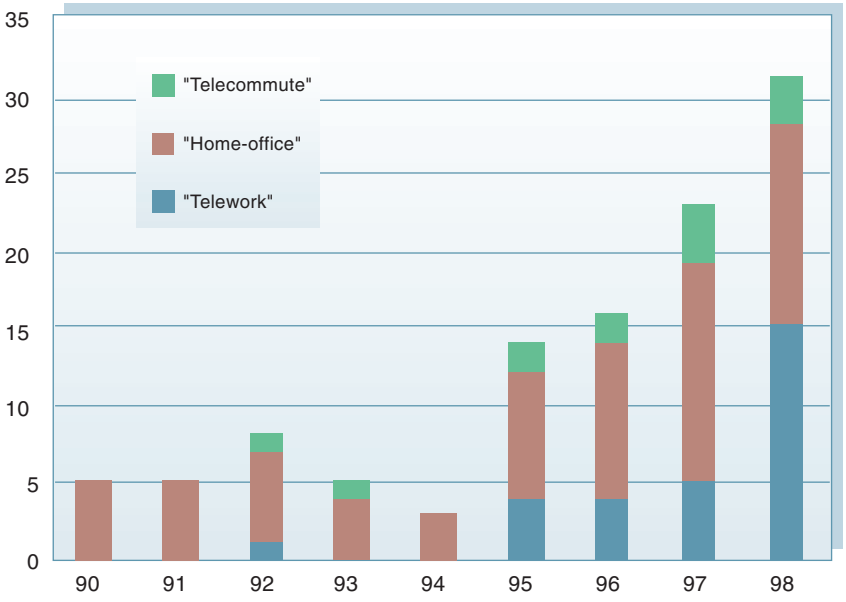

Figure 1 Total number of newspaper articles on telework ("fjernarbeid"*), home-office (*"hjemmekontor"*) and telecommuting (*"telependling"*), 1990 – 1998 in three Norwegian newspapers (Aftenposten, Dagens Næringsliv and Bergens Tidende)*

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[2] *Jarle Brosveet (1997) has used the concept "translation terrain" to describe the historical setting that provides the backdrop for the way technology is implemented. He writes: "the Norwegian or translation terrain consists in large part of regional sentiments which have pervaded the country's cultural and political past for centuries. Often, these "grassroots versus elite"sentiments have been termed parochial, meaning that they represent the attempts of the rural population to propagate local rule which focuses on elements of popular protest. These elements stress anti-bureaucratic, anti-centralist and anti-governmental values."*

[3] *Kjell Arne Røvik (1998) has showed how trends in organizational development have been slightly changed when adopted in an other part of the world. This has f ex been the case with institutional standards like Management By Objectives (MBO) and Total Quality management (TQM). The same seems to be the case with telework. This should not be taken as a critique of the scientific community, but it shows how telework is an elastic concept, which can be introduced for several reasons or needs.*

tions, telework became a favorite topic in the computer magazines. But also in the ordinary newspapers, the words telework (*"fjernarbeid"*), home office (*"hjemmekontor"*) and telecommute (*"telependling"*) gradually became a common occurrence. In 1998 more than 30 articles were published on the theme of telework, telecommute, or home-office in three larger newspapers.[5] In contrast, only five articles were published four years earlier (see Figure 1).

2.2 The need for knowledge

The renewed interest for telework by the public press fell into line with certain structural changes in the Norwegian labor market. During the early 1990s the labor market suffered from a lack of skilled workers in several areas. The situation of a mismatch between supply and demand of capacity of work had changed into a situation where there was a general lack of skilled workers particularly in the professions concerned with IT and engineering. In this context, telework was increasingly used by the enterprises as a way to attract new groups of skilled workers. In some cases the teleworking option even occurred in job advertisements for progressive private companies.

In most cases telework in the early 1990s represented an opportunity for ordinary employed workers. Yet, in some cases telework was discussed in relation to the use of self-employed as a way of achieving a more "flexible organisation" (Lie, 1994). The group of self-employed working from home has always been a significant part of the homebased teleworkers, reaching almost 50 % in some ratings, but no growth in the number of self-employed due to teleworking has been reported (cf. Julsrud, 1998). The discussions on a more flexible labor market based on looser relations between company and employed, did however clearly propel much of the debate on teleworking.

An alternative solution to the lack of skilled workers is of course to strengthen the knowledge and competence in the existing workforce. One major effort in this area was made by the Norwegian oil company Statoil, when they in 1993 offered a free PC with ISDN connection and Internet to all their employees. The idea was that if the staff could do more of their training at home, this would benefit both the individual and the enterprise. The terms of the recipients were only to submit some general PC training during the next years. Several other companies followed up the idea of home-PC for the employers during the next years and today 10 – 15 companies offer such arrangements (Folkedal et al., 1997).[6] *The home PCs* in Statoil and other companies did not comprise the opportunity of working at home during regular working hours, so it should not be regarded as teleworking. There is, however, reasons to believe that the introduction PCs in the homes brought more realism into the discussions of more regular teleworking in the future.

In parallel with the home-PC trend, many large enterprises have recently become interested in using telework as a part of larger *reorganizations of the office space*. Together with a general interest for office sharing systems, such as hot-desking and flexible offices, the focus on nomadic work has been much stronger the last years (Julsrud, 1998). The interest here is not on the supplementary home-office, but rather on more comprehensive changes in the total office space. Several Norwegian enterprises are currently running pilot studies with office sharing among groups of their staff. The objective here is of course to save costs on office space and real estate, but in some cases also to develop new communication environments among the employees. In other cases the objective is simply to stimulate the staff to work in closer contact with customers and clients.

2.3 Research initiatives

The first real Norwegian studies on telework followed much the same lines as the early California studies, trying to measure the impact of telecommunications on the use of the private car. In the late 1970s a theoretical model was developed by a group of social scientific researchers, estimating that telework together with other telecommunication-based applications, could generate 20 % more traffic, but also substitute 16 of the travels made by private car (Gulbrandsen et al., 1978). In the late 1980s more practical trials were launched, focussing on the use of telework to stimulate the local labor markets in rural parts of the country. The largest field trial included the launching of neighborhood offices in eight local municipalities and lasted for several years (Hetland et al., 1989). Thus, the shift of focus of this research was much in accordance with the political attitude signalled in official documents. Despite comprehensive efforts from local governments the centers were gradually closed during the early 1990s.

In 1994 the Norwegian Research Council launched another large research project on telework/telecommuting. The project group included researchers from Telenor and Avenir, and the project comprised working groups to examine critical issues on teleworking, as well as field trials with homework in 13 enterprises. Some of the immediate results have been presented in a Norwegian handbook for teleworkers (Bakke et al., 1998). There are still activities going on in the project.[7]

In addition minor reports have been written on the penetration of telework, qualitative analysis of teleworkers and theoretical contributions by Telenor R&D as well as other research institutions. The general pattern seems to be that the studies in the field have moved from looking into telework centers to examining home-based telework much like the interest in the official documents and reports. It seems that the discussion of telework among the researchers is closely connected to the understanding reflected in official documents and among the public. However, there have been some recent initiatives to establish local telework centers in Oslo and other urban areas. Some experiences have been discussed in a recent report (Bjørnholt, 1998), but it is still too early to decide whether these new neighborhood offices will succeed in the long run.

2.4 Summing up

The discussion so far has showed how telework gradually has been introduced

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[4] *During the period 1986 to 1995 the income after taxes has increased with 7 percent for the average Norwegian household unit (SSB, 1997).*

[5] *The terms telework, telecommute and home-office more or less cover the Norwegian terms; "fjernarbeid", "telependling" and "hjemmekontor" .*

[6] *However, not every company has been as generous as Statoil; most of the home-PC arrangements include part financing by the individual.*

[7] *This project is described in detail in the article "Developing telework regulations" by J.W. Bakke published in this volume.*

into the Norwegian public debate, and adopted in accordance with certain political goals and later, certain needs in business enterprises. I have focused on the presentation of telework in official documents and highlighted some major lines in the public discussion of telework during the 1990s. The interest has shifted somewhat in the direction of telework as a means for enterprises to hold on to skilled workers, and also to get into contact with new ones located outside the local area. The initial discussion of telework, characterized by a motivation to maintain employment in rural areas, seems to have faded somewhat.

It seems clear that the general interest for the topic has been increasing, at least measured by numbers of articles and numbers of initiatives in enterprises and among local groups. But there also seems to be a growing number of working methods included under the broad heading of telework. New concepts of "home PCs", "mobile work" and "flexible office spaces" have been introduced in the discussion during the last years, challenging the two traditional types of telework (homework and telework centers).

The presentation given in this chapter is, as I mentioned in the introduction, colored by my personal perception of the development within a field in which I also have been engaged, and also contributed to, myself. I believe, however, that the presentation provides a general framework for the statistical survey presented in the next chapter. In the final chapter, I will return to the themes outlined here, when I discuss the development of telework as a social innovation in the last chapter.

3 The distribution of teleworkers

3.1 Definitions of telework

As often remarked, no single definitions on "telework" are available. This causes problems, for obvious reasons, when one wants to measure and compare the diffusion of telework in different countries or regions. Lars Qvortrup has recently showed how measures of teleworkers in the UK have varied between 100,000 and over 1 billion [8] (Qvortrup, 1998). But even if there is no single definition available, there is on a more general level a common understanding of the "basic characteristics" of telework[9] (cf. Huws, 1988; Huws et al., 1990; Korte et al., 1996; Olson, 1987). Three main characteristics are often used to frame the field of teleworking:

- It is first of all *work* regulated by some sort of agreement;
- It is work that is done at a certain *distance to the main office*, employee or contractor;
- It makes use of *information and communication technology* (ICT) to assist the work that is conducted at a distance.

With reference to this framework, some major types of telework have been pointed out as most prominent, including "homework", "mobile work", and "telework centers", see Figure 2. In addition, it is possible to point at a type of telework that consists of a mix of homework and ordinary office work, called "alternating telework". Although it is possible to identify several subgroups, this seems to be the three major types of telework, supplemented by a variety of new types of office environments – "flexible offices".

The focus for this article is on the *home-based teleworker* because this is expected to be the most common, and it is the easiest to find empirical data. I will, however, also pay some attention to the distribution of mobile workers, because there is evidence that there are important connections between these major "modes" of teleworking, and that this type could be more important in the future (Julsrud, 1998).

While pointing at the general characteristics of telework describing the phenomena, it does not solve the problem of a concise definition of the different types of telework. Critical questions like; "how much must one work at home before it is seen as telework?" or "how much ICT is needed to call it telework?" are difficult to answer. Yet, for statistical means it is necessary to find a pragmatic and practical solution to these questions. I will here use an operational definition that stresses the first two points – that telework is paid work, and that it is conducted at a distance to the employer or contractor, slightly more than it is based on the use of ICT. More precisely, I will use the last point as a second order criterion to distinguish the ICT-oriented teleworkers from general homework, see Table 1.

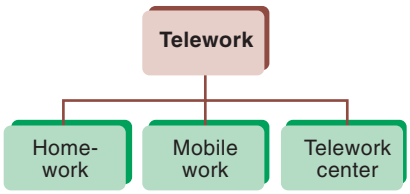

Figure 2 Major types of telework

Thus, I will first of all analyze the distribution of homework, full time, part time and mobile work. As a subgroup of the part time homework, I will apply the term ICT-based homework, to distinguish the PC users from the rest. It is important to notice that these categories are not fully exclusive: The IB homework is, in essence, a subgroup of part time homework. The homeworkers are also often represented in the group of mobile workers and vice versa. This makes the categories more like Chinese boxes than separate categories. Obviously, this puts some important restrictions on how to use the data.

3.2 Leading hypothesis

The discussion so far has brought to the surface some general expectations, or hypothesis, on the distribution and the motives of the Norwegian teleworkers (chapter 2). These expectations can easily be expressed in the form of four guiding hypothesis:

1) "The number of teleworkers is increasing among Norwegian employees." This should be a logical consequence of the more sound interest among the individuals and the organizations. The new emphasis on home PC arrangements points in the same direction.

2) "The teleworking practice is dominated by professionals who possess skills that are attractive in the labor market." Few indicators suggest that employees are forced to work at home

8) Robert Kraut (1989) has in a similar way pointed to the unfortunate fact that US measures of teleworkers during the eighties switched between 0 and 20 percent of the workforce.

9) Beer & Blanc have surveyed over 50 different definitions of telework and they report that there seems to be a common characteristic that they all focus on three dimensions: organization of the work, distance between the employer and the employee, and the use of information technology (after DiMartino & Wirth, 1990).

Table 1 Categories of teleworkers, applied in the analysis

Homework	Full time (FT homework)	Full time paid work conducted in the home 5 days a week
	Part time (PT homework)	Paid work conducted in the home more than 5 hours per week
	ICT-based (IB homework)	Paid work conducted in the home more than 5 hours per week with the use of PC (and possibly other ICT equipment)
Mobile work	Part time	Paid work that is conducted outside the office and the home more than 5 hours a week

or elsewhere. Rather, telework has been a fringe benefit by the enterprises to attract educated workers.

3) "The teleworkers are using more and more information and communication technologies (ICT)." This appears as a natural consequence of the penetration of communication equipment like PCs, Internet, ISDN, cellular telephones, pagers, etc.

4) "The teleworkers are mainly motivated by individual needs." This follows from the arguments presented above. The general trend seems to be that telework is more and more motivated by individual, more than societal needs.

I will use these hypotheses as guidelines for the analysis in the rest of this chapter.

3.3 The data

The data in this analysis is based on a household survey repeated three times; in 1995, 1997 and 1998. In each instance a battery of core question has been repeated, although some questions have been added in subsequent surveys. The informants are a representative sample of Norwegian households, including both wage earners and others between 17 and 79 years of age. The total survey has included about 2000 households each year, of which approximately 40 % have been considered wage earners.[10] The cumulated number of teleworkers (1995 – 1997) includes 29 full time homeworkers, 180 part time homeworkers and 443 mobile workers.

3.4 Number of teleworkers

As in most other European countries, there are fewer *full time homeworkers* in Norway (cf. Korte et al., 1996). The numbers have fluctuated somewhat during the period, but this group represents approximately 1 percent of the workforce, see Figure 3. In total, this means that about 23,000 persons use the home as their ordinary office. Turning to the *part time homeworkers*, that is wage earners who work more than 5 hours per week in their own homes, the number is more substantial. The general penetration of this group is approximately 7 % of the workforce, if we use the average number of the three surveys. Surprisingly, however, the numbers in this category have decreased significantly during the period, from over 8 % to 5.2 % in 1998.[11] This indicates that the number of people doing work tasks in their homes is *not* growing, as hypothesized. A closer look at the group of PT homeworkers reveals that approximately every third had spent one or more full days in their homes during the previous week, which represents about 1.8 % of the total workforce.[12]

The ICT-based homework, which consists of wage earners that conduct work in their own home more than five hours per week, and use ICT equipment, is of course a smaller group. As mentioned earlier, the only technology considered here is the use of PC in the daily work operations. Treated as a separate category, the ICT-based homeworkers repre-

[10] *It should be noted that the wage earners do not include those employed in the agriculture, fishing and forestry sectors. The reason for this is simply that in these sectors, homework has been a common practice for ages, so they should be kept apart from a possible new wave of teleworkers.*

[11] *Pearsons R = .006 (Value = -0.54 / St.Error = .019 / Tb = -2,743).*

[12] *This is what we could label the group of telecommuters, because their telework arrangements replace one or more work-travels. Replacing work travels with working at home or in a local tele-center is at the heart of this concept (cf. Nilles et al., 1976).*

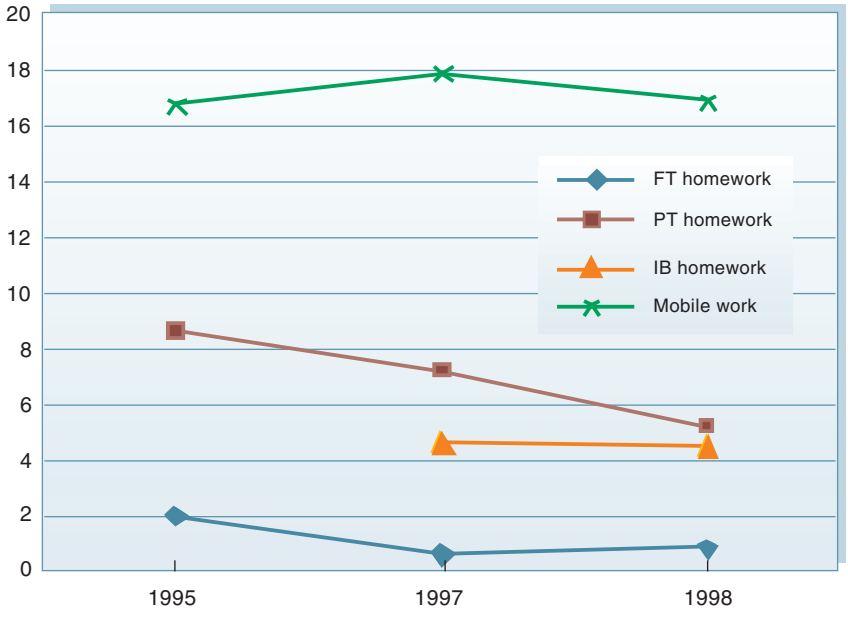

Figure 3 Penetration of different types of teleworkers in Norway 1995 – 1998

sent 4.5 % of the workforce, that is approximately 100,000 persons in Norway. In contrast to PT homeworkers, the number of ICT-based homeworkers has been constant at least for the last two years (from 1997 to 1998).

The group of *mobile workers*, as defined above, is the largest category. The percent of the workforce who conduct more than five hours of paid work outside the office and the home is between 16 and 17, and there are only minor changes over the period. It is however important to stress that this category includes more than the white-collar worker "on the run" with a lap-top under his arm and a cellular in his pocket. Mobile work, as it is defined here, also covers taxi drivers, truck drivers, sales people, construction workers and several other vocations.

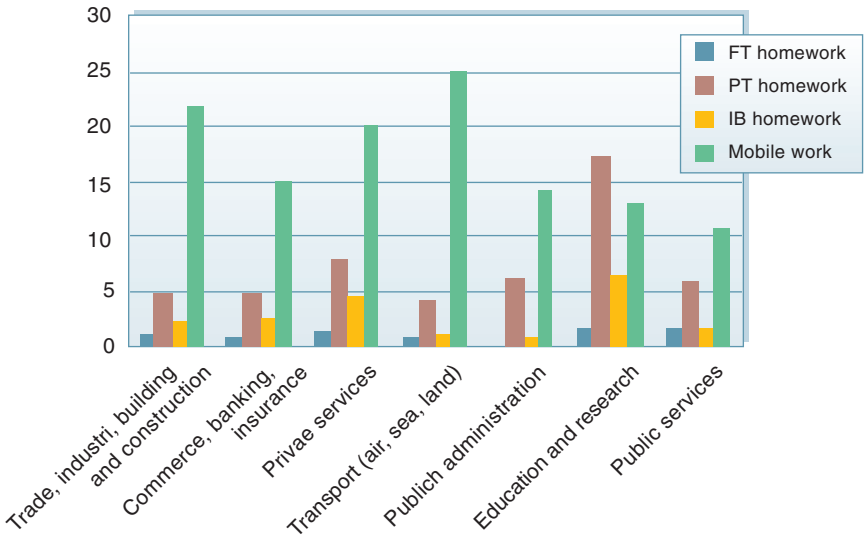

Figure 4 FT homework, PT homework, IB homework and mobile workers within different categories of work (1995 – 1998), in percent

3.5 The typical teleworker

Hypothesis two, presented above, stated that the teleworkers would have a relatively privileged status in the labor market. I will here look closer at the teleworkers' professions, status at work, income, gender and their family pattern.

Looking first at the *type of business* in which the teleworkers typically work, one finds that the different telework-types appear to be scattered over a surprisingly broad area, see Figure 4. The most salient attribute seems to be that there is far more homework in the category "education and research", than in any other. This is in particular the case for PT homework, where approximately 17 % of the employed work at home more than five hours a week. There is also a lot of PT homework in "private services". These two groups also deploy most of the ICT-based working from home. Mobile work is most common in the "transportation businesses" and "manufacturing industry".

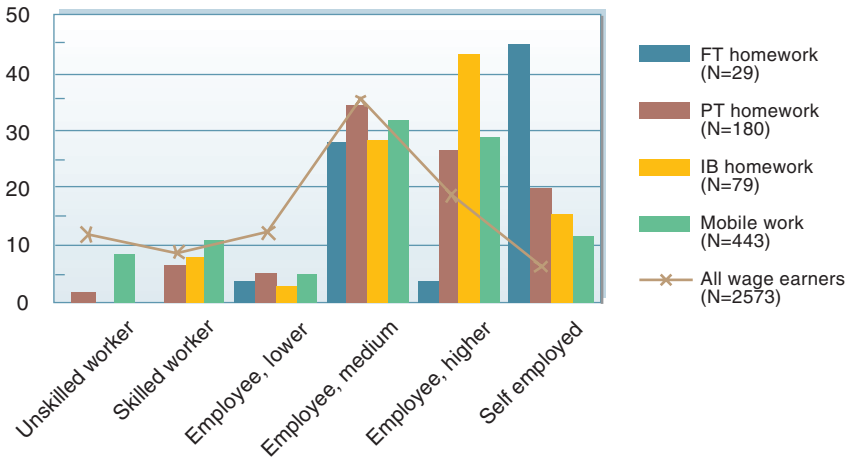

Figure 5 Teleworkers' social status (1995 – 1998). Percent of teleworkers in each category

Looking at the professions, there is also an impressive range represented among the teleworkers. The PT homeworkers include such different occupations as architects, data consultants, union workers and one freelance singer(!). The PT homework is most common among self-employed and white collar workers. As many as 29 % of the self-employed worked as part time homeworkers as did almost 10 % of the higher level clerks, and about 7 % of the middle level clerks. In contrast, only 0.9 % of the unskilled workers where PT homeworkers

Looking at the variable *status at work* it seems that telework is a habit among the higher level employees and the self-employed, more than among the skilled and unskilled workers and the lower level employees (see Figure 5). In particular ICT-based homework is more frequent among the higher level employees, and the full time homeworkers are most prominent among the self-employed. We also asked the respondents if they had a profession where they figured as leaders. Almost one third of the wage earners answered affirmative to this question. However, over 50 % of the FT homeworkers and the PT homeworkers indicated they had this kind of work. For the mobile group, the numbers were somewhat lower. Thus, the teleworkers were actually more often engaged in management work. On the other hand, it was even more compelling to see that *among the managers there were twice as many PT homeworkers, IB homeworkers and mobile workers as among the others*. This suggests that homework and mobile

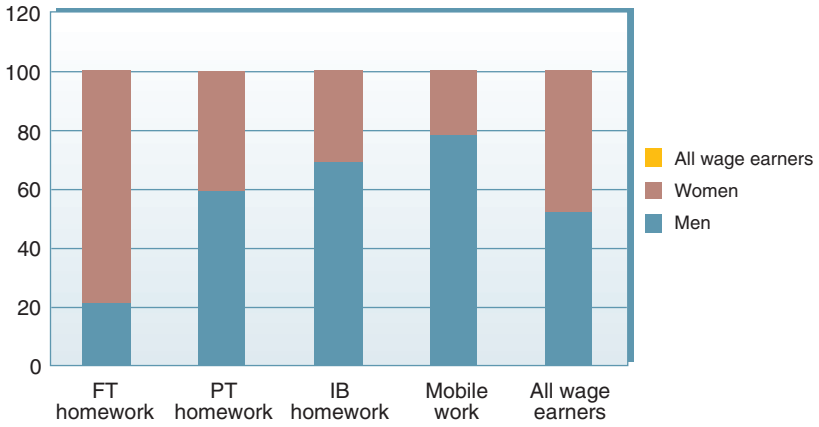

Figure 6 Percentage of men and women within different types of telework, and all wage earners in the sample (1995 – 1997)

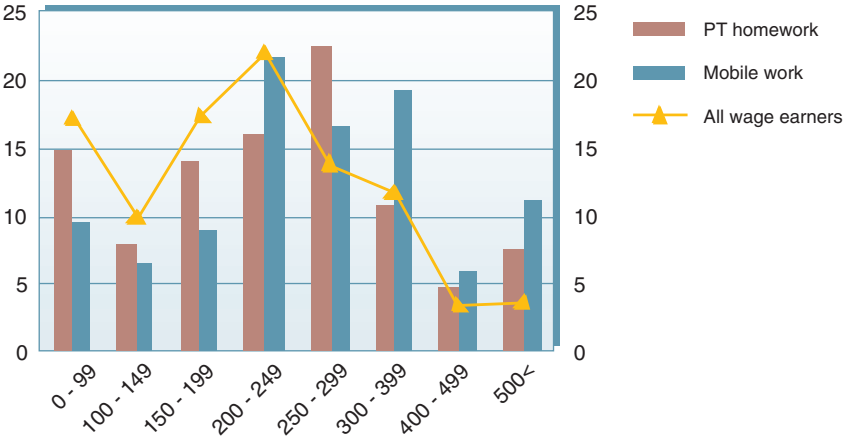

Figure 7 Gross income of PT homeworkers, mobile workers and all the wage earners in the sample, in percent

work are closely connected to the working situations of the managers

The impression of telework as a habit of the management is reinforced when looking at *the gross income* of the teleworkers in comparison to the total number of wage earners in the sample (see Figure 7). The PT homeworkers, and in particular the mobile workers, were more common among the respondents with gross incomes of over NOK 300,000.[13] Bearing this difference in mind, it is not surprising that there are slightly more men in the categories of PT and IB homework and mobile work, than the average wage earners. The FT homeworkers, on the other hand, is the only type of telework with a preponderance of women (see Figure 6).

[13] *Corresponding to approx. USD 37,000.*

3.6 Use of ICT among teleworkers

Are the teleworkers using more and more ICT, as stated in our third hypothesis? In our survey we asked if the teleworkers used communication media to keep in contact with the employees or the contractor. The results firstly indicate that there is a broad range of media in use by the teleworkers, and the most eager users seem to be the mobile workers and the ICT-based homeworkers, see Figure 8. Ordinary telephone and cellular are not surprisingly the most important medium, but e-mail has become as common as telefax and ordinary mail. E-mail is used by approximately every third PT homeworker and almost every second ICT-based homeworker and mobile worker.

It is here interesting to note that e-mail does not seem to replace the telefax, but it looks like these two technologies together with ordinary post is stimulating each other respectively. Considering that the ICT-based homework consists of the part time homeworkers who also use PCs in their work, it is a bit strange that the use of e-mail is not higher than 50 %. It should also be noted that the group who spend most of the time away from work, are the ones who use the least technologies. Probably this is explained by the fact that there is a large number of self-employed in this group, with no stable connection to a workplace outside the home.

Looking at the use of media technologies over time, it is clear that there has been a significant increase in the use of e-mail among the teleworkers. Figure 9 shows how this technology has developed rapidly within the categories of mobile work, part time work and ICT-based homework. For example, the part-time homeworkers have increased their e-mail use from 12 to 44 percent.

3.7 Teleworkers' motives

In the final hypothesis, it was stated that teleworkers would be mostly driven by individual needs. In the survey we asked the respondents to indicate their motives by choosing between seven options.[14] For each option it was possible to signal either "very important", "some importance" or "no importance". The question

[14] *The options were: 1) I need to make plans and prepare for the next workday 2) I need to do work that I did not manage to finish during regular working hours, 3) I want to spend more time with the family, 4) I want to avoid disturbances when working, 5) I want to spend less time on commuting, 6) It is decided by my employer, 7) I am a self employed, with no other workplace, 8) Other reasons.*

was only asked to the homeworkers, and due to the limited number of answers it is not possible to analyze variations between telework types. Figure 10 shows that among the self-employed workers, lack of other office space turned out to be the most important motivation selected by almost every fourth teleworker. Over 36 % indicated that this was of major importance.

The employed homeworkers seemed to be attracted by the opportunity to avoid disturbances (27.3 %) and to reduce their commuting time (22.3 %). About 8 % also indicated that the major reason for homeworking was to get ahead with their work tasks and to prepare for the next workday. The need to keep more in contact with the family appeared as a typical second-order motive. This was also the case for the female part of the teleworkers.

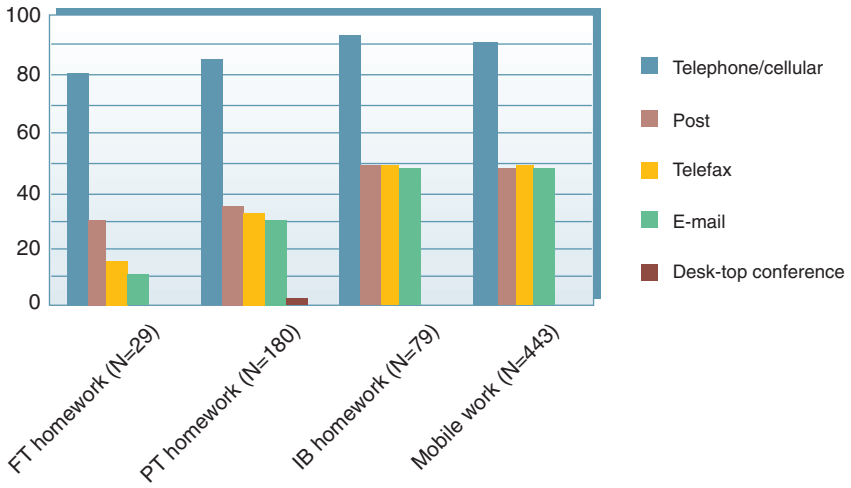

Figure 8 General use of ICT among FT homeworkers, PT homeworkers, IB homeworkers and mobile workers (1995 – 1998)

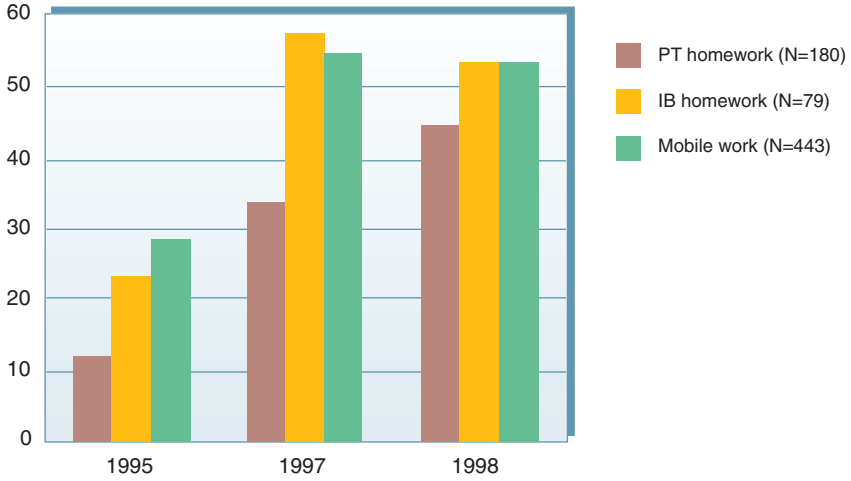

Figure 9 Use of e-mail among categories of teleworkers during 1995, 1997 and 1998

3.8 Summing up

The results presented in this chapter have shed some light upon our guiding hypotheses:

- The first hypothesis which stated that "the number of teleworkers is increasing among Norwegian employees" must be rejected. The number of part time homeworkers has actually been decreasing somewhat during the last three years, while ICT-based homework and mobile work have been stable during the 1995 to 1997 period.
- The second hypothesis, that "the teleworking practice is dominated by professionals who have skills that are attractive in the labor market" has been supported in this analysis. There is evidence showing that most of the teleworkers are in leading positions and earn more than the average employee. Among the managers, there were twice as many part time homeworkers, ICT-based homeworkers and mobile workers as the average.
- The third hypothesis, stating that "the teleworkers are using more and more information and communication technologies (ICT)" was supported. Focusing on the use of e-mail, both the part-time homeworkers, the ICT-based homeworkers and the mobile workers had more than doubled their use of this technology. The part time homeworkers had increased their e-mail use from 12 to 44 percent from 1995 to 1998.
- The last hypothesis, that "the teleworkers are mainly motivated by individual needs" was at least partly supported. The most important need expressed by the employed teleworkers was to work more undisturbed, while the need to look after the family was secondary. However, it also appeared that a lot of the homeworkers simply used the home as an office because they did not have access to other work spaces as self-employed.

4 Refocusing the picture

"In the future we will be able to work wherever we want to, whenever we want." This is the story of the future labor market, as futurists and the social researchers often tell it. However, the empirical evidence presented in this article leaves us with a sobering, but slightly disturbing picture of the situation. Telework seems to be developing on a relatively slow track, and parttime telework from home has actually been leveling out the last years. But while there has not been any "home-work revolution", homework is becoming more and more saturated by the new electronic communication media.

The paradox is intriguing but also a little ominous. In a certain sense it implies that telework is going in the direction of elitism, remembering that the number of teleworkers with management responsibility is relatively high. On the other hand, it is true that a large group of the homeworkers are self-employed. Their primary motivation to work at home is that this is their only available workspace.

In this chapter I will elaborate further on possible explanations for the development traced out by the survey analysis, trying to refocus the picture of the teleworkers. The question I will try to answer is simply: why is the number of homeworkers not increasing, when there are so many efforts being made to support this? And what implications will this have for the way the labor market will develop the next 2–3 years? But before I go on to the discussion, I will pay some attention to similar surveys from other countries.

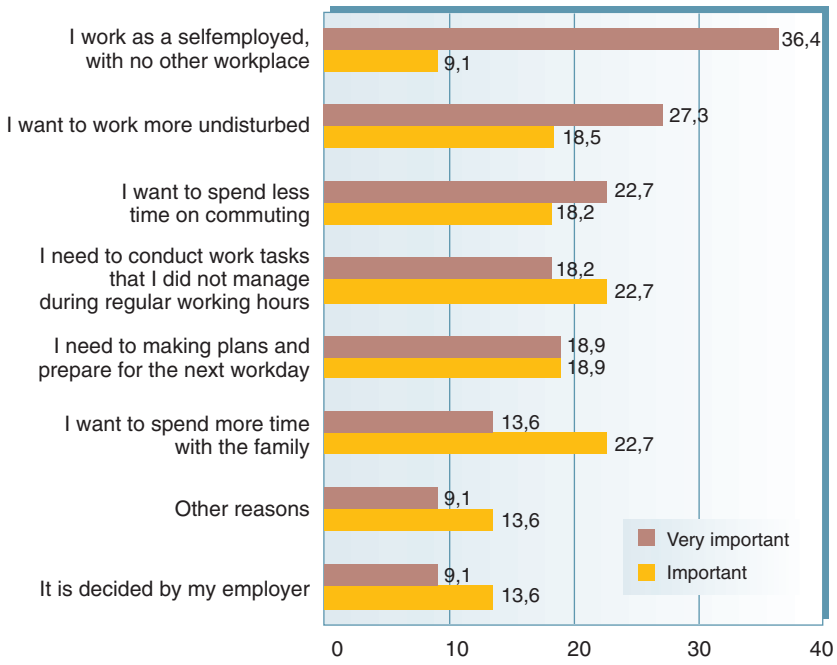

Figure 10 The homebased teleworkers' major reasons for conducting work at home, in percent (N = 22)

4.1 Results from other countries

Is this a unique Norwegian phenomenon? If we take a brief look at surveys from the United States, it actually looks like we have fallen in arrears with the general development. According to a frequently cited survey by FIND/SVP, a New York based research and advisory company, the number of US teleworkers has increased from 8 to 11 million during the period 1995 to 1997. This indicates a 30 % growth. It is however unclear which criteria have been used in this analysis (http://www. at.com/press/0797/970702.bsa.html).

The survey of European teleworkers published by Empirica in 1990 and 1997 is probably the largest and most thorough analysis that has been conducted in Europe (Huws et al., 1990; Korte et al., 1996). It is also a study that has been repeated with a five year interval, so it includes time-span information. These data estimate that the number of teleworkers ranges between 2 and 8 percent of the enterprises in the five largest EU nations. Looking at the development over time, it is clear that the interest for and knowledge about telework has been increasing. However, this has not resulted in a rapid growth of European teleworkers. This leads the authors to conclude that telework in the future hardly will exceed 6–8 percent of the workforce, including teleworking centers.

According to a study published by the Swedish KFB institute (Engström et al., 1998), the number of Swedish employees who conduct at least two hours a day of paid work in their homes is about 700,000. Using this rather wide definition it is stated that about 18 % of the workforce are (part time) teleworkers. Compared to a former study, conducted eleven years earlier, this represents a four percent increase. The authors admit "in relation to the enormous attention focused on teleworking in recent years ... this increase may appear somewhat modest" (Engström et al., 1998, page 29). Moreover, they find that the number who use less time in their home (2–5 and 6–8 hours per week) has been decreasing, while there is an increase in the number of long week homeworkers (17–24 hours a week or 3 days).

4.2 The counteracting forces

This brief outlook does not suggest that telework from home in general is a lost idea, with no future. After all, the interest for doing work at home is still sound among the wage earners in most European Countries, including Norway.[15] We should also remember that there is a large group of mobile workers, even if this group includes a lot of traditional jobs. But even so there is staggering evidence that the penetration of telework in the homes does not follow the steep curves of the diffusion of the Internet or the personal computer. Despite the expressed interest of the wage earners, and despite the fact that there is more and more ICT in their homes (and at their workplaces), there are certain conditions that work against it. In this article there is not room to elaborate on the possible explanations for this. However, to shed some light on this problem I will briefly point to three possible fields of explanations, which I will call "counteracting forces".[16]

The first counteracting force is related to the *content of the work*. One of the major

[15] *A survey of Norwegian wage earners found that over 30 % wanted to work at home one or two days per week, if possible (Lødemel, 1996).*

[16] *The conditions I discuss here should not be taken as only "barriers", like "negative attitudes among the management" or "lack of information of the advantages of telework". They are referring to more basic changes in the organization of work and home, that seem to be moving in the opposite direction of telework.*

challenges for working at a distance is to engage in situations which demand more complex communication with two or more participants. Telecommunication media are excellent when the need is to handle unambiguous messages between two persons (cf. Trevino et al., 1990). It is often a disadvantage however when handling communication which demands more complex interaction between several parts, for example when discussing different ideas in a group, or negotiating with business partners. There is some evidence showing that in the network economy, these complex communication situations are getting more common (cf. Zuboff, 1988). One explanation to the slow uptake of telework might thus be that the content of the work tasks is changing in a more human-oriented direction, demanding more face-to-face contact.

The second counteracting force is related to *how modern companies tend to organize themselves*. During the last 20 years there has been a strong movement towards the reengineering and reinvention of the modern organizations. There are multitudes of concepts and theories describing ways modern organizations should design their work tasks. Some of the best known are "Just in time production" (JIT), "Total Quality Management" (TQM) and "Business Process Reengineering" (BPR). The theories are obviously presenting and arguing for different "cures" for the organizations. But they also have some common characteristics (cf. Holter et al., 1998; Rørvik, 1998). For instance, they all seem to stress:

- Removal of unnecessary expenses related to staff and administration;
- Closeness to customers and clients;
- Quality in all parts of the value-chain;
- Working in smaller independent units (projects).

To some extent telework arrangements are a part of this new organizational design. Greater flexibility in place of work is an element of the flexible firm. However, the habit of working from home may easily obliterate the need for closeness to customers and clients. If the strategy of the company is to become more service oriented, there might be scepticism towards allowing employees to spend more time in their homes. Moreover, the typical trend toward more work in teams, with frequent shifts of team members, can come into conflict with distant working members. Teamwork often needs a lot of immediate face-to-face contact. The reinvention of organizations can thus make management embrace telework, but in some cases it can also make them turn away from it.

The third possible counteracting force I will stress stems from *the teleworkers' private sphere*. Usually telework is considered to be a positive contribution to the private life of the teleworker, because he or she can spend more time with family and friends. But from a more negative point of view it is argued that the home no longer is the peaceful "oasis" that it used to be. Arlie Russel Hochschild (1989) has suggested that people simply do not want to work at home, partly because the private home has become a very noisy and stressful place, but also because the workplace has become more and more humane and attractive. According to Hochschild, the workplace is getting more like a new home, and the home more like the old workplace. Her "out of home argument" finds some support in time-budget analysis, showing that people spend less time in their homes today, than 15 years ago[17)] (SSB1992). One reason for this is that the number of single households is increasing, especially in urban areas. For this group of wage earners, who often have most of their social network at their workplace, telework might be less attractive.

It might be that the home – at least for some employees – is turning into a less important place, while the workplace is turning into a place where also more social needs are gratified. However, the reasons that Hochschild points at are not so much the lack of interest for the families by wage earning mothers and fathers, as the invisible pressure present in the organizations to "be accessible" as much as possible. Thus, her point is to a large extent reflected in Richard Sennet's book "The corrosion of character" (1998) where it is argued that the new flexibility results in a demand for constant accessibility and visibility. According to Sennet employers are reluctant to give employees sufficient freedom, and the homeworkers are more and more targets of electronic control devices. He is afraid that the "flextime worker" will lose control over the labor process, even if they control the location of it (Sennet, 1998, page 59).

[17)] *This is based on time-budget analysis of Norwegian households 1970 – 1990.*

4.3 The driving forces

The discussion of the potential "counteracting forces" may leave the impression that telework is too complicated in today's business climate. The general point however, is that teleworking from home is evolving on a slower track than expected some years ago, not that the idea itself is ephemeral. What we see is that the ones who actually *are* working from home – a relatively stable group of employees and self-employed – are using the communication technology more and more. The number who conduct work in the home *in addition* to regular work is probably increasing steadily, even if this falls beyond the concept of telework as it is defined here (ie. as paid work). Initiatives like "home PCs" for the employees support the unpaid homework instead of paid "telework". The problem seems to be to move beyond the occasional (unpaid) homework, to more regular use of home-offices, with the opportunity to conduct paid work from the home.

What then are the forces that stimulate more regular homeworking? The empirical survey suggests that the reasons might not be what we expect them to be. A major reason for the individual worker to work in the home seems to be the *need for undisturbed work*. Today, many home-offices figure as a shelter for information workers who need to get ahead with their work. It is here striking that those who work most at home – the full-time homeworkers – use the least technologies, while the mobile workers are "the lead users". In a labor market with an evolving tempo, the need for concentration will be more sound.[18)] Another major driving force is probably the need of the private enterprises to *get access to – or hold on to – their "best brains"*. A home-office solution is in many cases just what is needed to make the employees accept a longer distance between home and workplace. Due to the lack of IT knowledge in Norwegian enterprises, the leading IT companies will probably go on to offer home PCs and home-offices to their staff in the future.

[18)] *A recent study, widely published in Norwegian newspapers, has found that an average office worker is being disrupted every 10 minutes by a telephone, e-mail or a telefax. According to the study conducted in four European countries, extended use of ICT may hinder the productivity in the companies (cf. Aftenposten, 02.06.99).*

The knowledge gap in the IT sector will probably also generate several new *home-based businesses*. The self-employed with knowledge in relevant areas will be given new opportunities in a movement towards a global labor market, which is also becoming increasingly individualized (Castells, 1996; Sennet, 1998; Beck, 1986). As we enter the new millennium it looks like the trend towards a labor market with more *temporal and individual contracts and arrangements* is important for the development of telework. Telework is well suited for temporary work-arrangements as well as part-time work on a global as well as a local level. The self-employed teleworker – working for several global businesses – will probably appear as one of the major types of homework in the future. This employee may work at home, or in a local neighborhood office together with other self-employed.

These factors imply that homebased telework will be a common part of tomorrow's labor market. Yet, the picture of today's teleworkers covers more than regular home-offices. As the material presented above notes, mobile work and flexible use of office space is getting more and more common. There are reasons to believe that these workforms will become more and more popular in combinations with homeworking and working from telework-centers. *Regarding the mobile work*, the *need to reach the customers* is a major driving force. The customization of all types of work and the growing number of jobs in the service sector will make this all the more common. It is not so much that there will be new types of jobs because of the technology, but the fact that mobility makes it possible to do work in places and times that used to be no-work time. The new workplaces are for example the car, the airport, the train station or the hotel room. In addition, the instant communication link between the "nomadic worker" and the head office represents a new dimension of instant feedback. As the companies pay more attention to the restructuring of the office space in the direction of desk-sharing and hot-desking, the number of mobile teleworkers will probably increase significantly in the future.

5 Lessons learned?

The overview of the Norwegian telework I have provided in this article covers only a small time-span, from 1995 and three years on. The focus has mostly been on homebased telework, although I have paid some attention to the parttime mobile workers. What can we learn about the diffusion of telework on a more general level? Is it possible to say something about the nature of telework as a social diffusion?

Firstly, it is clear that the motives and arguments for telework has changed several times since the idea was first introduced to the organizations and employees in Norway in the early 1980s. In general, there seems to have been a *move from focussing on societal needs towards organizational and individual needs*. An important lesson learned so far seems to be that the need of the employees must to a certain degree correspond to a need present in the organization if telework can be implemented successfully. (However, this does not imply that there must be similar needs or objectives with the telework-arrangement.) There are several reasons for implementing teleworking in an organization, and several combinations of individual and organisational needs will take place. The relatively slow uptake of this new workstyle suggests that there is still some mismatch between these motives. We should probably also reconsider the idea of telework – as it is defined here – as a phenomenon that eventually will embrace every employed person.

Secondly, telework as an "idea of reorganizing the work by the use of ICT" has clearly been connected to the social and political climate during the period. The political angle of incidence has also had implications for how it has been studied and tried out in practical field trials. In the long run, however, these initiatives have had little effect on the actual spreading of telework in Norway. Looking at the actual number of teleworkers, it is hard to see any effect of these practical trials. However, the trials have probably had an impact on the increasing interest for telework among the public, and among employees and managers. Similarly, it is also clear that a strong interest for the phenomenon of telework in newspapers and magazines has little effect on the actual number of teleworkers.

Thirdly, our investigation has shown that the new technology pervades more and more of the telework that is taking place, in the homes and elsewhere. *The diffusion of personal computers, mobile telephones and Internet has not in itself led to many new teleworkers*, but the present group of teleworkers has clearly taken advantages of the new technology. The general pattern seems to be that the technology makes every employee more and more involved in the use of ICT and thus also more accessible by electronic devises. Still, the use of ICT seems to be dependent on the type of telework in question. The use of ICT is closely connected to their motivation for a more flexible work style. For an important group it is important to restrict the number of incoming telephone calls, e-mail, etc., while others need full accessibility. This will probably cause increasing differentiating regarding the teleworkers' media use.

Finally, the overview has shown that telework is a concept that covers a growing number of sub-categories, such as home-offices, mobile offices, home-PCs, etc. Much of the transformation that is taking place at today's workplaces is happening on the boundary line of what is covered by the term "telework" (eg. home-PCs for the employed, occasional work outside the office, mobile offices). When the connection between work and place is getting looser, it is not sufficient to talk only about "telework". This should clearly lead the scholars in the field to develop more sophisticated ways of study and define the objects of interests. At this point it seems to be absolutely necessary to make use of more detailed and well defined concepts (eg. mobile telework, ICT-based homework, etc.) to explain the development. Future research in the field should make a serious effort to develop new concepts that help us to better understand the transformations that take place in the future labor market.

6 References

Bakke, J W, Bergersen, E. 1997. *Teleworking : the Norwegian experience.* Kjeller, Telenor R&D. (Research note N 19/96.)

Bakke, J W et al. 1998. *Håndbok i fjernarbeid*. Oslo, Arbeidsmiljøforlaget.

Beck, U. 1986. *Risk Society. Towards a New Modernity.* London, Sage.

Berg, A J et al. 1988. *Distansarbete i Norden*. Helsingfors, NordREFO.

Bjørnholt, M. 1998. *Knutepunkt telependling. Forstudie av erfaringer, muligheter og suksessfaktorer.* Bø, Telemarksforskning. (TF note 5/98.)

Brosveet, J. 1997. *Frihus 2000: Public Sector Case Study of a Norwegian IT Highway Project.* Trondheim, Centre for Technology and Society. (SLIM working Paper No. 3.)

Castells, M. 1996. *The rise of the network society.* Malden, Mass., Blackwell.

Di Martino, V, Wirth, L. 1990. Telework: A new way of working and living. *International Labour review,* 5 (129).

Engström, M, Johanson, R. 1998. *Following IT into New Forms of Organisation and Work Methods.* Stockholm, Kommunikationsforskningsberedningen. (KFB-Report 1998:5).

Feenberg, A. 1991. *Critical theory of technology.* New York, Oxford University Press.

Folkedal, G, Jakobsen, M, Julsrud, T. 1997. *Telenors ansatte på nett – Forslag til hjemme-PC-ordning for Telenor.* Kjeller, Telenor R&D. (Research note N 57/97.)

Gulbrandsen, O, Håvold, J I, Tank-Nielsen, C. 1978. *Teletjenester og persontransport. En modellanalyse.* Kjeller, Televerkets forskningsinstitutt. (TELSAM-rapport nr. 3.)

Hetland, P et al. 1989. *Nært, men likevel fjernt. Telematikk og lokal utvikling.* Stavanger, Rogalandsforskning. (RF-rapport 123/1989).

Hochschild, A R. 1997. *The Time Bind: When work becomes home and home becomes work.* New York, Metropolitan Books.

Hoksnes, A, Nordli-Mathisen, V. 1991. *Egen jobb i eget hjem.* Oslo, Marcus forlag.

Holter, Ø G et al. 1998. *Omstillinger i arbeidslivet.* Oslo, Arbeidsforskningsinstituttet.

Huws, U, Korte, W B, Robinson, S. 1990. *Telework. Towards the elusive office.* West Sussex, Wiley.

Huws, U. 1988. Remote possibilities: Some difficulties in the analysis and quantification of telework in the UK. In: Korte, W B et al. (eds.). *Telework: Present situation and future development of a new for of work organization.* North Holland, Elsevier, 61–75.

Julsrud, T. 1998. *Combinations and tracks: An investigation of the relationship between homework and mobile work.* Paper presented at Teleworking Environments, Turku, September.

Korte, W B, Wynne, R. 1996. *Telework. Penetration, potential and practice in Europe.* Amsterdam, IOS Press/Ohmsha.

Kraut, R E. 1989. Telecommuting: The trade-offs of home work. *Journal of communication,* 39, 19–47.

Lødemel, T. 1996. *Arbeidstidsundersøkelse FAFO/Opinion.* Oslo, Næringslivets Hovedorganisasjon. (Arbeidsnotat nr. 2/96.)

Mackay, H. 1995. Theorising the IT/Society Relationship. In: Heap, N et al. (eds.). *Information Technology and Society.* London, Sage, 41–53.

Ministry of Trade and Industry. 1998. *Norge en utkant i forkant. Næringsrettet IT-plan 1998–200.* Oslo.

Ministry of Communication and Transportation. 1996. *Den norske IT-veien, bit for bit.* Oslo. (Rapport fra Statssekretærutvalget for IT.)

Nilles, J et al. 1976. *The telecommunications-transportation tradeoff.* New York, Wiley.

NOU. 1983. Telematikk. Teleutvalgets utredning nr. 2. Oslo, Ministry of Transport (Norges offentlige utredninger; 1983: nr. 32.)

Olson, M. 1987. Organizational barriers to telework. In: Korte, W B et al. (ed.). *Telework: Present situation and future development of a new form of work organization.* North Holland, Elsevier, 77–100.

Qvortrup, L. 1998. From teleworking to networking: definitions and trends. In: Jackson, P J, Van der Wielen, J M (eds.). *Teleworking: International perspectives.* London, Routledge, 21–39.

Rokkan, S. 1987. *Stat, nasjon, klasse: Essays i politisk sosiologi.* Oslo, Universitetsforlaget.

Rørvik, K A. 1998. *Moderne organisasjoner. Trender i organisasjonstenkningen ved tusenårsskiftet.* Bergen, Fagbokforlaget.

Sennet, R. 1998. *The corrosion of character. The personal consequences of work in the new capitalism.* NY, WW Northon & Company.

Statistisk sentralbyrå (SSB). 1992. *Tidsbruk og tidsorganisering 1970–90.* Oslo. (NOS; C10.)

Statistisk Sentralbyrå (SSB). 1997. Inntekts- og formuesundersøkelsen for husholdninger, 1986–1995 : Yngre enslige er taperne. *Ukens Statistikk,* 35.

Toffler, A. 1980. *The third wave.* New York, Pan Books.

Trevino, L K, Daft, R, Lengel, R H. 1990. Understanding managers media choices: A symbolic interactionist perspective. In: Fulk & Steinfield (eds.). *Organizations and Communication Technology.* Beverley Hills, Sage.

Williams, R. 1974. *Television, technology and cultural form.* Cambridge, Fontana/Collins.

Winner, L. 1987. *Autonomous technology.* Cambridge, Mass., MIT Press.

Zuboff, S. 1988. *In the age of the smart machine. The future of work and power.* New York, Basic Books.

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Developing telework regulations

JOHN WILLY BAKKE

«The challenge that many designers of organizational structures are already facing [...], is an immensely complex phenomenon for which 'teleworking' is merely the crudest shorthand – nothing less than the redesign of the shape of time.»

(Duffy, 1997)

Introduction

The topic of 'teleworking' appears in a number of diverse discourses, like organizational design, management techniques and office design, as well as the role of teleworking in societal transformations towards a 'home-oriented society', a 'risk society', or a society of 'digital nomads' (see Nilles, 1998; Duffy, 1997; Toffler, 1981; Beck, 1992; Makimoto and Manners, 1997; among several other sources). A central theme in the discourses on teleworking is the *'teleworkability'* of work tasks, referring to the possibility of performing work tasks at another location than the regular premises of the employer. Teleworking schemes and handbooks strongly emphasize this issue, and in a similar way, predictions about telework diffusion patterns are typically based on an analysis of the teleworkability of singular jobs or work tasks. This focus on the teleworkability of work tasks has to be central, since it is a *sine qua non* for other concerns, like recommendations and warnings, and for discussions of various impacts or implications of teleworking. Focusing solely on the ability to perform work tasks at locations other than the employer's, does, however, cover ony one aspect of telework, and one may argue that this perspective represents a rather atomistic and individualistic approach to the discussion of telework arrangements. What this individualistically oriented perspective misses, is that work tasks are embedded in a wider context. In this presentation, it will be argued that the development and diffusion of telework arrangements and plans will be better understood by supplementing the individual preference perspective ('does teleworking seem like a good idea for me and my organization?') with an institutional, working life perspective, acknowledging the importance of labour legislation and other workplace regulations, both locally and on a larger scale (see the discussion in Bakke, 1998). Within this perspective, teleworking may be described as an atypical or detraditionalized work practice, where established regimes of workplace regulation with rather standardized working conditions are being supplemented or replaced by local or individual arrangements.

Telework regulation

All working life arrangements are embedded in a set of regulatory frameworks, encompassing both formal instruments like labour legislation and agreements, and informal aspects like traditions and norms. The latter aspects, which include traditions, culture, meanings, values, interpretations, and conceptions of appropriate behaviour at work, are of equal importance as the formalized ones (see du Gay, 1997; Jakhelln, 1996a). For 'ordinary work', the set of regulatory frameworks is fairly extensive, specifying in detail a number of mutual rights and obligations, whereas for telework, the corresponding set of formal regulations is poorly developed, and there has not yet been developed a set of telework values, norms and paradigmatic practices (for a discussion of Norway, see Jakhelln, 1996b, Bakke 1998). On the transnational level, certain elements for a regulatory framework have been developed (see below), but they are still far from being important for actual telework practices.

The introduction of teleworking may be seen as an example of flexibilization or *detraditionalization* of work, where work sites as well as labour contracts and working hours are opened for re-negotiation (cf. Beck, 1992; Olberg, 1995). The absence (relatively speaking) of telework regulations may have been the result of lacunae in the regulatory framework (as is the case for the Norwegian *Working Environment Act*), or it may be an element in a strategy for de-regulation (or rather – re-regulation) of work. Irrespective of its sources, this absence allows for – and requires – a number of choices to be made by the parties involved, regarding local rules of conduct: With several degrees of freedom, few paradigmatic models, and few standards and regulations, the prospective teleworkers and employers face a complex body of choices – and may end up with a tailor-made organization, or with solutions inappropriate for their organizational needs.

Laws and provisions are not the only mechanisms for regulating (tele-)work practices. Other mechanisms include collective and individual agreements, traditions and norms, and corporate culture. These mechanisms differ on several accounts, but have in common the effect of providing rules of conduct as well as conceptual models or schemes for organizing working life. The popular genre of telework handbooks may in this perspective be seen as instances of regulatory mechanisms, by being vehicles for presenting and disseminating concepts and paradigmatic models of 'good practice'.

A tentative categorization of regulatory mechanisms is shown in Table 1.[1)]

[1)] *The primary goal of this categorization is to demonstrate a multitude of regulatory mechanisms which may co-exist and overlap, and to some extent may substitute for each other.*

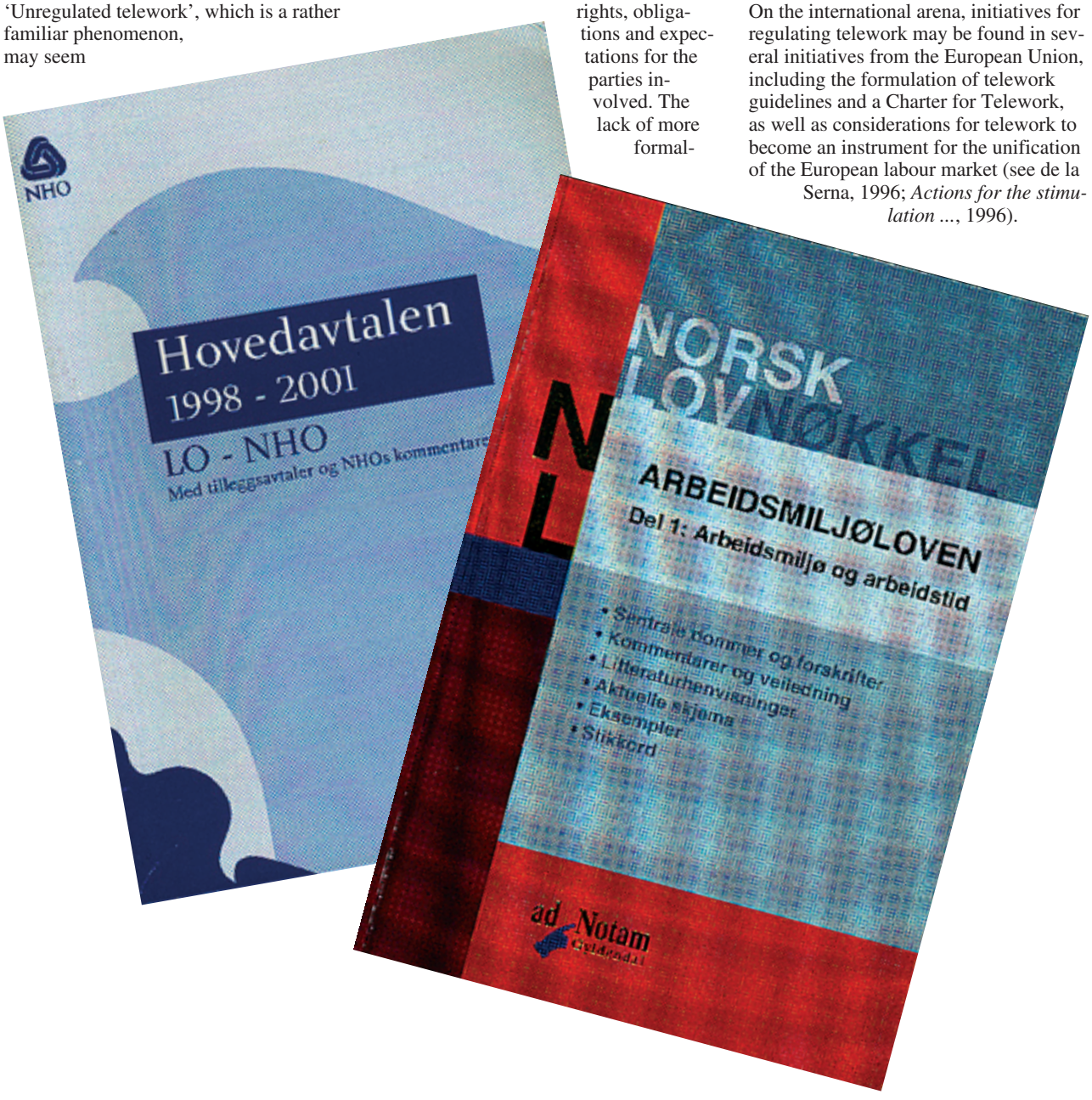
Table 1 Regulatory mechanisms

	General, overarching regulations	Local regulations
Formal, binding	Laws Provisions Common law Collective agreements Trans-national regulations	Policy documents Local agreements Individual agreements
Informal	Norms Traditions Paradigmatic models Charters Handbooks	Established practices Corporate cultures

It is generally accepted that the concept of 'teleworking' is somewhat fuzzy, covering a variety of work arrangements. For numerous purposes it will be sufficient to deploy such a broad definition, whereas for specific themes it is necessary to be more precise. Within the field of (tele-) work regulation, one crucial distinction is between employed teleworkers and those who work as independent or self-employed (see Jakhelln, 1996a). Labour legislation is relevant for the former group only, whereas a number of the 'softer' regulatory mechanisms are equally relevant for both groups.

'Unregulated telework', which is a rather familiar phenomenon, may seem to escape the perspective of telework regulation, and unregulated and informal telework arrangements may even be perceived as an attractive alternative to supposedly bureaucratic arrangements, threatening to block flexibility and to invade the privacy of personalized work arrangements ('my home office is my castle'). As a response to this position, one may argue that unregulated telework might be a viable solution for incidental and supplemental work tasks, whereas it seems like an improbable solution for regular telework arrangements, since employment regulations imply and require a set of rights, obligations and expectations for the parties involved. The lack of more formalized arrangements can also become problematic in cases like injuries (was it an occupational injury or not?), questions of workplace insurance and so on. And if one wants to defend unregulated telework, one also has to argue why only parts of the working week should be regulated, or why only a part of the working stock, the on-site workers, should be covered. On the level of telework policies, one may further argue that informal, unregulated telework arrangements does not seem to be a proper way to obtain recognition for telework as a valid, regular way of organizing work.

On the international arena, initiatives for regulating telework may be found in several initiatives from the European Union, including the formulation of telework guidelines and a Charter for Telework, as well as considerations for telework to become an instrument for the unification of the European labour market (see de la Serna, 1996; *Actions for the stimulation ...*, 1996).



The International Labour Organization (ILO) has adopted a *Home Work Convention* and a *Home Work Recommendation* (C177 and R184 respectively). The criticism has however been raised that the area of coverage for the Convention and the Recommendation is too wide, since they aim at regulating all instances of home work in all member states, including extremes like industrial home work with child labour and voluntary telework for business professionals. The Convention has not yet come into force.

One complicating factor in the regulation of international and trans-national telework, is the status of prospective regulatory bodies, wanting to formulate telework regulations on an international basis. A further one is found in the field of labour legislation, where one may distinguish between various national or regional traditions, differing among other dimensions on the role of collective agreements, and on the question of detailed and specified rules versus common law (see Nyström, 1992; Dølvik et al., 1996). This variety of approaches to labour legislation represents challenges both for attempts towards establishing overarching, trans-national telework regulations, and for regulations of trans-border telework arrangements.

Telework and Norwegian labour legislation

As stated above, working life in general is embedded in a comprehensive set of regulatory mechanisms, whereas there are major lacunae in the field of teleworking. In Norway, one major instrument for work-place regulation is the *Working Environment Act*. This Act regulates topics like working hours, requirements to the work environment, and certain procedures for organizational conduct and development. The Working Environment Act represents a formal regulatory mechanism of great potential relevance for telework – potential, as the Act, formally speaking, does not apply for home-based telework. Based on the intention of the law, however, there is no reason to assume that home-based telework *ought* to be unregulated, and there have been several political initiatives for an extension of the Act to include home-based telework (recent initiatives include St.meld. nr. 38 (1997–98); Nærings- og handelsdepartementet, 1998; see also Jakhelln, 1996; Bakke, 1998).

Formally, laws and provisions cover the entire population of employers and employees, whereas collective agreements are binding only for the members of the organizations entering the respective agreements. In Norwegian working life, collective agreements have got a prominent role, as the institutional and regulational frameworks of the labour market policy represents what may be called a variant of the broader Nordic model for labour legislation. This model is characterized by strong and influential organizations of labour and capital with good connections to official authorities. Further, there is a centralized system of collective bargaining, providing an important source for regulatory policy in addition to (national) labour legislation. An indication of the central role of collective agreements outside the field of wage bargaining, is that several working life reforms originated in agreements before they got incorporated into labour legislation (cf. Dølvik et al., 1996; Nyström, 1992).

Among the collective agreements, the *Basic Agreement* between the Norwegian Confederation of Trade Unions and the Confederation of Norwegian Business and Industry[2)] is of central importance, both through its formal area of coverage, through its *de facto* function as a model for other collective agreements, and through its status as normative model for work-place arrangements outside the area of coverage of the agreement. In the revision of the Basic Agreement in 1998, a *General agreement on distance working*[3)] was included. In this General Agreement, the parties acknowledge the

General agreement on distance working

NHO (Confederation of Norwegian Business and Industry) and LO (Norwegian Confederation of Trade Unions) see that more and more Norwegian enterprises are organising the work differently from what has been customary. This trend is accelerating. The principal driving forces include new information and communications technology, changes in the pattern of trading between enterprises, changes in customers' requirements, altered and more individualized needs on the part of the employees, and the need for greater skills.

To a greater extent than ever before technology has made it possible to perform the work at a location that geographically is distant from the employer's permanent premises. Increasing numbers of employees are choosing this form of work, often working from their own homes. Distance working involves new challenges and opportunities for employers and employees and the community as a whole. In part it leads to greater flexibility for the individual worker, and greater and altered demands to management and co-operation. To enable the individual enterprises to develop and pursue a good personnel policy in this field, it will be necessary to build up awareness and knowledge on the part of employers and employees.

The central organisations recognise the importance of closely following up developments in this field. Competence regarding the organisational challenges and opportunities of this new form of working is imperative for giving members sound advice concerning the manner in which the work can and should be organised. LO and NHO therefore undertake to commence systematic collection of information and conduct dialogues with the appropriate professional environments. A group with representatives for the various parties will be appointed to work on the challenges and problems arising from the use of distance workers.

(From LO – NHO: *Basic Agreement 1998 – 2001*)

[2)] *Hovedavtalen LO – NHO, in Norwegian.*

[3)] *Felleserklæring om fjernarbeid.*

Telework promotion plans in Norway

Background

In Norway, elements of a telework policy were formulated in the early 1980s. In an Official Norwegian Report on the future of telematics (NOU 1983:32), teleworking was discussed as an instrument for decentralization, job creation and knowledge transfer to rural areas. Motivating factors for the interest in teleworking was partially the technological potentials (an obvious motivation in a report on the future of telematics), partially societal concerns. In the 1980s, a number of telework research projects were conducted (see Hetland et al., 1988; Lie, 1985), but the slow development of teleworking made most researchers and practitioners consider teleworking a fad or an impractical idea. In a number of companies, however, an un-monitored development took place, with the establishment of home-based work and mobile work arrangements, but with few references to the discourse on teleworking.

In the nineties, there has been a revival for the idea of teleworking, including research projects, like surveys of teleworking in Norway (Hjemmebasert fjernarbeid ..., 1998), studies of teleworking and labour legislation (Jakhelln, 1996; Bakke, 1998), and estimates of teleworking's impact on commuting and pollution in urban areas (Jacobsen et al., 1996). Further, commercial actors have (re)discovered teleworking as a potential market, and official authorities and the employees' and employers' organizations have become engaged in this topic (cf. St.meld. nr. 38 (1997-98); LO, 1995; LO – NHO, 1998).

National Information Networks and Project Telework

Currently, teleworking has become a theme in scenarios and strategies for the further development of Norway, as expressed in numerous documents from official authorities (cf. St.meld. nr. 38 (1997–98); Nærings- og handelsdepartementet, 1998). Central to these initiatives is the program for *National Information Networks* (NIN), supported by the Research Council of Norway. The core concept 'information network' is here defined as both the technical infrastructure and the organization and interaction between relevant users and operators, to develop and disseminate usage patterns for the benefit of companies, local areas and individuals (NIN, 1995; NIN, 1998).

In the NIN-program, telework development projects (1994 – 2001) represent one of approximately ten key areas of application. The main goal of the telework development projects has been to contribute to the further development of telework as an attractive alternative for organizing work, based on existing Norwegian working life norms and traditions. The project group responsible for the telework development projects has been the consultancy firms *Avenir AS* and *Semco AS*, in collaboration with *Telenor Research and Development*.

One major element in the development projects has been a series of pilot experiments with teleworking in Norwegian companies and institutions. Further, a number of working groups has been established to discuss and to formulate policies on selected themes. The result of the telework project so far has been a 'package' of resources, helpful for companies wanting to establish telework projects, with a *telework handbook* as one of the main results (Bakke et al., 1998). The handbook is primarily intended to be a reference work for employers and employees who are considering teleworking, or are in the early phases of implementing a telework scheme. Emphasis is on the establishment of telework schemes, motivated by the fact that the early phases of the respective pilot experiments were far more time-consuming and more complex than expected. Further results from the project include documentation from working groups (abstracted in Bakke et al., 1998), and the dissemination of experiences gained from the pilot experiments (Julsrud and Opheim, 1998). A proposal for provisions to the Work Environment Act has also been formulated (see Bakke, 1998). In the present stage of the project (1999 – 2001), focal points are teleworking in small and medium sized enterprises and in the public sector, as well as long-term experiences, societal implications, and the role of teleworking for the individual. Further, a Norwegian forum for telework will be established.

Within the project, the recommendations and proposals have been motivated by the poorly developed common framework for telework regulation in Norway, hence the need to formulate recommendations to local and individual agreements in a way to compensate for the lack of a more general regulatory framework.

For the establishment of telework arrangements, the recommendations from the projects include factors like:

- The importance of strategies and procedures for the design and implementation of telework arrangements. The recommendations are process-oriented, with an emphasis on local adaptation of more general principles.
- Telework projects have to be established with broad participation from affected parties, including representatives from the unions, from personnel and IT departments, and from those who will not be teleworking.
- It is recommended to formulate a local telework policy, in order to establish common rules of conduct, ensuring a predictable framework for existing and future telework arrangements.
- For the individual teleworker, the importance of a written agreement is emphasized.

For the practice of telework, it is recommended to

- Establish or strengthen result-oriented management routines;
- Reconsider organizational routines, to take care of the development and assignment of work tasks, as well as the individual's career development;
- Establish routines to uphold and strengthen co-determination and democracy at work, as well as work-place loyalty and work-place identification;
- Establish information and communication channels which are accessible irrespective of location;
- Establish procedures for logistics and support.

The proposal for provisions is motivated by the fact that the Working Environment Act does not apply for home-based teleworking. The general intention of the proposal is to extend the area of application to include telework as far as possible, but without introducing unwanted bureaucracy and rigidity. The proposal includes items like

- The area of application for the provisions should be home-based telework, except sporadic and insignificant instances of working at home (other instances of telework are already covered by the Act);
- The regulation of daily working hours should be suspended, while upholding limitations regarding weekly working hours;
- The Directorate of Labour Inspection should uphold a right to inspect the work-site;
- The system of internal control [1)] should be extended to the telework sites.

The proposal has been forwarded to the Ministry of Local Government and Regional Development, for eventual treatment.

[1)] The system of internal control delegates aspects of work site inspection from public authorities to the company in question. The system's procedures shall be reported to the authorities (cf. Brunborg and Ihlen, 1997).

importance of distance working, and the parties have agreed to systematically follow up developments in this field. Based on the results from this monitoring of telework experiences, one probable next step is the formulation of (elements of) a telework policy in a future revision of the Basic Agreement.

As telework is an emergent organizational form without an accumulated body of practice, the informal regulatory mechanisms like norms, traditions and generally accepted models for work practices have not yet been developed to any extent. A common approach for the development of codes of practice is the more or less systematic monitoring of experiences and work practices, from which the dissemination of results may take place through media like reports, management courses, or telework handbooks.

Project Telework – a Norwegian telework development initiative

As an instrument for the development and dissemination of telework practices and telework knowledge, the Research Council of Norway has supported a telework development project as a part of its programme for National Information Networks (see separate instalment on Telework promotion plans in Norway). A main goal for the telework project has been to contribute to the further development of teleworking as an attractive alternative for organizing work (see NIN, 1999).

Recommendations and proposals from the telework project are formulated in a *Telework Handbook*, in working group reports, and in the proposal for provisions to the Work Environment Act. The project and its results have already proven influential through the dissemination of results and practices, in particular through a wide deployment of the Handbook. Further, the project has been given a central role in the process of formulation of telework policies and practices, as expressed by official authorities (see NIN, 1999; St.meld. nr. 38 (1997–98); Nærings- og handelsdepartementet, 1998).

Results from the project are abstracted as a separate instalment in order to demonstrate in more detail one specific approach to telework regulation, characterized by the formulation of somewhat extensive local agreements due to the situation with a poorly developed overarching framework for telework regulation. A continued monitoring of experiences with teleworking will contribute to the on-going process of developing both the formal and the informal mechanisms for telework regulation.

Comparing telework programmes and regulations

Within the field of telework, a large number of promotion and development programmes have been formulated, like the American Clean Air Act and the initiative for 'information superhighways' (see NIST, 1994), the Bangemann Group Report, and other initiatives from the European Community (Club de Bruxelles, 1994; de la Serna, 1996). A comparison of telework development programmes, and the actual practices these programmes inspire, is of great importance for an understanding of the dynamics of telework development and telework regulation.

There are several common themes in the various telework development programmes, partly through a migration of initiatives and arguments from programme to programme, where the American plans and the Bangemann Group Report have been particularly influential. In spite of common themes, telework development programmes differ considerably regarding ambitions and goals, and the means by which the goals are to be accomplished.

The diversity of programmes may be elaborated through an understanding of development programmes as pragmatic acts of communication – communication with the intent of achieving changes. Within this perspective, the study of the textual content of the programmes is important, but does contribute only to a partial understanding of them and their relevance. In addition, one has to study the types of actors and institutions involved in the formulation of the programmes and supporting them. Further, one has to consider the regulatory environment wherein the telework initiatives are located, and how these initiatives may support and amend existing regulations. When comparing telework initiatives cross-nationally, one also has to consider the different labour-management relations and management traditions, as well as the various approaches to labour legislation in the respective countries.

References

Actions for the stimulation of trans-border telework and co-operation in Europe. 1996. Brussels, European Commission DGXIII.

Bakke, J W. 1998. *Fjernarbeid, arbeidsavtaler og arbeidsrett.* Oslo, Norges forskningsråd.

Bakke, J W et al. 1998. *Håndbok i fjernarbeid.* Oslo, Arbeidsmiljøforlaget.

Beck, U. 1992. *Risk society.* London, Sage Publ.

Brunborg, H, Ihlen, F. 1997. *Internkontroll i praksis.* Oslo, Cappelen Akademisk forlag.

Club de Bruxelles. 1994. *The future of the information society (the 'Bangemann Group' report).* Brussels.

Duffy, F. 1997. *The new office.* London, Conran Octopus Limited.

du Gay, P (ed.). 1997. *Production of culture / Cultures of production.* London, Sage / The Open University.

Dølvik. J E et al. 1996. Norwegian labour market institutions and regulations. In: Dølvik, J E, Steen, A H (eds.). *Making solidarity work.* Oslo, Scandinavian University Press.

Hetland, P et al. 1988. *Fjernt, men likevel nært.* Stavanger, Rogalandsforskning.

Jacobsen, J K S et al. 1996. *Fjernarbeid og potensial for reduksjon i arbeidsreiser.* Oslo/Kjeller, Transportøkonomisk Institutt / Telenor R&D.

Jakhelln, H. 1996a. *Oversikt over arbeidsretten.* Oslo, NKS-forlaget.

Jakhelln, H. 1996b. Fjernarbeid. In: Jakhelln, H, Bakke, J W (eds.). *Fjernarbeid og arbeidsrett.* Kjeller, Telenor R&D.

Julsrud, T. Hjemmebasert fjernarbeid i Norge 1994–97. *Faglig nyhetsbrev fra Telenor FoU,* nr. 2, 1998.

Julsrud, T, Opheim, H. 1998. *Erfaringer med fjernarbeid i norske bedrifter.* Oslo, Norges Forskningsråd.

Lie, M. 1985. *Fjernarbeid. Vegen til det gode liv?* Trondheim, IFIM.

LO. 1995. *Informasjonshefte om fjernarbeid.* Oslo, LO.

LO – NHO. 1997. *Basic Agreement 1998 – 2001.* Oslo, Norwegian Confederation of Trade Unions and Confederation of Norwegian Business and Industry.

Makimoto, T, Manners, D. 1997. *Digital nomad.* Chichester, John Wiley & Sons.

Nilles, J M. 1998. *Managing telework.* New York, John Wiley & Sons.

NIN. 1995. *National Information Network.* Oslo, Norges forskningsråd.

NIN. 1999. Til debatt – Fjernarbeid. *Temahefte nr. 1/99.* Oslo, Norges Forskningsråd.

NIST. 1994. *The information infrastructure: Rethinking society's goals.* Gaithersburg, National Institute of Standards and Technology.

NOU 1983:32. *Telematikk*. Oslo, Universitetsforlaget.

Nærings- og handelsdepartementet. 1998. *Norge – en utkant i forkant: Næringsrettet IT-plan 1998–2001.* Oslo, Nærings- og handelsdepartementet.

Nystrøm, B. 1992. *EG och arbetsrätten.* Stockholm, Publica.

Olberg, D (ed.). 1995. *Endringer i arbeidslivets organisering.* Oslo, FAFO.

de la Serna, E. 1996. DIPLOMAT: European telework charter. *Notiziario del Lavoro,* No. 81.

St.meld. nr. 38 (1997–98). *IT-kompetanse i et regionalt perspektiv.* Oslo, Nærings- og handelsdepartementet.

Toffler, A. 1981. *The third wave.* New York, Pan Books.

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Approaches to understanding teleworking

LESLIE HADDON

Over the course of some years of reviewing literature and conducting empirical research on telework, it is quite clear that it is a diverse phenomenon, approachable in numerous ways and for a range of objectives. Furthermore, the actual experience of teleworkers is varied and dynamic, as is their relationship to information and communication technologies (ICTs).

The following sections aim to address all these issues by:

1 setting the scene in terms of indicating the diverse perspectives brought to the topic, including public representations of the practice;

2 exploring the issues involved in defining telework and drawing boundaries around the practice;

3 charting the dimensions according to which home-based teleworking experiences can be differentiated;

4 indicating the key dynamics by which teleworking may change over time;

5 providing a framework for specifically considering how we might analyse the role of ICTs in such teleworking households.

Images: The diverse perspectives on telework

Telework has attracted interest from diverse quarters. What has therefore emerged is not one but a variety of discourses about telework, involving different images of the teleworker, different 'problems' for which telework is a solution and different perspectives from which to evaluate this phenomenon. While more detailed histories of the concept have been provided elsewhere (Huws, 1991; Julsrud, 1996), it is nevertheless important broadly to indicate some key strands since this will become relevant to a later discussion of definitions of telework and drawing boundaries around telework.

If we start by considering the interests of the various research communities, the topic of telework started to gain publicity in academic circles in the early 1970s, especially when the energy crisis led researchers to consider telecommuting as an alternative to physically commuting. Huws (1991) notes that these writers usually portrayed the teleworker as a male manager or professional living in the outer suburbs. Since that time, geographers and town planners have retained an interest in the effects of telework upon patterns of commuting and hence upon urban design and ways of life. The Rio accords to reduce car emissions for environmental benefits have helped to reinforce some interest in this dimension (Gillespie et al., 1995).

In the 1980s another academic strand of analysis emerged from managerial and business schools, and in particular from schools of personnel management[1)] (eg. DeSanctis, 1984; Olsen, 1987). Under the heading of 'human resource management', telework has been seen by these writers as simply one form of flexible labour among others which could be clearly located within contemporary discussion of the need to develop firms which could adapt more easily to market changes.

Huws (1991) describes a later discourse into which telework has been inserted – one concerning the enterprise economy. Here telework is an intermediary stage on the road to entrepreneurship, where employees break away from their previous company to set up a small business in the home – perhaps as a prelude to moving out into separate premises[2)]. In fact, Huws notes that the image here is one of males working long hours to inject new life into the traditional values of self-reliance and the free market – even if many women have also set up businesses.

A more critical approach to telework has been adopted by researchers working for Trade Unions and bodies such as the UK's Low Pay Unit which have long monitored telework as part of the changing nature of working conditions (eg. Huws, 1984). Their concern dates back to fears in the 1970s about the impact of new technology on work, especially the threat of deskilling. Making comparisons with traditional homeworking, these researchers feared that teleworking could be a means of applying exploitative conditions of service to the clerical labour-force. In particular, the benefit for management of flexibility – and its promise of reducing labour costs – had a different meaning for the unions. It could imply a 'casualisation' of the workforce, as the firm reorganised its employees into core and peripheral workers (Holti and Stern, 1986; Brocklehurst, 1989). Moreover, isolating employees from one another militated against collective union action to resist pressures from employers. Thus, teleworkers might not only become non-unionised but non-unionisable.

Huws draws attention to the way in which optimistic writers in the early 1980s saw telework as a solution to a tension within society between the need for women's paid labour in the white-collar workforce and for their unpaid labour at home. In this scenario, telework helps to retain the traditional family, with women staying in their 'proper' place within the home. Understandably, there has been a strong feminist response to this suggestion, especially following their 1970s focus on the housewife who was trapped and isolated in the home (Huws, 1991). Going out to work and being present in the workplace was seen as being important for women's self-identity, social standing and influence. Feminists have been keen to point out that although telework may be a solution to women's dual role, and hence one adopted by some women, it is by no means the ideal solution – with many writers pointing to the difficulty of working with young children around, and the stress of coping with both work and domestic roles when in the home (Olsen and Primps, 1984; Christensen, 1987). Moreover, there has been a feminist undercurrent in much union research which draws parallels with women's negative experience of traditional homework. Women are already disproportionately located in the peripheral, secondary labour markets with poorer conditions and narrower options. The fear is that teleworking might have the potential to exacerbate this trend, and further marginalise women within the workforce.

Beyond these various research communities, the concept of teleworking is now well and truly in the public domain: The predictions of popular futurologists such

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1) These generated not only much speculation about the many issues which could arise around telework but provided the source of many empirical studies which have emerged in recent years.

2) Rank Xerox' 'networking' scheme was the most publicised case of this move to self-employment, whereby the firm encouraged some senior executives and professional staff to set up their own businesses while initially guaranteeing them some work from Xerox (Judkins, P. et al, 1985).

as Toffler in the 1970s and 1980s did much initially to establish telework in the popular imagination (Toffler, 1980). Some of their descriptions of telework fitted in with themes from the more libertarian politics of the 1960s where IT could be used to break down vast corporations by allowing decentralised small workplaces to intercommunicate. In this scenario, 'creative' workers – implicitly male – choose telework as a lifestyle option (Huws, 1991). Since that time ongoing media representations of the practice have often focused more on professional telework. Meanwhile, telework has been the subject of policy discussions[3] which have inspired research, policy-oriented documents and symposia both from individual governments and from the EC[4], all of which add to the public image of this form of working. Lastly, some companies, especially those ICT suppliers with an interest in promoting telework have not only conducted their own research (eg. Haddon, 1992) but have also contributed to the image of telework. Many of these representations of home offices understandably emphasise the role of technology, often presenting relatively higher-tech versions of the experience.

While not exhausting all the possible approaches to telework (see also Julsrud, 1996), the aim of this section has been to draw attention to the sense in which teleworking is a social construction. Of course that does not mean that people do not work at home using ICTs, for example. What it does mean is that researchers approach the concept with different agendas, different frameworks, different priorities which can have a bearing on what, of the many things that are possible, they find and report. And as we shall see, when there are many decisions to make when choosing how to define telework, it can even affect how we measure telework. Finally, the fact that this concept is in the public domain can help to shape how we think of the phenomenon, and in so far as both governments and companies themselves sponsor research this too can have a bearing on how telework is examined.

Boundaries: Defining the limits of telework

If the first section dealt primarily with the question of why study telework and the images evoked within different perspectives, this section turns in more detail to issues of what do we count as telework and who do we count as teleworkers. In other words, where do we draw the boundaries around the phenomenon. Clearly this is important for any attempts to measure the prevalence of the experience, but it is also relevant for studies charting the experience of teleworking from whatever perspective since drawing the boundaries differently will lead researchers to focus on different groups of teleworkers. Since the later focus of this article is on home-based teleworking, the emphasis on this discussion is on telework with a home-based component[5].

One issue is the degree to which ICTs form a substantial, strategic or necessary part of telework. In fact, some very early research on teleworkers did not require the use of ICTs as part of the definition of the telework phenomenon (Huws, 1984). Centrally it involved some sort of information processing. But for many years the use of computers especially has tended in practice to form part of the very definition of teleworking, differentiating it from traditional homework, and there is normally reference to some kind of telecommunications link to distant employers or clients.

The first problem is deciding how important a role technology plays in the work process. Huws (1995) refers to people who make 'incidental' use of ICTs in the course of their work, for example farmers, plumbers, artists and craft workers who use PCs for letters or accounts[6]. Of course, with increasing prevalence of computers over time this becomes more and more common. But amongst these examples she also includes architects, who in a sense are processing information. If they work at home they are probably doing so for a distant client. And for many architects computers are increasingly an everyday tool in their design work. This example just highlights the point that there will be grey areas in deciding the centrality of technologies (Wilson, 1991).

The second technology issue concerns the nature of the telecommunications link. A minimalist definition would consider voice telephony to be sufficient[7]. Yet from early days there have been those who have insisted that telework should entail an electronic link – originally a modem link to a distant mainframe. These two definitions would produce very different pictures of the numbers of teleworkers. In fact, one interesting development is the rise of the Internet, which is finding a role for both self-employed teleworkers and teleworking employees (Haddon, 1998). Since using the Internet would now count as an electronic link it has the potential to increase greatly the number of teleworkers according to the second definition. And yet this clearly does not mean that many more people have suddenly started working from home – they have merely changed one aspect of their work process by going on-line.

Next there are certain questions concerning time. One first issue, which is not given so much coverage in the telework literature, concerns the amount of time people work in general, let alone in the home or elsewhere. As we shall see, some studies of teleworking are willing to include part-time as well as full-time workers (eg. Huws, 1995), but the question then arises concerning what the lower limits of part-time work would be. In the course of conducting my own empirical studies in households on various topics over a number of years, it is

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[3] *Not only from the state: in the UK, for example, regional development agencies, railways and tax offices have followed developments since this might have implications for their fields.*

[4] *For example, between 1977 and 1981 the French Government sponsored a number of reports and conferences (Monod, 1983). The US Government has instigated both technology assessments and conferences (Huws, 1991).*

[5] *The difficulties of defining forms of remote working other than that based in the home are discussed in a number of other studies including Huws, 1990.*

[6] *This is elaborated in Huws, 1988.*

[7] *In fact, after discussing the problems of the 'communications' link, the Empirica study of the 1990s chose to allow mail and courier services for delivery of the results of the telework to a remote employer or subcontractor (Huws et al, 1990).*

clear that some people work only occasionally or very little, especially if averaged over time.

But the temporal issue which is more frequently discussed in relation at least to home-based telework concerns either the proportion of time (as a percentage) or the amount of time worked in the home compared to time worked elsewhere. The decision as to where to draw the line is very varied. Gillespie et al. describe how some researchers exclude occasional, part-time telework altogether. They go on to describe how one Dutch study defines telework as spending 20 % of work time away from the office of employer (ie. not necessarily in the home), while the Huws study for the UK's Department of Trade and Industry operationalises telework to include those who work at least 50 % of the time in the home[8].

Meanwhile Michaelson, approaching the whole subject of telework from the view of international time budget analysis, uses perhaps the lowest cut-off point by defining telework as involving at least one hour working in the home (Michaelson, 1998). In a paper comparing Swedish and Canadian data, he then proceeds to show that if people work less than four hours in the home they tend to work a higher proportion of their time at an external workplace (in a ratio 60 : 40), whereas if they worked more than four hours in the home then they work most of the time at home (85 % of the time). This approach allows him to generate another distinction between teleworkers based on time in the home – between 'extensive' vs. 'intensive' home based workers. He then goes on to show that differences exist between these groups, eg. in terms of the activities that they enjoy.

It is possible to illustrate further the differences in figures for working at home that different cut off-points will produce by considering some European data from a five-country study of telecommunications practices (covering France, Germany, Italy, Spain and the UK)[9]. Taking the subset of people within the whole European sample who worked at all[10], one question in the survey asked whether the respondents spent "any significant amount of time working at home, excluding work you might bring home in the evenings and weekends". The wording was meant to exclude 'overspill work' – ie. work which spills over from the office, in the sense that people who work a full day elsewhere then also bring home some extra work in the evening and at weekends[11]. We then asked those who said they worked at home what percentage of their normal working time was conducted in their home. (See Table 1.)

Table 1 Proportion of time spent working in the home; from (Fortunati, 1998)

Percentage of time worked at home	Number of those in the sample	Percentage of those in the sample who worked
up to 25 %	254	8.1 %
26 – 50 %	157	5.0 %
51 – 100 %	125	4.0 %

Now these figures are not in themselves meant to provide a measure of 'teleworking' in the sense that no other criteria – such as the use of technology – have been included. Hence the figures include all forms of work in the home, including more traditional paid homework. These figures show that 17.1 % were claiming to do at least some proportion of their work at home. If we are only interested in those who do at least a quarter of their work at home, the figure drops to 8 %, and if we specify that we only want to know those working over half the time at home, the figure drops to 4 %.

Two of the questions in the survey asked (a) whether they had access to a PC at home, and (b) whether they used a PC in the course of their work. If we add these requirements in order to try to at least eliminate some traditional homework, we have a picture for the European sample as a whole[12], as seen in Table 2.

One final observation from looking at the national data separately is that there is not always a straightforward pattern of those working up to a quarter of the time in the home being more numerous than those working from a quarter to a half of the time, who in turn are more numerous than those working more than half the time there. This pattern may be followed by France, Italy and the UK, but not by Germany and Spain. (See Table 3.)

Moving on now to the next element defining telework, employment status provides another issue where different researchers make different decisions – and obviously this can have a major

Table 2 Proportion of time spent working in the home: with PCs; from (Fortunati, 1998)

Percentage of time worked at home	Percentage of workers using a PC for work and with a PC at home
up to 25 %	3.5 %
26 – 50 %	2.7 %
51 – 100 %	1.1 %

[8] *One difficulty with the 50 % cut-off point, even if I have used it myself, is that it fails to capture those who work predominantly in offices, but then spend one or two days working at home – which is not only a current practice, but one vision of how teleworking could develop (Wilson, 1991).*

[9] *This research was conducted in 1996 and commissioned by Telecom Italia. The main findings, although not the particular data reported here, appear in Fortunati, 1998.*

[10] *The total sample size for this telephone survey was 6609, covering all ages from 14 upwards. 3135 of the respondents were in paid employment and answered this question.*

[11] *In fact, 20.3 % of those who worked brought home some 'overspill work'. Of these, 39 % did so occasionally (less than once a week) and 60.4 % did so more regularly (ie. at least once a week).*

[12] *To the extent that respondents answered these questions – some did not.*

Table 3 Proportion of time spent working in the home: with PCs and by country

% of time worked at home	France	Germany	Italy	Spain	UK
	N = 495	N = 979	N = 475	N = 403	N = 635
up to 25 %	3.1	1.6	2.7	4.6	6.7
26 – 50 %	2.1	3.6	1.7	2.0	2.9
51 – 100 %	0.2	1.7	1.1	2.2	0.6

influence on how researchers measure the extent of telework. For example, Gillespie et al. note that comparing two studies of the UK, the one excluding the self-employed produced figures 10 times smaller than the one including them (Gillespie et al., 1995). Some studies have produced more complicated decisions on this issue. For example, the Huws study for the DTI included self-employed people working for a single client but excluded freelancers working for several clients. On this occasion the decision was made because the project was focused on best management practices, and so freelancers, as 'self-managers', were not so relevant. Nevertheless, this example serves to remind us how even the process of mapping the field is shaped by the goals of the particular project.

One of the other standard issues discussed in literature reviews is whether telework should include only home-based work or other variants where there is conceivably still some form of remote working (eg. telecottages, remote offices). As is often the case, the choice depends on the focus of the project. For instance, the wider definition probably has more relevance for studying the 'impact of ICTs on the spatial organisation of work' (Gillespie et al., 1995) and issues such as managing a distant workforce. On the other hand, when my own research focused on the teleworkers as part of a series of studies of the experience of ICTs in households, it made more sense to go for the narrower focus on what have been called 'electronic homeworkers' (Gillespie et al., 1995) for the purposes of that study.

In more recent years there has been some discussion of how to conceptualise nomadic or mobile workers. Gillespie et al. observe that they tend not to be counted as teleworker in US studies and in one French study they discuss, but they then point out that many European managers nevertheless regard them as being teleworkers (Gillespie et al., 1995). Hence these researchers consider mobile workers to be one of the subsets of teleworkers. We can add some complexity to this issues by considering a Norwegian survey by the telecom company Telenor which did not insist on telework based at home and mobile work being mutually exclusive categories (Julsrud, 1998). Here telework was defined as working in the home for five or more hours, while mobile work was defined as working outside the home and main office site for five hours or more. While there were differences overall between home-based teleworkers and mobile workers (for example, in their use of ICTs), a third of the Norwegian sample of teleworkers were actually also mobile workers according to this way of counting.

Huws discusses a number of these issues in explaining her operational definition of telework in the DTI study of its prevalence in the UK. After years of studying telework, she observes that there is 'no clear-cut choice between logically distinct alternatives' (Huws, 1995). This is also clear from the above discussion. It is impossible to provide an absolute figure for the number of teleworkers in the abstract. There are obviously many decisions to make. Once you make them, putting aside any practical methodological difficulties concerned with the process of counting, it is possible to generate some 'hard' data that corresponds to what people do. But it is important to remember that the data is only as good as, and reflects, the definition. And given the range of perspectives, understandings and agendas outlined in the first section, it is understandable where there are a variety of definitions, of figures and even of descriptions of the experience of teleworking to the extent that different researchers focus on different people.

Diversity: The experiences of telework

At this point we turn to the actual experience of telework – or at least to home-based telework. Certainly some of the media images and representations from companies can be misleading in that they depict a fairly stereotyped, often professional, experience whereas telework is by no means such a unitary phenomenon. Within the telework literature general differences between male and female and clerical and professional telework have been noted, but here I use my own research to delineate some dimensions according to which the circumstances, and hence the experiences, of teleworkers vary.

The following descriptions draw mainly on a year-long British empirical study of households containing home-based teleworkers (Haddon and Silverstone, 1993; a shorter version of which appears in Haddon and Silverstone, 1994b). This was part of a series of studies of different social groups looking at the role of ICTs in the home[13]. Twenty households with teleworkers were studied, which involved both the adult household members filling in weekly time budget diaries, and then being interviewed for several hours, individually and together, and two separate occasions. In terms of the various boundaries described above, a relatively generous definition was used. The participants had to use a PC and at least voice telephony in their work, although that did border on 'incidental' use in one or two cases. They could be employees or self-employed, full-time or part-time (which could mean just a few hours on average) but they had to work a majority of the time at home.

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[13] *The other two studies in this particular project were of lone parents (Haddon and Silverstone, 1995) and the young elderly (Haddon and Silverstone, 1996). Prior to this particular research, I had conducted both literature reviews (later appearing as Haddon and Lewis, 1994) and previous empirical research on teleworkers (Haddon, 1992). Some years after this study, later research on the Internet also involved some teleworkers (Haddon, 1998). So while the following descriptions draw mainly on the 1993 year-long study, they are also informed by these other sources.*

The first aspect which can shape the experience of telework is the question of motivation (on this issue, see also Huws, 1991). Why does teleworking appeal or why is it felt to be the best option from the choices available? The rationale involved, the goals that teleworkers hope to achieve, is important precisely because it has a bearing on teleworker expectations, what they value about the telework, and what facets of the work constitute a problem. Thus, appreciating the motivation for teleworking can help us to understand teleworker behaviour, their strategies, whether they are satisfied, whether they are enthusiastic, 'get by', or give it up.

By far the main domestic motivation for teleworking relates to children[14)] – which often means a combination of wanting to spend time with children and managing the practicalities of taking the children to and picking them up from school, a nursery or a childminder. With exceptions, it appears to be virtually always women who take up teleworking for this reason, which can often mean that the women concerned are balancing telework and domestic commitments to a greater extent than many male counterparts. That said, there are differences in emphasis among these female teleworkers, which again differentiate their experiences. For example, for those, especially professionals, trying to maintain a career, the pattern of organising of work into substantial blocks of time often matching ordinary office hours is often very similar to that of male teleworkers (Haddon and Silverstone, 1993). Other women who have a commitment first and foremost to their domestic role try to find a form of work which fits in and fits around this. Often, but not only, in the case of clerical workers, this work can be as fragmented as domestic tasks, and is sometimes fitted in during evenings or at weekends.

Still on the theme of motivations, there are several work-related reasons for taking up telework. It can simply reflect a preference for the autonomy and freedom some people see and find in working from home, in some (albeit less frequent) cases, telework is even valued as an alternative form of work, with countercultural or pre-industrial connotations (Haddon and Silverstone, 1993). Equally, teleworking can be embraced in that it enables entrepreneurship, as some people make the decision to break away from employers and set up their own businesses. On the other hand, the adoption of teleworking does not always take place for such positive reasons. It can be a strategy to get away from problems experienced in an office workplace or to avoid some commuting – meaning that the question of travel is not only a concern of geographers and town planners. Moreover, teleworking may be seen as the only remaining option following forced redundancy or early retirement. Obviously, the degree to which telework is enthusiastically taken up can have a bearing on how people feel about the whole experience and on the choices they make.

The next aspect is the status of telework in the home. The perceived significance of telework is important because it can influence the very identity of the teleworker and also have a bearing on how teleworkers and other household members feel about the intrusion of telework into the home. If it is given a high value, telework can be used to justify exemption from certain household responsibilities or to excuse teleworkers from participation in the social life of the household – a situation that seems to occur more with male teleworkers. It may also enable teleworkers to gain the support of others in helping with that work. And it has a bearing on the power of the teleworker to command space within the home for that work.

In fact, the status of telework is another key dimension which differentiates the meaning of working at home for many men and for women. The women in our own study were far more likely to be secondary earners, reflecting the wider marketplace for male and female labour. They were usually interested in telework because it fitted in with looking after children, and many were involved in part-time telework. In contrast, most of the males in this study worked, or aspired to work, full-time. They were far more likely to be the primary earners – or aspire to be so in the case of those setting up new businesses. 'Aspiration' is a crucial nuance here, because the significance of telework is by no means simply determined by the amount of monetary income it generates at any one time. The status of telework is both a psychological issue for teleworkers themselves and an understanding negotiated in the household. For example, where money for buying equipment has to come out of combined household finances there is always grounds for some friction and debate over the status of telework. Having first stressed broad gender differences, as in the case of the organisation of time, there were differences in the status of work among male teleworkers as well as among female ones.

Different teleworkers have different degrees of control over their work, which obviously problematises some of the claims that teleworkers automatically benefit from increased flexibility and autonomy (Haddon and Silverstone, 1992). To illustrate what this can mean, in our own study some self-employed clerical teleworkers, for example, those involved in word-processing, were afraid to turn down work for fear of not being given work in the future. Yet others had developed strategies or negotiated with clients to manage their work flows. Nor were such differences unique to clerical workers. While some teleworkers in a professional or managerial capacity did operate with autonomy, others were concerned that work ate more and more into home life, as they made themselves more contactable outside work hours, for example.

The centrality of ICTs to telework was discussed earlier in relation to defining the boundaries around what counts as telework. But the role of ICTs can also be a differentiator of the telework experience. For example, that study indicated how to greater or lesser extents ICTs could play a role in enabling telework to be an option in the first place: but while particular ICTs played an essential role for some types of telework this has to be contrasted with cases where the work could have been conducted without them. In between these two sets of teleworker, there were some people for whom ICTs were more than just a facilitator because of the magnitude of task and time pressures involved[15)]. For these, mostly but not exclusively self-employed, teleworkers ICTs made telework a more feasible option. At the same time the centrality of ICTs to the labour process could have a bearing upon perceptions of the work

[14)] *Caring for the sick or elderly is another, although very little is known about the number of teleworking carers.*

[15)] *Elaborated in Haddon and Silverstone, 1994.*

(eg. whether it is seen as being 'high-tech'). It influenced the value teleworkers placed on and their efforts to develop ICT-related skills. And the centrality of ICTs sometimes justified ICTs entering the home or being appropriated for work.

Dynamics: The range of teleworking careers

The decision to take up teleworking should not be seen as being final. It is a provisional, perhaps temporary commitment to a working arrangement. For some it is a choice taken with relatively more enthusiasm. For others, the decision to telework and continue teleworking is made with some ambivalence, and with at best a partial commitment.

For some people telework is indeed the final stage in their career: once they become involved in teleworking they continue to do so for the rest of their working life. This may be a lifestyle choice, a decision to embrace teleworking because of the problems of on-site working, or because of the autonomy it may offer. But equally, this may be because there are few better options: eg. for the manager made redundant who is unlikely to be employed again because of age.

For others, teleworking is only a stage in their lives, an option like taking a career break, or the decision of many mothers to work part-time while the children are young and return to full-time working later. It may be a fairly short stage, as in the case of one of our interviewees who started a new business and worked at home a few months before moving into rented offices. Or it may last for some years, as with a number of our households where women had planned to stay home as their children progressed from birth to school age or even into their teens.

In the following discussion, the concept of telework trajectory is utilised to describe some of these stages because it captures the way in which telework takes place in a constantly changing household environment and remains a potentially contingent arrangement. It can also illustrate the different routes into, through and out of telework. Lastly, we can ask how the various trajectories give rise to different issues in households and to different responses.

In our sample it was clear that certain antecedent experiences could pave the way for telework, making this form of working less problematic. One of these is simply the experience of growing up with parents who worked (in the case of agriculture) immediately around the home, so that there was some familiarity with the blurred boundaries between home and work. Another factor favouring telework is that in some localities working at home was already a common practice, as in the case of traditional outworkers employed by the Nottingham hosiery industry. In some occupations, such as accountancy, it was common for women to move into the home for a few years when children arrived and the same might also be said of typists who shift to working at home. Finally the growing public visibility of telework through media and the telework literature itself created an awareness of the concept, and first attracted the interest of some of the teleworkers we studied.

Turning now to immediate trajectories into telework, one route into telework was from an exclusively domestic role. This was usually experienced by women who for a time prior to working have been preoccupied as housewives and childcarers. This had sometimes been for a short period of a few years or the domestic role may have been a longer one lasting until the children were teenagers. In fact, the transition from this domestic role is a useful case for illustrating the significance which trajectories can have upon the whole telework experience. Often such teleworkers had made a break with any previous work contacts through whom they could easily get support (eg. in terms of receiving advice or being passed on work if they were self-employed). Where these teleworkers had previously been moving in social circles of other mothers with young children, they now sometimes faced dilemmas as regards finding the 'free time' for maintaining social contact with this group of friends while making the time for work.

Some related experiences occurred among those entering into telework from involvement in some form of education (eg. a degree). While this background may have had some of the temporal rhythms of industrial work in that deadlines had to be met and attendance might have been required at certain times during the day, nevertheless there had usually been a considerable amount of flexibility in terms of choosing the time to study and making time for social contacts. Meanwhile, moving from limited part-time work outside the home to teleworking could also lead to easier transition which involves less adjustment than when the precursors were purely domestic work or full-time office work.

The contrast with the domestic trajectory is clearest in the case of those who have come to telework from a full-time office environment. For example, in our study, those who continued to work for the same employer when they changed to teleworking would often carry on working roughly the same core hours – unlike those from a domestic background, they were not interrupted by any friends who expected them to be free for socialising. Sometimes they were also locked into working some core hours because of the requirements of their employers (ie. in order to co-ordinate with other office-based staff). For those employees who were taking part either in a teleworking scheme or a more informal arrangement there was also some scope for maintaining useful contacts in the office who could help out with work problems. Even some of those who had made a break from their previous employers to set up their own business still kept some old work contacts and often retained much of the time structure of their previous employment.

Another route into the home includes those self-employed who retreated into the home for longer or shorter periods. For example, because of the contraction of their business some had given up their previous rented offices. For others, teleworking was a stop-gap between winding up one business and setting up another in a new office. As in the case of those setting up businesses for the first time, those retreating to the home sometimes brought other staff into their homes to work with them. For those who had been made redundant and taken early retirement, teleworking was often not only an unplanned experience, for which there had been limited preparation, but one which was not necessarily welcomed. Some found their experience of losing their work, often through the restructuring of firms, to be traumatic. They were teleworking by default. Some showed an interest in moving out of the home and back into the office, but others felt that they had no prospect of becoming an employee because of their age.

Turning now to the nature of trajectories during a teleworking career, a range of work-related factors can mean that the experience of telework changes over time, perhaps raising new problems and requiring new forms of accommodation. One obvious development in our study related to changes in the work performed, which included alterations in the number of hours worked and when these occurred. The amount of work teleworkers had could change as employees took on new roles or as businesses grew. The work sometimes started to require the involvement of others, co-ordination with colleagues, the employment of other staff or participation of the teleworkers' own families in the work process. And of course telework could also decrease, for unplanned reasons or by choice, as when some older teleworkers wound down towards retirement.

Another dynamic involved changes in the balance of working at home and from home, where there might be more or less need to visit employers or clients. So telework could become more mobile work, or a higher proportion of it could take place in an office. The degree to which teleworkers had to be contactable could also alter over time, with repercussions for the choice of hours when they worked or how much domestic life was interrupted. Other changes involved the very nature of the work being undertaken, for self-employed and employees alike, and changes in the pace of work. This could in itself reflect taking on different clients or a re-organisation at a central work-site such that those on telework schemes were assigned to different departments with new modes of working. Teleworkers could even move between self-employed and employee status, especially if doing contract work.

The other major influence on the experience of teleworking comes not from the work but from domestic life. For example, individuals are part of households which change. Single people take on partners, others end such relationships and find new partners – sometimes all while teleworking. Hence, in our study the telework could now take place in new households, involving re-negotiation of its meaning, of spatial and temporal boundaries, etc. with new partners who themselves had different patterns of work from the previous partners. Certainly one very significant domestic factor was simply the growth of children. That process created a whole host of new demands and considerations that could have a bearing on, for example, the times when work took place, the location of telework in the home and even the very viability of telework.

Lastly there are the trajectories out of telework. In our sample domestic pressures were one consideration: even those who preferred to work at home found that their changing household circumstances – eg. through the arrival of children or the increasing disruption from family members – could render teleworking impracticable. Others who had never been so enthusiastic about teleworking – for example because of the difficulties of separating home and work, or because they missed the sociability of the office workplace – looked for the first opportunity to work outside the home again. For some self-employed teleworkers the insecurity (eg. of contract work) was a constant concern and reason for giving up the telework. Where telework had only ever been a temporary reaction to circumstances, returning to office-based work involved relatively little sense of loss. Sometimes teleworking was no longer an option, for example, if an employer no longer allowed it, or if teleworking employees moved into new roles within the firm where this mode of work was untenable. Meanwhile, some self-employed teleworkers gave up working at home when they lost their businesses for various reasons.

But there were also more positive reasons for the end of teleworking. This included the search for better career opportunities, the straightforward desire to move on, to have a change and take up new challenges and the opportunity for better pay on-site with an employer. For the self-employed, the expansion of work and the need for greater space sometimes meant that the home could no longer contain work even if, once again, those concerned might have preferred to have continued working at home. But lastly it is worth adding that whether through desire or lack of better options, those who give up teleworking may always return to it – in which case, re-entry trajectories also exist.

Implications: Telework and the experience of ICTs

This final section turns to the issue which has for some years motivated my own interest in telework and which fits in with a central concern of this journal – teleworkers' relationship to ICTs. The aim is to indicate some of the framework that has been developed, both theoretically and empirically, for thinking about the place of ICTs in households generally, and in teleworking households in particular.

One point that should immediately be clear is that although the very first part of this article outlined some key frameworks for studying telework, they clearly do not exhaust all the motivations for researching this phenomenon – it is always possible to come to a topic with a new agenda. And indeed that is exactly what happened in the teleworking study described above. A programme of research then based at Sussex University[16] and focusing primarily on ICTs chose to use telework as a case study for illustrating the implications for technologies of changing boundaries between home and work.

The series of research projects in the late 1980s and throughout the 1990s focused on the 'domestication' of ICTs – ie. the processes by which, to a greater or lesser extent, these technologies find a place in everyday life (Silverstone et al., 1992). To a large extent this approach drew upon the growing literature on 'consumption' (Douglas and Isherwood, 1980; Bourdieu, 1986; Miller, 1987; McCracken, 1990) which went beyond the narrower emphasis on 'usage' that was more commonly associated with the analysis of technologies to consider the symbolic dimensions of ICTs and their place within the social processes of the household.

A distinguishing feature of this research was the focus on households, which decentralised the 'main' or 'end' user who is so often the subject of other research. The research recognised the ways in which others in the household make some contribution to the experi-

[16] *This work, initiated by professor Roger Silverstone shifted institutional base over time from Brunel University to Sussex and now to the LSE.*

ence of ICTs. Individual use of technology takes place in a context where various household members have both commitments, routines and general demands on time and space as well as values, hopes and concerns which all interact and in so doing shape consumption. But to extend that line of argument for the purposes of this article, telework itself takes place in this same social context – ie. other household members are affected by and affect the experience in various ways. That focus on the whole household, reflected methodologically in interviews with teleworkers' partners, provided a slightly different perspective on this working practice, compared to many studies which deal either with the teleworker as an individual or with his or her relationships with an employer (also noted in Gray et al., 1993).

The decision to focus on telework also brings us back to the earlier discussion in this article of where to draw boundaries around a phenomenon. If the emphasis is on what happens, and crucially what happens to ICTs, when paid work takes place within the home, then in principle the project could also have considered some mobile work (since the home is often one base from which people go out). Indeed, it could also have covered 'overspill work', since this extra work can still be enough to justify the acquisition of ICTs (for instance, acquiring Internet access: Berg, 1988). However, telework was ultimately chosen as a particularly dramatic case to consider since so much of the home's routines could change with the start of this working practice. And since it was still a relatively uncommon arrangement, those involved were often very reflective about the issues they faced and about the decisions they had had to make.

As might be expected, the heterogeneity of telework outlined above, especially in terms of its importance and its economic value, had a bearing on what ICTs are acquired. So despite images of the well-equipped home office, in the case of lower paid, often part-time teleworking vast expenditures on such technologies simply could not be justified. And even when more (potential) income was involved, there was sometimes still some negotiation between household members concerning what technologies were really 'necessary' for the work – especially in the case of self-employed teleworkers drawing on the family pool of income. This was in a context where it was sometimes actually difficult to decide how important particular types of hardware, software or services really were for work purposes. Indeed, work sometimes served to justify the acquisition of an ICT which was of more general interest (which later studies also found to be generally true of Internet access (Haddon, 1998) and mobile telephony (Bassett et al., 1997)). Finally, the arrival of telework did not necessarily lead to new purchases[17] – existing equipment was sometimes used for new work purposes. But that again could raise a whole set of issues within households, as others besides the teleworker laid claim to the family PC or the domestic phone that had now become work tools.

ICTs then had to fit into the organisation of domestic time and space, and the ability to command temporal and spatial resources, as we have seen, in part relates to the importance of the telework. Yes, home offices do exist, but the use of ICTs also takes place in bedrooms, guest rooms, living rooms and kitchens – even in the case of professional teleworkers, if their homes have limited space and/or they have to meet the demands made by children. Meanwhile, while some teleworkers in the study were in a position to choose to prioritise work over domestic commitments, carving out blocks of time for telework and hence the use of technologies, other teleworkers fitted work and the use of ICTs around domestic commitments, sometimes using their technologies in the evenings or at weekends.

If we are to understand the usage of ICTs, we also need to appreciate that rules emerge as to who can use what, when under what conditions – although such rules can always be challenged. For example, in the study we had examples of teleworkers rationing their children's use of the work computer, or trying to persuade other household members not to block the sole domestic phone with social calls at certain times in case the teleworker needed to be contactable for work. This leads to questions concerning the extent to which ICTs are devoted to telework, versus the extent to which they are, more commonly, also used for other personal purposes or used by household members other than the teleworker. The original 1993 study looked mainly at equipment like PCs, telephony-related equipment, photocopiers, etc. in this respect, but more recently the same seepage of work ICTs into other aspects of everyday life was also true in the case of teleworking households accessing the Internet (Haddon, 1998).

Finally, the changing experience of telework discussed earlier under the theme of trajectories can have some bearing on the careers of ICTs[18] (Haddon and Silverstone, 1994b). Once they have entered the home, the ICTs in our study do not necessarily settle down into some fixed unchanging role. Older ICTs were sometimes 'inherited' by other household members as new versions were acquired. ICTs could move to different parts of the home and be used at different times. They sometimes took on a new salience, and were used in new practices as the nature of work, of domestic circumstances and also of relationships with social networks outside the home changed.

To sum up this section, the initial acquisition of ICTs is one stage of the wider consumption of these artefacts, and can itself be the result of some negotiation in the homes of teleworkers. Usage is but another facet of that consumption, and must be understood within the spatial and temporal rhythms of the home, as well as the understandings that arise between household members about both the nature of telework and about the usage of technologies. And that consumption can change over time, in part due to the dynamic processes at work in such households.

[17] *Obviously ICTs such as PCs, phone lines and Internet access (Haddon, 1998) are sometimes supplied by employers (or clients) – which come with varying rules about how strictly they must be used solely for work purposes.*

[18] *As can other factors such as the availability of new hardware, software, services, etc.*

End note

As those who have researched teleworking will be aware, there are numerous definitions of the phenomenon and variations concerning where to draw boundaries around this working practice. The first sections of this article indicated some of the key considerations in this respect and how particular studies operationalise the concept partly in accordance with the perspectives and agenda behind those projects – sometimes influenced by the prevalent image of teleworking, which is itself a concept in the public domain. In addition, there are still some decisions to make, cut off points to draw, which remain to some degree arbitrary. That observation is not meant as a criticism – it is a reminder that there is simply no one single definition and therefore, in principle, no one single measurement of teleworking.

When we turn to the experience of teleworking, this article has both emphasised how much diversity exists, as well as indicating some main dimensions differentiating the experience, based on empirical research. This included some experiences which are relatively neglected in the literature, such as the unenthusiastic teleworker thrown into this situation through redundancy. Ultimately one implication is that there can be no one simple evaluation of the phenomenon if the experience is so heterogeneous.

Lastly, the article has dealt with two aspects which are rarer in the existing literature. The first is the attention given to the dynamics of telework, the ways in which and reasons why the experience of telework changes over time, the differences which the mode of entry can make and the fact that there is a variety of modes of exit from this situation. The second aspect is the very specific question of the experience of ICTs in the homes of teleworkers, where a broad framework was provided for thinking about the consumption of these technologies in the light of the diverse and changing experiences of teleworking

References

Bassett, C et al. 1997. In the company of strangers: user perceptions of the mobile phone. In: Haddon, L (ed.). *Communications on the move : the experience of mobile telephony in the 1990s.* Farsta, Telia. (COST248 Report.)

Berg, A. 1988. *Locating the virtual community in the households of Europe : the Norwegian national report.* SINTEF IFIM, a report for NCR Financial Services.

Bourdieu, P. 1986. *Distinction : a social critique of the judgement of taste.* London, Routledge and Kegan Paul.

Brocklehurst, M. 1989. The reality and rhetoric of new technology homeworking : some lessons for personnel managers. *Personnel review,* 18 (2).

Christensen, K. 1987. Impacts of computer-mediated home-based work on women and their families. *Office: technology and people,* 3, 211–230.

DeSanctis, G. 1984. Attitudes towards telecommuting : implications for work-at-home programs. *Information and management,* 7, 233–239.

Douglas, M, Isherwood, B. 1980. *The world of goods : towards an anthropology of consumption.* Harmondsworth, Penguin.

Fortunati, L (ed.). 1998. *Telecomunicando in Europa.* Milano, Franco Angeli.

Gillespie, A, Richardson, R, Cornford, J. 1995. *Review of telework in Britain : implications for public policy.* Sheffield, Employment Department. A report for the Parliamentary Office of Science and Technology.

Gray, M, Hodson, N, Gordon, G. 1993. *Teleworking explained.* Chichester, John Wiley.

Haddon, L. 1992. *Clerical teleworking and family life.* Martlesham Heath, British Telecom.

Haddon, L. 1998. *Locating the virtual community in the households of Europe : the international report.* London, London School of Economics. A Report for NCR Financial Services.

Haddon, L, Lewis, S. 1994. The experience of teleworking : an annotated review. *International journal of human resource management,* 5 (1), 193–223.

Haddon, L, Silverstone, R. 1992. *Information and communication technologies in the home : The case of teleworking.* Falmer, University of Sussex. (CICT/SPRU, Working Paper 17.)

Haddon, L, Silverstone, R. 1993. *Teleworking in the 1990s : a view from the home.* Falmer, University of Sussex. (SPRU/CICT Report Series; 10.)

Haddon, L, Silverstone, R. 1994a. Telework and the changing relationship of home and work. In: Mansell, R (ed.). *Management of information and communication technologies : emerging patterns of control.* London, Aslib, 234–247.

Haddon, L, Silverstone, R. 1994b. The careers of information and communication technologies in the home. In: Bjerg, K, Borreby, K (eds.). *Proceedings of the international working conference on home orientated informatics, telematics and automation.* Copenhagen, 27 June 27 – 1 July, 275–284.

Haddon, L, Silverstone, R. 1995. *Lone parents and their information and communication technologies.* Falmer, University of Sussex. (SPRU/CICT Report Series; 12.)

Haddon, L, Silverstone, R. 1996. *Information and communication technologies and the young elderly.* Falmer, University of Sussex. (SPRU/CICT Report Series; 13.)

Holti, R, Stern, E. 1986. *Distance working : origins, diffusion, prospects.* Paris, Futuribles.

Huws, U. 1984. *The new homeworkers : new technology and the changing location of white collar work.* London, Low Pay Unit.

Huws, U. 1988. Remote possiblities : some difficulties in the analysis and quantification of telework in the UK. In: Korte, W, Robinson, S, Steinle, W (eds.). *Telework : present situation and future development of a new form of work organisation.* North Holland, Elsevier, 61–76.

Huws, U, Korte, W, Robinson, S. 1990. *Telework : towards the elusive office.* Chichester, Wiley.

Huws, U. 1991. Telework Projections. *Futures*, January/February, 19–31.

Huws, U. 1995. *Teleworking in Britain : A report for the Employment Department.* Sheffield, Employment Department. (Research Series; no. 18.)

Judkins, P et al. 1985. *Networking in organisations : the Rank Xerox experiment.* Aldershot, Gower.

Julsrud T. 1996. Teleworking : The vision. An historical view of theories and trends. *Telektronikk*, 92 (1), 16–25.

Julsrud T. 1998. Combinations and tracks : An investigation of the relationship between homework and mobile work. In: *Teleworking environments. Proceedings of the third international workshop on telework,* 1–4 September, Turku, Finland. (TUCS General Publication No. 8.)

McCracken, G. 1990. *Culture and consumption : new approaches to the symbolic character of consumer goods and activities.* Bloomington, Indiana University Press.

Michaelson, W. 1998. *Home-based work : what does time-use indicate?* Paper presented to the XIV World Congress of Sociology, 'Social Knowledge: Heritage, Challenges, Prospects'. Montreal, 26 July – 1 August.

Miller, D. 1987. *Material culture and mass consumption.* Oxford, Blackwell.

Monod, E. 1983. *Telecommuting : a new word, but is it still the same old story?* Paris, CESTA.

Olsen, M. 1987. Telework : practical experience and future prospects. In: Kraut, R (ed.). *Technology and the transformation of white collar work.* London, Lawrence Erlbaum Associates, 135–152.

Olsen, M, Primps, S. 1984. Working at home with computers : work and non-work issues. *Journal of social issues,* 40 (3), 97–112.

Silverstone, R, Hirsch, E, Morley, D. 1992. Information and communication technologies and the moral economy of the household. In: Silverstone, R, Hirsch, E (eds.). *Consuming technologies.* London, Routledge, 15–31.

Toffler, A. 1980. *The third wave.* New York, Pan Books.

Wilson, A. 1991. *Teleworking : Flexibility for the few.* Falmer, Institute of Manpower Studies. (University of Sussex Report; no. 210.)

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Homework and boundary work[1)]

BIRGITTE YTTRI

1 Introduction

This article deals with how homebased telework affects the boundary between work and leisure when the workplace is moved to the employees' home. In-depth interviews with ten people, doing some or all of their work from home is the basis for the empirical study (Yttri, 1998). By using sociological boundary theory, I will consider its application to how homeworkers construct boundaries between work and leisure in the private sphere.

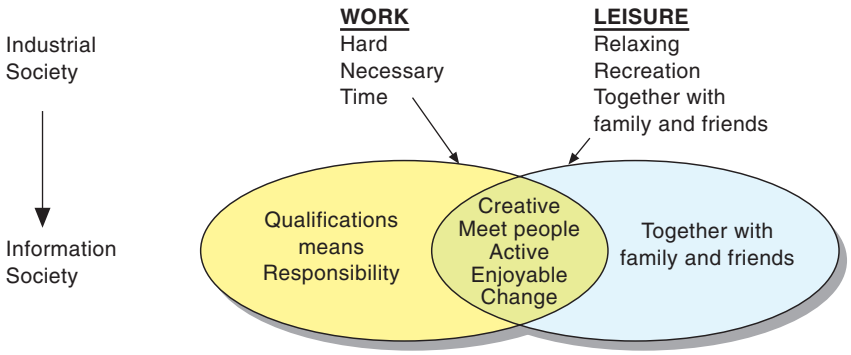


Figure 1 The concept of work and different relations between work and leisure in the Industrial Society and the Information Society (Jensen, 1998)

2 The concepts of telework and boundary work – and its definitions

In the literature about telework it is possible to find a diversity of definitions, theories and concepts related to telework. None of these concepts are universal or adequate for this type of work (Bakke, 1997, p. 78; 1995, p. 5; Huws, Korte and Robinson, 1990 p. 1; and Julsrud, 1994 p. 3). A lot of concepts are used to characterise this kind of work: distance work, telework (Huws et al., 1990; Gray, Hodson and Gordon, 1993), telecommute (Nilles, 1994), remote work (Hamblin, 1995) and homework. This article will concentrate on wage work done *at home*, and therefore *homebased telework* will be used.[2)] This means that work done in other places, for example in the car, at the hotel, on the plane – or so-called nomadic telework – is not in focus. Neither is work done in neighbourhood centres, or so called remote work.

Choosing which concepts to explain this way of organising work also implicates choosing criteria to be included in a definition. Several different concepts for this way of organising work are being used in the literature and in practical life, just as no absolute definition of homebased telework exists. This article focuses on the boundaries between leisure and work in the private sphere, and this definition of homebased telework will be used:

> Homebased telework is wage work, which – by agreement – is done by a company's employee, in his/her home. Some kind of ICT-mediated contact will exist between the teleworker and the company.[3)]

The concept of *boundary work* can be defined as the "(...) never-ending, hands-on, largely visible process through which boundaries are negotiated, placed, maintained, and transformed by individuals over time" (Nippert-Eng, 1996 p. xiii). Boundary work is a mental process, consisting of strategies and practises we use to create and modify cultural categories. The boundary work determines how much we segment and integrate home and work.

What homeworkers do during their day, influences how they organise it (Zerubavel, 1991 p. 1), and the relationship between work and leisure are different from person to person (Nippert-Eng, 1996 p. 4). To construct or mark a boundary or line means "(...) to surround it with a mental fence that separates it from everything else" (Zerubavel, 1991 p. 2). Every time we see someone making distinctions between the space and time of home and work, *there* is the leisure-work boundary (Nippert-Eng, 1996 p. 42).

In the next part I will present the problem in this article, and then I present the sociological boundary theory of Christena Nippert-Eng. After presenting the theory of Mary Douglas, a presentation of the empirical data material will be given. Finally, I conclude by discussing how the theories presented explain the boundary work of the homeworkers in the empirical material.

3 The problem

The concept of work has changed in the last years, and is to the purpose of work in the Information society rather than work in the Industrial society. A division of human relations and physical placements are results of the 'new content' in our work and the way we organise it (Jensen, 1998). In the Industrial society, time, place and the relations between people were dedicated to work *or* leisure. Work was hard and necessary time, while leisure was relaxing, recreation, and time to be together with friends and family. Colleagues belong to work, family and friends to leisure. In the Information society, work and leisure are characterised by overlapping activities and relations, like in Figure 1 above – presented by Jensen.

This means that one of the 'basis thoughts' in sociology – the distinction between the public and the private sphere, and between work and leisure / family life is disrupted by the introduction of new ways of organising work.

The introduction of Information and Communication Technology (ICT) in the home is responsible for a blurring[4)]

[1)] *This article is based on my post-graduate thesis "Social organization of homebased telework. Its effects on the boundary work between work and leisure" (Yttri, 1998).*

[2)] *I will also use the terms homework, homebased teleworkers and homeworkers.*

[3)] *Inspired by the definition made by Bakke.*

[4)] *By* blurring *is understood that the boundaries between the private and public spheres become more diffuse due to the introduction of work at home (Meyrowitz 1985 in Mante-Meijer, 1997 p. 15).*

of boundaries of here and there, of now and then, of public and private, of home and workplace. ICT causes a reduction in spatial and temporal order (Mante-Meijer et al., 1997 p. 15).

The understanding of the distinctions between work and leisure in both time and place is brought into sharp focus when work is brought into the private sphere – homebased telework can therefore challenge the boundaries between work and leisure (Bakke, 1994a p. 17). Some of the homebased teleworkers experience this disruption between the public and the private sphere, and empirical studies in this field can explain how work influences the boundary between work and leisure.

Organization of homebased telework

Homebased telework *combines different arenas* in the everyday life of the individual. Homeworkers combine areas that are seen as separate, such as work/home, work life / domestic life and public/ private sphere (Salmi, 1997 p. 132–133). Just as with the freelance workers who have no decided work hours (Lie, 1994 p. 9), homeworkers usually have no agreements about how work from home should be regulated or organised. As Bakke states:

> "Teleworking is not a 'pre-packaged' way of organising work – there are several options and choices to be made, while there are relatively few traditions and regulations for this area of work." (Bakke, 1997 p. 83.)

Everyday life for the homeworker is not regulated in the same way as for those working in the employer's office. For the 'office worker', the job is rooted in frames like laws, traditions and norms (Bakke, 1997 p. 86). This framework does not exist for the homebased teleworkers, and it is not obvious how they will organise their work and leisure at home or in the private sphere.

In the *public sphere* and for the *office-workers*, a framework of different agreements exists stating when and where the wage work should be done. The 'normal' way to organise work is that the employees carry out wage work in a private company or public department (Engelstad, 1991 p. 74), and use the private sphere, or his/her home for housework, leisure and domestic life. The *homebased teleworkers* do wage work in their own home – in the *private sphere* – where work and leisure are concentrated in the same place, a place normally used for leisure, and not for wage work. Homeworkers are not bounded by the same regulations and limitations as people working outside the home, and the homeworkers have to sort out their everyday life without these limitations (Haddon and Tucknutt, 1991).

The first question in this article is to focus on how homeworkers organise their day, measuring how homeworkers are organised at home by studying the homebased teleworkers in relation to time and place. Through the empirical material and the homeworkers' descriptions of when and where they work, their routines and breaks, I will discuss how homeworkers do boundary work.

4 Construction of boundaries

Christena Nippert-Eng and Mary Douglas are both engaged in everyday life, in the content of the categories of work and leisure, among other things, and what these categories mean to us. Through their theories on boundaries, symbolic patterns and order it is possible to understand how the homeworkers do boundary work. In the boundary theory of Nippert-Eng we can see how employee's working at the workplace are being categorised into the ideal types *integrator* and *segmentator*. Mary Douglas' concept of *dirt* describes how order can be attained through the creation of symbolic patterns in the private sphere.

Nippert-Eng: A sociological boundary theory

Christena Nippert-Eng uses work and home as distinctions in the analysis of how workers construct boundaries between work and home. This article focuses on the areas of work and leisure *within* the private sphere. When work and leisure are located in the private sphere of the employee, cultural understandings of workplace in the public sphere are disrupted. It is the *meeting* between work- and leisure activities in the private sphere that makes the homeworkers' boundary work between work and leisure interesting.

On the background of the assumption that overlapping of boundaries are overlooked in studies of home and work (Nippert-Eng, 1996 p. 279), Nippert-Eng constructed a sociological boundary theory that shows how boundaries between different areas are being *placed* and *transcended*. The main purpose for Nippert-Eng is to understand how boundaries between work and leisure are being defined for each other. To create boundaries means that homeworkers maintain the categories of work and leisure, and the creation of boundaries are a mental activity being practised through different practical activities (Nippert-Eng, 1996 p. 7), such as *when and where* to work.

The definition and experience of the categories of work and leisure can be viewed as a continuum where the ideal types *integrator* and *segmentator* represent the extremes (cf. Nippert-Eng, 1996 and Figure 2 below). Ideal typical representations are not descriptions, but models (Fivelsdal, 1979 p. X), which means cultivated and unreal categories. Therefore, integrators and segmentators are not personality types, but ways in which we classify things, actions and thoughts (Nippert-Eng, 1996 p. 17). Normally, people place themselves between the ideal types on the continuum, and no home worker is *either* integrator *or* segmentator.

Through boundary work we place ourselves on the continuum (Nippert-Eng, 1996 p. 7). For the *integrator*, the categories of work and leisure are overlapping. The distinctions between home and work are limited, and home and work are one and the same. The *segmentator* feels that work and leisure are separate categories, and they separate strongly between work and home, and "everything belongs to work or home". When the employees do some extra work at home in the evening they place themselves near the integrator-category. Through different boundary work, and through the typology integrator/segmentator, it is possible to see varying degrees of "publicity or privacy" connected to time and place for the employee, or the homeworker (Nippert-Eng, 1996).

Figure 2 Integrator and segmentator as extremes on the continuum

Our understanding of home and work decides how we shape and experience our surroundings and the time we spend on activities of home and work (Nippert-Eng, 1996 p. 24). Nippert-Eng argues that the placement of boundaries takes place through the use of different 'tools'; "... that is, one's personal position along the integrator-segmentation continuum is highly dependent on three elements. The first is internalised, cultural images of 'home' and 'work'. The second is unique permutations of social-structural constraints that emanate from both realms. The third is the personal practices through which we enact and elaborate images of these categories and situational constraints." (Nippert-Eng, 1996 p. 6.)

Nippert-Eng also asks what is the size of a category. The categories of work and leisure can be small or large, and they enlarge or contract over time (Nippert-Eng, 1996 p. 277), depending on who is understanding them. Boundaries will change depending on gender, family relations and way of living, among other things. This will affect homeworkers' understanding of work and leisure (Nippert-Eng, 1996 p. 15, 36, 279). Depending on how we think, we place and transcend boundaries around the category of work. The boundaries will help us to separate one category from another (Zerubavel, 1991 p. 2). Through individual understanding and experience of the contents in the categories of work and leisure, homeworkers construct boundaries between these areas.

Boundary work, or to construct a boundary, also deals with both *placing* them, and with *getting over* the boundaries (Nippert-Eng, 1996 p. 102). Nippert-Eng says that the transitions between two categories are decided from the *similarity* of the categories. Segmentators mean that work and leisure are different categories and move in a *one-way* direction between the categories (Nippert-Eng, 1996 p. 281). Nippert-Eng says:

> "The more we segment, for instance, the more our commuting routines depend on the direction of the commute. The more we integrate, the more irrelevant direction becomes and the less our commuting routines are a good prediction of where we're going" (Nippert-Eng, 1996 p. 281).

A segmentator "(...) must be something of a chameleon (...)" (Nippert-Eng, 1996 p. 102) to change the mental setting and to cross the boundaries between work and leisure. Integrators construct boundaries between work and leisure, which are *two-way* transitions (Nippert-Eng, 1996 p. 281). Integrators can 'jump' between work and leisure without problems, and it is impossible to tell whether they are on their way to work or leisure (Nippert-Eng, 1996).

Mary Douglas: symbolic patterns create order

Mary Douglas concerns herself about what makes our everyday life meaningful and what makes our thoughts clear. Douglas' concept of *dirt* in her theory on *order* can be a useful framework to understand how things and activities, which belong to work, *pollute* the home because they, due to our cultural understandings, do not belong to the private sphere. Together with the typology of integrator and segmentator in the boundary theory presented by Nippert-Eng, Douglas' concept of *order* can create an understanding of how homeworkers organise and construct boundaries.

Douglas says that the membership in a society and in a culture tells individuals what belongs and what does not belong to a category. Through the concept of *dirt* Douglas shows how our classification of things creates *symbolic patterns* that we act towards. Distinctions such as black/ white, dirty/clean and work/home are categories that have a meaning and a uniform understanding among the people in a culture when we draw a dividing line between them (Whutnow, 1984 p. 82). The distinctions tell us when we have come across a boundary (Whutnow, 1984 p. 82), and Douglas wants to know when is something 'clean', and when is it 'dirty'.

Douglas means that it is the *placement* of the symbol or the thing that decides if it is dirty or clean, and illustrates this by an example where shoes are clean on the floor, but dirty on the table. This is how *dirt* is defined as "(...) matter out of place" (Douglas, 1990 p. 155). Through our thoughts we sort out the symbol that we think of as *dirt*. What is dirt "(...) is that which must not be included if a pattern is to be maintained" (Douglas, 1994 p. 41).

Things and activities connected to the work at home are not dirt itself, but the placement of the things and activities makes them dirt. Therefore dirt can be seen as normal and functional. Douglas also says that dirt disrupts order (Douglas, 1994 p. 2), and in this way things and activities belonging to work are dirt when they are being placed in the kitchen, but are not dirt in the work place. The experience of dirt depends on the homeworker who places the things belonging to work, and their understanding of what is clean and dirty.

Through Douglas' concepts things and activities related to work in the private sphere can be seen as dirt that is being cleared when the homeworkers organise their everyday life. The way homeworkers place their working time during day and night, and their working place at home, can be seen as a clearing in the private sphere, so that the home is in a way so that the homeworkers understand the home as a category. Zerubavel calls the segmentator clean and the integrator unclean (Zerubavel, 1991 p. 37), and this statement can illustrate how the concepts of Douglas and Nippert-Eng can be put together.

Through the concepts of Nippert-Eng it is possible to say that the less homeworkers see leisure and work as separate worlds, the less disorder they see when leisure and work overlap. A segmentating homeworker will se more dirt than the integrating homeworker, and the segmentating homeworker will use more time to clear up the home than the integrator (Nippert-Eng, 1996 p. 100, 102).

To create order in existence we need to place things in symbolic patterns. In this cultural conditional symbolic pattern leisure belongs to the home and the private sphere, and work to the work place and the public sphere. Even if the boundaries in society get displaced, the homeworkers need to create order in the private sphere – order that includes both work and leisure. How homework creates order depends on each homeworker, but a separate work room and firm working time can be clearings that provide maintaining a symbolic pattern in the private sphere.

Summing up the theoretical framework

The common denominator for these two theories is the target of order in the private sphere. Through internal organising the homeworker will provide order at home. How order is understood is individually conditional. The same concerns

the understanding of work and leisure. Where the boundaries between work and leisure are placed is also individually conditional. By using these sociological theories and this theoretical framework, I will find out how homeworkers construct boundaries between work and leisure in the private sphere.

5 Organisation of work in the private sphere

The empirical parts of this article consist of material from in-depth interviews with five male and five female teleworkers working at home at least one day every week. The homeworkers work at home from one to five days a week, and in diverse combinations of days or weeks at home and at work. The informants work as writer, sales people, and layer, as translator and researchers, and all of the informants have worked as homebased teleworkers for more than six months – this also implies that they have experience in this way of working.

This part of the article focuses on *when* and *where* the homebased teleworkers work. Without regulation homeworkers can work during the day or the night, they can work in common areas, or in separate workrooms. How we *organise* our work is about *how* we work, *what* we do, *when* and *where* (Olberg, 1995 p. 5). Compared to workers working daytime at the office, the homeworkers have the possibility to organise their days in other ways.

When do the homeworkers work?

Work time can be separated into *length* of work time and *placement* of work time. The *length* of the work time says if the worker works the whole day or part-time, understood as how many hours the employee works each week. Concerning *placement* of work time during the day, this first of all represents how workers organise their workday, but in this article it is also understood as how workers organise their leisure time.

The flexibility that homework offers is one of the greatest advantages connected to this way of organising work (Huws et al., 1990 p. 69). Work time is flexible if it varies both in length and placement, and if the employee has the possibility to decide on his own the length and placement of work time (Hörning et al., 1995 p. 34–35). The empirical material in this study shows that the homeworkers feel that homebased telework can be flexible, but within different limits.

The work time of the homeworkers in this empirical study is not specified in their agreements, and therefore a lot of possibilities exist concerning when they can work during the day and night. Homeworkers in this study say that the fact that they 'instruct' themselves to be available results in work time at home being felt as a constraint. Haddon and Tucknutt say it is a kind of 'constraint' connected to the work time in the office (1991). When homeworkers feel that they have to be available during daytime, the flexibility that homework offers is reduced (Haddon and Tucknutt, 1991; Haddon and Lewis, 1992 p. 214).

One of the homebased teleworkers says this about work time and expectations from the firm:

> Informant A: *(...) I usually start at eight, and then I work the usual worktime ... until a quarter to four ... At least ... it is like it has always been ...*
>
> Interviewer: *What do the company expect from you while you are working from home?*
>
> Informant A: ***I** expect of **myself** that I work from eight till a quarter to four.*

Nearly all of the homeworkers in this study work from eight till four o'clock, the same time of work as they practice during workdays at the office. Only a few of the homeworkers spread their working hours during day and night – such as Informant B, who states:

> Informant B: *(...) I work now or I am working until the middle of the night – it doesn't matter ... I work best when the world is 'closed' – after it is dark outside. Everything that I have done is done at night. Then I can read and do other things during the day.*

What also might be the case with informant B, is that some of the homeworkers in this study are "(...) more likely to be an *'office-liver than a home-worker'*" (Gurstein, 1991 p. 174). One of the homeworkers says that an extra portion of self-discipline is needed to work from home, and the concept of "workaholism" is widely used in the literature about homework. The concept "workaholism" illustrates that homeworkers work at times when they should take time off from work – just as Informant B (Haddon and Lewis, 1994 p. 209; Huws et al., 1990 p. 66; Hamblin, 1995 p. 485; Gray et al., 1993 p. 49; Forebäck, 1995 p. 92). When the homeworkers do not have an agreement about when to work, their self-discipline will be tested.

Some of the homeworkers say that it was tacitly understood that they should work the same time during the daytime at home, as they did in the office. As another informant states:

> Interviewer: *Do you have an agreement about work time when you work at home?*
>
> Informant C: *No, but it is a silent understanding that it is normal work time ... also at home ...*
>
> Interviewer: *... What do the company expect from you while you are working from home?*
>
> Informant C: *Then **they** expect that I am available **all** the time ...*

Some of the informants say that there is a string to when they should work at home. This implies especially a string to accessibility, and some homeworkers are even more available when working at home than in the office. Among the homeworkers in this study, the demand, or believes that they have to be available for the company during special times of the day, decide the work time for the homeworkers. The findings also show that the statement of work, contact with customers and collaboration with colleagues decide *when* the homeworkers do their work at home. Even if the homeworkers characterise their work as independent, some must while others choose to be available during the daytime. Daily work time is also a habit from the office.

Another explanation to the way the homeworkers place their working time can be that the homeworkers are not only tied to the employers' obligations, but also to the structure of time in society. This means the work hours for other family members, work hours at school and in the nursery (Lie, 1994 p. 8). When homeworkers work during the daytime they can participate in other leisure activities which belong to leisure and social life (Ellingssæter, 1987 p. 83; Lie, 1994 p. 8). Work done during the daytime from Monday to Friday (Statistical Analyses, 1989 p. 100) is often understood as *'normal'* and preferred work time. Standardised work time is the primary structure of

time in society, it is the normative construction and an institutialised form which is resistant to change (Hörning, Gerhard and Michailow, 1995 p. 88).

The homeworkers in this study have a work time that is *concentrated* in one period mostly during the daytime. Anyway, this is often formulated as a question concerning the work time of homeworking women and men. Stereotypical representations of homeworking men and woman often 'see' women working during the day and night, and men working during normal work hours. There is a tendency among the women in the empirical material to work during the whole day and to include other tasks, such as washing clothes, doing the dishes, etc. It is important to underline that the homeworking women in this empirical study do house work during the work day in order to have a break – not because they enjoy doing house work or because they have to do it.

Nearly all of the homeworkers work between nine and four/five in the afternoon, and the work time has not changed significantly after the homeworkers started to do their work from home. The study also shows that work time, understood as number of hours worked, changes very little for the homeworkers. It is possible to say that the homeworkers have *a predictable and firm* work time, and not an accidental and variable work time (Moland and Olberg, 1989 p. 23). The homeworkers copy their work time at home from the office work time and keep the *collective work time* instead of choosing an individual work time, such as many of them can do.

The homeworkers place themselves on the continuum as integrators or segmentators when they organise their work time. When we study the work time for homeworkers by using the concepts in the boundary-theory by Nippert-Eng, they seem to be segmentators. By working during the daytime the homeworkers make clear distinctions between work and leisure. The statement from Andreas can illustrate how he places himself on the continuum as a segmentator:

> Informant D: *(...) it is the same every day. I am available from a quarter to nine until four o'clock. Then I am not available any more. Then I close the door to the office and shut off my mobile telephone (...)*

The placement of *work time* during the daytime, such as at the external workplace, shows how the homeworkers create an atmosphere and an experience of order in the private sphere. This is also the case when we study *work place*. Work place at home is in focus in the next part of this article.

Where do homeworkers work at home?

The sociologist Anthony Giddens has described how our homes are *regionalised* (Giddens, 1984 p. 119). Arenas we live on in our everyday lives are divided into regions, where the public region is open to the public, and the private region is closed to the public. Different assemblies are regionalised internally (Giddens, 1984 p. 85, 118). Residences are regionalised into floors, living rooms, and the rooms in the house are in different ways parts of *different zones* in time and space. Some rooms are being used in the daytime and will be an official scene, while other rooms are being used for resting and are part of the private scene (Giddens, 1984 p. 119).

Traditionally, work takes place at the office, but the homeworkers have to find a place for work in their private spheres. Where homeworkers choose to do their work in the private sphere is a way to distinguish work from leisure. The 'terms' *separate workroom* and *common areas* can deepen into what kind of rooms homeworkers use for work in their homes. A separate workroom is not used

Illustration 1 Blurring boundaries? Integrator working in the living room at home (Illustration by Lise K. Brustad in PROFIL No. 8/97)

for other activities than work, and common areas are used for both work and leisure. Homeworkers in this study work in the garage, in the sleeping room, in the kitchen and in a separate workroom. Nearly all of the homeworkers have a room for work that is also being used for leisure. As Hanne states, it is easier to work in a room being used only for work.

> Informant E: *(...) it is not an ideal place, but it is ok ... And I am happy that I have a separate room for work – so I don't see it all the time.*

For the homeworkers working in a separate workroom, the boundaries between work and leisure are clear; when you step into your workroom – you work, and when you get out of there – it is leisure time. A separate workroom at home helps the homeworkers to create clear and distinct boundaries between work and leisure.

Especially the homeworking women work in common areas. Research on homebased telework has found that men and women arrange differently at home (Lie, 1984 p. 10; Gurstein, 1991 p. 170; Huws et al., 1990 p. 56). This is also the case in this study, where men have a separate workroom, and the homeworking women work in the kitchen or in the bedroom. Results from this empirical study and other studies on telework explain this by saying that women place their workplace in common areas to be available for the family. Men place their workplace in a separate room at home so that they can work without being disturbed (Lie, 1984 p. 10; Haddon and Tucknutt, 1991). This way of organising work means that women are integrators with no boundaries between work and leisure, and men are segmentators with a distinct relation between work and leisure.

Another important aspect of what kind of boundary homeworkers create between work and leisure is where they work in the private sphere. When the homebased teleworkers do their work in common areas, they create boundaries between work and leisure that make no distinction between these two areas – in other words blurring boundaries. If the teleworkers work in separate workrooms, a distinction is made between work and leisure, because these categories are separated in both time and place.

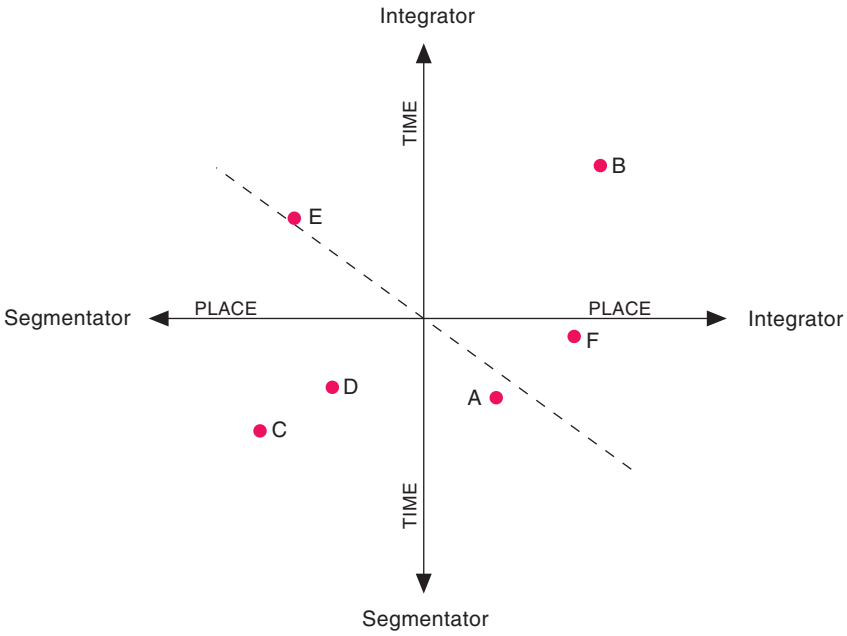


Figure 3 Placements as integrator or segmentator at the continuum seen in relation to time and place

As with the placement of worktime, placement of workplace in separate workrooms or in the common area shows how homebased teleworkers create order in their homes. Some of the homeworkers feel that work in common areas is creating a kind of order, while others prefer to work in a separate room to create order at home. By working in the most suitable workplace, the homeworkers attain the desirable order.

When following the theory of Mary Douglas, homeworkers working in a separate workroom think of activities and things connected to work in the common areas in the home as dirt. To avoid disrupting symbolic patterns they avoid mixing up places of leisure and work.

Summing up

One way of summing up how the homebased teleworkers organise at home, is by Figure 3.

The figure shows how the informants in the empirical material place themselves at the continuum as integrators or segmentators, according to the theory presented by Nippert-Eng. Some of the informants, B, E and F, have organised their work time and work place in such a way that they are integrators, while informants A, C and D are segmentators. Informant B, E and F integrate work time and leisure time, and they work in common areas at home. The other informants, A, C and D, separate work time and leisure time, and have a separate workroom at home. The informants have placed themselves on the continuum either as segmentators or as integrators, but, as the figure shows, informant A and E are close to the other category, or close to be both a segmentator and an integrator.

6 Bridges between work and leisure

Routines

Routines are actions made by habit (Giddens, 1987 p. 143). Routines are often seen as negative, but routines give rise to security, more time and control over everyday life (Salmi, 1997 p. 135). Therefore routines are actions done over and over again which create a pattern. As Giddens states "(...) routine (whatever is done habitually) is a basic element of day-to-day social activity" (1984 p. xxiii).

Workers need routines in the morning as a 'warming up' before starting on actions that are characterised by non-routine – such as work (Nippert-Eng, 1996 p. 113). A typical 'warming up' is commuting[5] from home to the central work place. The travel or commute to work can readjust and prepare employees for work (Bakke, 1993a p. 2). But what about the homeworkers who do not commute to work?

The homebased teleworkers in this empirical study do not travel to work. Instead, they practise different routines as a 'warming up' before work, such as morning hygiene, a coffee break or reading the newspaper. These routines help the homeworkers to readjust their mental focus from domestic life to working life. Reading the paper and drinking a cup of coffee is a *mental commute* for homeworkers, 'a mental movement' from one place and one time, to another place and another time (Nippert-Eng, 1996 p. 105). Routines also make it easier for the homeworkers to finish work – by for example walking the dog. Mental adjustments can also be seen as the changing of roles.

The transitions between leisure and work can be described by the concept *rites du passage*. By reading the newspaper homeworkers place themselves in a *liminal zone* where the homeworkers are in the middle of a time and a place, in a situation characterised by 'time out'. This situation is characterised by *betwixt and between* (Turner, 1990 p. 147) what has been – and what is coming (Turner, 1990).

Transitions are periods connected to time and place which are set apart to attain mental adjustment between work and leisure (Nippert-Eng, 1996 p. 117). The varying lengths and contents in the routines show that it is more difficult for some of the homeworkers to readjust from domestic life to work life, than for others.

Integrating and segmentating homeworkers do different routines before and after work. Segmentators use a lot of time to make transitions between leisure and work – integrators do not. If the homebased homeworkers 'need' to read the paper, walk the dog and take children to the nursery before they are ready for work – they keep in their minds a distinction between work and leisure and it is therefore difficult to change from one area to another. As this informant states:

> Interviewer: *What is it like to get started in the morning?*
>
> Informant F: *First of all I read the newspaper, then I do the vacuum cleaning, I have a cup of coffee and then start to work ...*

As the segmentation homeworker says in the statement above, segmentators need a long stay in the liminal zone to transcend the boundaries, and therefore segmentators know if they are moving towards work or towards leisure. The integrators in the empirical material move between leisure and work in the so-called two-way commute. This means that they do not need to perform any kind of rites before work. The integrators switch between work and leisure activities in a way that they find suitable when the transcend of the boundaries happens.

Breaks as a routine

Breaks can be seen as transitions, or 'bridges'. By bridges we understand things and activities that simplify the transition between work and leisure (Nippert-Eng, 1996 p. 117). Integrators do not need these bridges, but segmentators do. Everyone knows what a break is; a coffee break or lunch is a reason for taking a long or short break from work. At the office short breaks together with colleagues happen often during the day – by the copier or the coffee machine, or when colleagues meet by coincidence to 'smalltalk' in the corridors. Taking a meal together with colleagues at the office often takes place at special times and special places – this means that the breaks are *scripted* (Frønes, 1995 p. 97).

The homebased teleworkers in the empirical data material have no special time or place for breaks, nor any colleagues to take a break with. The homeworkers in this study often take lunch while they are working, just sitting at their desk, some of the other homeworkers go out for a walk to get some fresh air. By focusing on what activities the homeworkers are doing during their breaks, it is possible to find out if they behave as segmentators or integrators.

All of the homeworkers say that they have some kind of break during the day, but how many, when and the length of the breaks vary. Some of the homeworkers have many short breaks during the workday, while others have lunch and short breaks at specific times. It seems that the homeworkers feel lonely during the breaks, and that short breaks are non-existing for the homeworkers.

Integrating homeworkers do not distinguish work time from leisure time, but segmentating homeworkers need this distinction. Therefore segmentators take a break from work by doing something else – sometimes nearly the same as during lunch at the office. Integrators eat while they are working, because they do not 'need' a break from work to distinguish this activity from leisure activities. If integrators take a break they may carry out some private activities, such as washing clothes, doing the dishes or calling a friend. The habits of women and men related to routines and breaks are also different. Among the homeworking women in this empirical study a lot of routines or activities are necessary to get the work started. The men start to work right after breakfast. This means that men can be defined as segmentators and women as integrators – not separating work from leisure.

7 Discussion and conclusions

In this article I have shown how homebased teleworkers organise their everyday life at home, and how they experience this way of organising their work and leisure. Just like the workers in the study done by Christena Nippert-Eng, the homebased teleworkers in this empirical study are also divided into the two categories of integrators and segmentators. This theory is a contribution to cognitive sociology and to the micro-perspective of sociology.

The empirical data material presented in this article shows that the sociological boundary theory presented by Nippert-Eng is useful to explain how homeworkers do their boundary work. By using concrete examples I have used the theory of Nippert-Eng to show how the homeworkers in this study construct boundaries between work and leisure, and through different ways of organising everyday life the homeworkers *place themselves* as segmentators and integrators. The theory of Mary Douglas is useful as a background, knowing that order

[5] *Commuting can be understood as a travel by car, by foot or in other ways, from one place to another.*

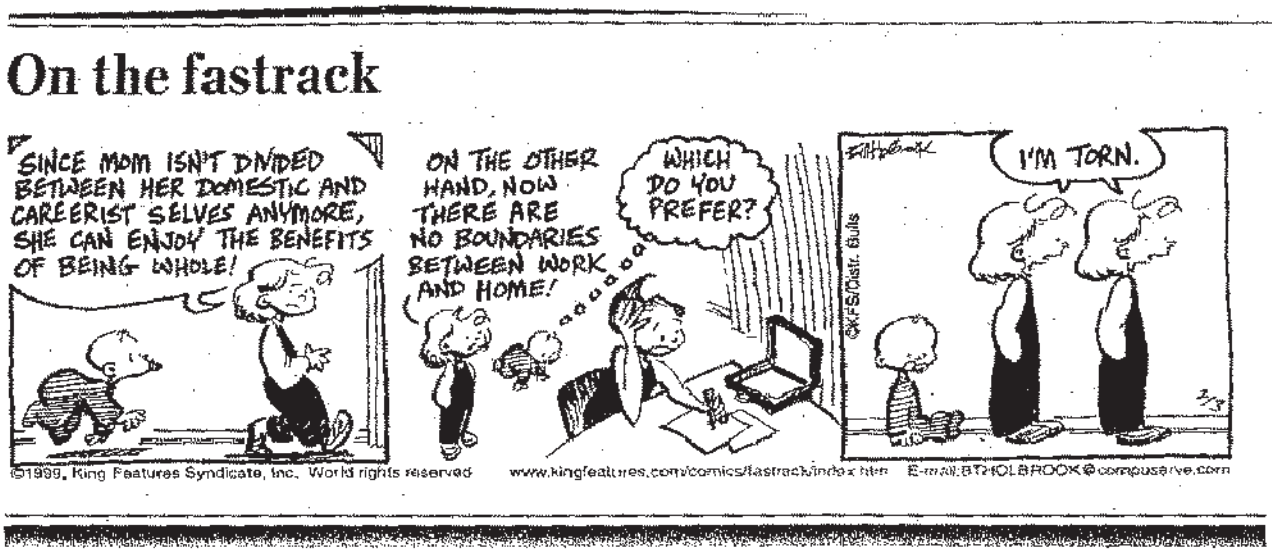


Illustration 2 Why is boundary work necessary?
The remote worker's competing roles of mother and employee cause a conflict in laying down boundaries between leisure and work

in the private sphere is preferable. The homeworkers' way of organising work in the private sphere is their way to construct boundaries between work and leisure (Nippert-Eng, 1996 p. 7), and to reach order at home.

The theory presented by Christena Nippert-Eng can also be difficult to use. The theory makes use of the concepts of segmentator and integrator to show how workers create boundaries between work and leisure. The concepts are ideal types and the homebased teleworkers mentioned in this article are not either segmentators or integrators, but *both* – as shown in Figure 3 – by placing themselves somewhere in the middle between the two categories. The use of ideal types makes it difficult to place the informants in the study as *either* segmentators *or* integrators. Nearly all of them are integrators *and* segmentators – depending on whether our focus is work time, work place, routines or breaks. A use of other concepts than segmentator and integrator, and different criteria for being included in the categories, could make the use of the theory better.

How the homeworkers place themselves between the two extreme positions of segmentator or integrator on the continuum, depends on how they organise themselves at home, and on how they understand the categories of work and leisure. To create *some kind* of boundaries between time and place is most obvious – it is easiest to see which times and what kinds of workroom belong to work, and what belongs to leisure. Anyway, it can be necessary to ask if the homeworkers will become integrators by working at home. It can be easier to be a segmentator than a integrator. The integrators are more flexible, and they handle the situation in a better way. The integrators also create boundaries that are subtler and they can handle more disorder than the segmentators. Increased focus on boundary work, blurring boundaries and the difficulties of being an integrator in the research on homebased telework, can imply increased consciousness among homeworkers on boundary work and being an integrator or a segmentator. Some of the homeworkers in this empirical study started teleworking and their boundary work as integrators and have ended up as segmentators. This implies that it is important to study teleworkers with experience as homeworkers to get a view of how they do their boundary work. In the end, I think it is important to underline that it is the individual who chooses whether integrating or segmentating work and leisure is preferable.

8 Literature

Bakke, J W. 1997. The ergonomics of teleworking. *Telektronikk*, 93 (3/4), 78–89.

Bakke, J W. 1995. *Fjernarbeid – en visjon i forandring.* Kjeller, Telenor R&D. (Telenor R&D Note; N61/95.)

Bakke, J W. 1994a. *Arbeid på hjemmebane.* Kjeller, Norwegian Telecom Research. (Televerkets forskningsinstitutt Note; N40/94.)

Bakke, J W. 1994b. *Teleworking on the domestic scene.* Lecture presented at HOIT Home-Oriented Informatics, Telematics & Automation, Copenhagen, 27 June – 1 July, 1994. Kjeller, Norwegian Telecom Research. (Televerkets forskningsinstitutt Lecture; F17/94.)

Bakke, J W. 1993a. *Fjernarbeid som organisasjonsform.* Kjeller, Norwegian Telecom Research. (Televerkets forskningsinstitutt Lecture F 6/93.)

Douglas, M. 1994 (1996). *Purity and danger. An analysis of the concepts of pollution and taboo.* London, Routledge & Kegan Paul Ltd.

Douglas, M. 1990. *Symbolic pollution. Culture and society. Contemporary*

debates. Cambridge, Cambridge University Press.

Engelstad, F. 1991. *Hva mener vi med arbeid? Noen begrepsmessige refleksjoner.* Oslo, Institutt for samfunnsforskning. (Arbeidsnotat 91:9.)

Ellingsæter, A L. 1987. *Ulikhet i arbeidstidsmønstre.* Oslo, Universitetsforlaget A/S. (Vedlegg til Arbeidstidsutvalgets utredning. NOU 1987:9B.)

Fivelsdal, E. 1979. *Om Max Webers sosiologi. En innledning. Makt og byråkrati.* Oslo, Gyldendal.

Forsebäck, L. 1995. *20 seconds to work. Home-based telework.* Stockholm, Telia AB. (Teldok. Report 101E.)

Frønes, I. 1995. *Handling og sosial struktur. Andre del.* Oslo, Universitetet i Oslo, Institutt for sosiologi. (Notat Nr. 4b.)

Giddens, A. 1987. *Social theory and modern sociology.* Cambridge, Polity Press.

Giddens, A. 1984. *The constitution of society. Outline of the theory of structuration.* Cambridge, Polity Press.

Goffman, E. 1992. *Vårt rollespill til daglig. En studie i hverdagslivets dramatikk.* Oslo, Pax.

Gray, M, Hodson, N, Gordon, G. 1993. *Teleworking explained.* Chichester, Wiley.

Gurstein, P. 1991. Working at home and living at home: emerging scenarios. *The Journal of Architectural and Planning Research,* 8 (2), 164–180.

Haddon, L, Lewis, A. 1994. The experience of teleworking: an annotated review. *The International Journal of Human Resource Management,* 5 (1), 193–222.

Haddon, L, Tucknutt. 1991. *Clerical teleworking – how it affects family life.* BT Laboratories. 1999, 09, 29 [online]. – URL: http://www.labs.bt.com/library/on-line/telework/reports/contents/clerical.htm

Hamblin, H. 1995. Employees' perspectives on one dimension of labour flexibility: working at a distance. *Work, Employment & Society,* 9 (3), 473–498.

Hörning, K H, Gerhard, A, Michailow, M. 1995. *Time pioneers. Flexible working time and new lifestyles.* Oxford, Polity Press.

Huws, U, Korte, W B, Robinson, S. 1990. *Telework. Towards the elusive office.* Chichester, Empirica.

Jensen, J B. 1998. *Fremtidens arbejdsbegrep.* 1999, 09, 29 [online]. URL: http://www.cifs.dk/artikler/dk_jbj_a01.htm

Julsrud, T E. 1994. *Kommunikasjon, arbeid og medier.* Oslo, Universitetet i Oslo, Institutt for medier og kommunikasjon. (Hovedfagsopppgave.)

Lie, M. 1994. *Fleksibilitet: Et nytt arbeidsliv eller gammelt nytt?* Trondheim, SINTEF/IFIM. (IFIM-notat 1.)

Mante-Meijer, E A, van der Loo, H R. 1997. Blurring of life spheres: Flexibility and teleworking. In: *A Report from the Home and Work Group.* Stockholm, Telia AB, 13–35. (COST 248.)

Meyrowitz, J. 1985. *No sense of place.* Oxford, Oxford University Press.

Moland, L, Olberg, D. 1989. *Man må jo prøve å være litt elastisk. Informantintervjuer om fleksible arbeidsformer, organisering og arbeidstid innen varehandelen og hotell- og restaurantområdet.* Oslo, FAFO. (Arbeidsnotat.)

Nilles, J M. 1994. *Making telecommuting happen. A guide for telemanagers and telecommuters.* New York, Van Nostrad Reinhold.

Nippert-Eng, C. 1996. *Home and work. Negotiating boundaries through everyday life.* Chicago, The University of Chicago Press.

Olberg, D (ed.). 1995. *Endringer i arbeidslivets organisering – en introduksjon. Endringer i arbeidslivets organisering.* Oslo, FAFO. (FAFO-rapport 183.)

Rasmussen, T. 1995. *Moderne maskiner. Teknologi og samfunn.* Oslo, Pax.

Salmi, M. 1997. *Home-based work, gender and everyday life. Virtually Free? – Gender, Work and Spatial Choice.* Stockholm, Swedish National Board for Industrial and Technical Development. (NUTEK B 1997:7.)

Silverstone, R, Hirsch, E. 1992. *Introduction. Consuming technologies: media and information in domestic spaces.* London, Routledge.

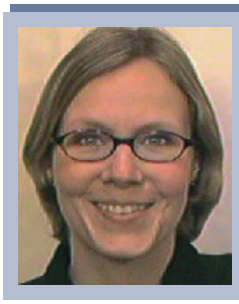
Turner, V. 1990. *Liminality and community. Culture and society. Contemporary debates.* Cambridge, Cambridge University Press.

Whutnow, R et al. 1984. *Cultural analysis. The work of Peter L. Berger, Mary Douglas, Michel Foucault and Jürgen Habermas.* London, Routledge & Kegan Paul.

Zerubavel, E. 1991. *The fine line. Making distinctions in everyday life.* New York, The Free Press.

Yttri, B. 1998. Fjernarbeidets sosiale organisering. *Om fjernarbeidets innvirkning på grensetrekkingen mellom arbeid og fritid.* Kjeller, Telenor R&D. (Telenor R&D Report; R36/98.)

Statistical Analyses. 1989. Oslo, Statistics Norway.



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Flexible work and health

ERIK BERGERSEN

1 Introduction

In the modern, post-industrial world, most men and women have sufficient material resources for sustaining a good life, including good health. After the demise of infectious diseases earlier in this century, diseases of affluence have taken their toll, particularly heart diseases; but with improved diet, physical exercise, better diagnostics and medical care, the prevalence of these diseases is also reduced. In spite of this, and of the vast array of services offered by modern medicine, there are ailments that seem to increase in the population, such as musculo-skeletal diseases, hypersensibilities etc., which are difficult to heal and which contribute heavily to the human and economic cost generally, and that of absence from work through illness.

Within the domain of health and work, large differences in workers' health have been observed, and a significant part of the difference depends on variations in the characteristics of the work situation. Some of these characteristics are associated with those that teleworkers appreciate most when they telework, such as improved job control and less stress. In this article, the reader will be introduced to research that substantiates some of the health effects of the psycho-social work environment, and postulate that telework – and non-telework – may be organised to benefit from this.

However, not all teleworkers are senior male experts doing high quality work from their villa or mountain cabin – a popular image of the archetypal privileged teleworker. Some are female with more concern for the domestic agenda than their male counterparts; some do 'heads down' clerical work with strict and close deadlines; some take purchase orders or customer complaints by telephone and are not at all in command of their own pace of work or at discretion as to which task to take up next. Also, some may have a perceived or real feeling that the work they do, and the way they do it, is not appreciated by their line managers or their office-bound colleagues, or that most interesting new tasks go to those who are present in the office. Such effects may be experienced as very detrimental to the work environment. Thus, there are considerable challenges in making telework a panacea for good health.

We do know that some gross parameters of the work environment, such as position in a hierarchy and job control, influence gross parameters of health, such as morbidity and mortality; we also know that they influence specific areas of health such as cardiovascular diseases and diseases of a number of other organ systems. There are also strong indications that psycho-social work environment influences diseases of the muscles and the skeleton, which contribute heavily to sick leave and permanent departure from working life.

We do not know what effect the specific factors of the work environment has on various types of teleworkers. The purpose of this article is to point to some of the known facts about psycho-social work environment and their impact on health; to outline some of the theories for the connection between the psycho-social factors and observed health effects, and some of the conclusions that may be drawn for the practice, planning and organisation of telework, and finally suggest some perspectives on further development in this area.

1.1 Why is this important?

Health deficiencies impose heavy burdens on the employee, on the employer and on society. Health care may take a tenth of GDP in an industrialised country, and compensation for worker sick leave half that again. Even modest reductions in work-associated illnesses will have significant economic benefits.

With the current trend towards higher levels of morbidity in society, and with a significant increase in broad, non-specific ailments – not easily given a diagnosis and attributed to a single cause – it is more important than ever to understand complex causes of illness (Drever, Whitehead, Roden, 1996; Drever & Whitehead, 1997). New ways of organising work, with an emphasis on self-driven, self-motivated, always available employees seem to carry risks of its own, with burn-out, general fatigue and the whole gamut of somatic diseases as a result. With an increasing pace of change in the workplace – of tasks, organisations, relationships – the strain will increase for most people. A better understanding of how the work environment influences health, and what means of intervention are available to improve the situation, will be indispensable.

It is also important to have in mind that even if the measured costs in money and suffering of an increasing morbidity is challenging, one must ponder the loss of energy, creativity and productivity that probably precedes the development of a diagnosed illness and a registered sick leave.

2 The issues

2.1 Work and health – a delineation

Health and work is a comprehensive subject, with numerous aspects which for decades have held the attention of the research community as well as public regulatory bodies and the organisations of labour and industry. In the industrial society, physical working conditions and their effect on workers present at the workplace: heat, cold, dust, chemicals, noise, radioactivity etc., have received much attention and become the subject of national legislation and international conventions. So has work ergonomics, which influences persons in the performance of their work. In the post-industrial society, where less than a fifth of the working population is employed in primary and physical goods production, these health risks from the physical environment may be less pronounced. For the purpose of this article, the relevant effects of the psycho-social work environment will be sufficiently illuminated if we limit the discussion to 'office work'; consequently the physical work environment will not be discussed here.

The health effects of the psycho-social work environment manifest themselves in a number of diseases. It has been found, however, that there is a great deal of co-variation in the diseases of various organs systems and more non-specific syndromes. For conciseness, this presentation will mainly be concerned with cardiovascular diseases, which are widespread, have received much attention and are reasonably straightforward with respect to symptoms and diagnosis. This should not lead the reader to underestimate the importance of other diseases, eg. muscular-skeletal diseases. They may have a physical cause, but many researchers are concerned that the aetiology of these diseases may have an important psycho-social component.

For the interested reader Kristensen (1989a,b) gives an extensive survey of research on both physical work condi-

The work characteristics

The assessment of the psycho-social work environment in the Whitehall II study points to the relevance for telework. Self reports by the civil servants with questionnaires derived from the work of Karasek, Theorell and others (eg. Karasek, 1979; 1990), and ratings by personnel managers.

In the assessment of the work environment, three characteristics were investigated by 25 items, nine of the fifteen for job control covered and six covered skill discretion.

Job control

Decision authority

Do you have a choice in deciding how you do your job?

Do you have a choice in what you do at work?

Others take decisions concerning my work.

I have a good deal of say in decisions about work.

I have a say in my own work speed.

My working time can be flexible.

I can decide when to take a break.

I have a say in choosing with whom I work.

I have a great deal of say in planning my work environment.

Skill discretion

Do you have to do the same thing over and over again?

Does your job provide you with a variety of interesting things?

Is your job boring?

Do you have the possibility of learning new things through your work?

Does your work demand a high level of skill or expertise?

Does your job require you to take the initiative?

Job demand

Do you have to work very fast?

Do you have to work very intensively?

Do you have enough time to do everything?

Do different groups at work demand things from you that you think it is hard to combine?

Social support

How often do you get help and support from your colleagues?

How often are your colleagues willing to listen to your work related problems?

How often do you get help and support from your immediate superior?

How often is your immediate superior willing to listen to your problems?

Do you get sufficient information from line management (your superiors)?

Do you get consistent information from line management (your superiors)?

Independent assessment of the work environment

The line management of the civil servants studied assessed the work environment of the respondents by grading four items: How often does the job involve working very fast? How often is it extremely important to do the work without mistakes? How often do groups at work demand things which are difficult to combine? How often does the job permit complete discretion and independence in determining how, and when, the work is to be done?

tions and a number of other factors including physical inactivity, shift work, etc. with relevance to cardiovascular diseases.

2.2 Relations between psycho-social work environment and health

This work originated in the observation that important health variables, such as morbidity and mortality, are related to parameters in work life in ways that may appear counterintuitive. The English Whitehall studies provide an excellent example: In the Whitehall I study (Marmot et al., 1991), 18,133 male civil servants from London department offices were followed for up to 25 years. In this study, it was found that men in the lower grades of the British civil service had almost three times the 10 year risk of dying from coronary heart disease compared with men in the higher grades. Less than half of this gradient could be explained by accepted coronary risk factors, and it was hypothesised that psycho-social factors might explain some or all of the observed excess mortality.

In the Whitehall II study, 10,308 male and female civil servants from 20 departments in London were followed through a mean of 5.3 years (Bosma et al., 1997). After correcting for the ordinary risk factors, such as age, gender, overweight, smoking, alcohol consumption, etc., one factor again remained as the most important predictor of morbidity and mortality: rank in the hierarchy. A civil servant at the bottom level of the hierarchy had three times the risk of dying in any given year, compared to a colleague at the top level of the hierarchy, and this goes for a long list of causes (ibid).

The design of the Whitehall II study permitted an investigation of the relationship between psycho-social work environment and newly reported cases of coronary heart disease in both men and women. One self report questionnaire at baseline examination (1985–88) and two more during follow-up, provided information on psycho-social factors of the work environment and coronary heart disease. Independent assessments of the work environment were obtained from personnel managers at the baseline examination.

The Whitehall II study provides evidence that excess risk of coronary disease was found for both male and female British

civil servants in jobs characterised by low job control. This association was independent of employment grade, negative affectivity (the disposition to respond negatively to questionnaires, which may inflate correlations between self reported work characteristics and self reported disease), and classical coronary risk factors. These factors include smoking, cholesterol concentration, diastolic blood pressure and body mass index.

Key messages from the analysis of Whitehall II data are:

- Low job control in the work environment contributes to the development of coronary heart disease among British male and female civil servants;
- The risk of heart disease is associated with both objective low control and perceived low job control;
- Increase in job control over time decreases the risk of coronary heart disease. This suggests that policies giving people a stronger say in decisions about their work or providing them with more variety in work tasks may contribute to better cardiovascular health.

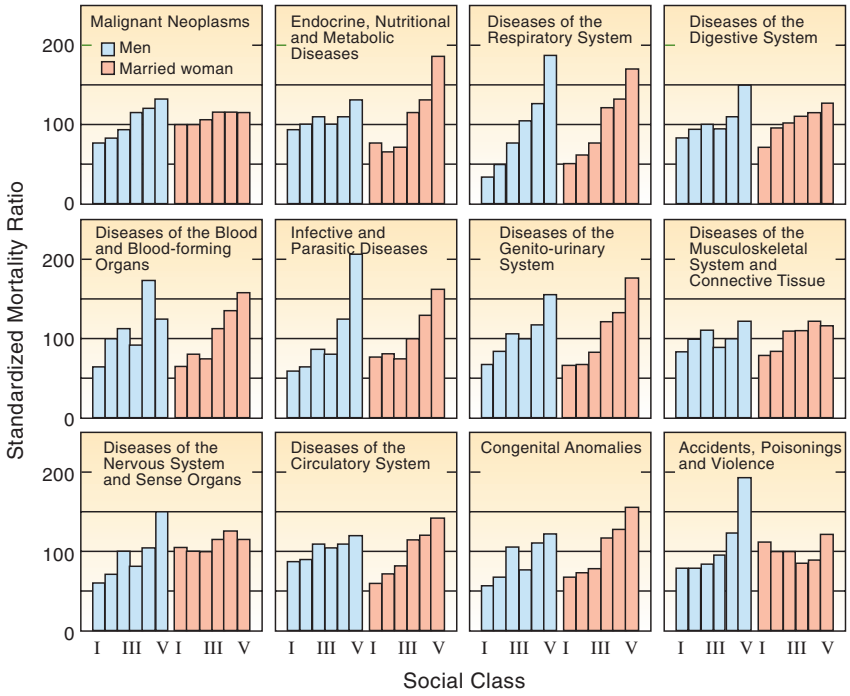


Figure 1 Occupation class and mortality from several causes in adult men and married women by husband's occupational grade. From (Haan, Kaplan, Syme, 1989)

Relevance for Telework

The measures for job control, job demand and social support employed in the Whitehall II study conform quite nicely with the factors cited by successful teleworkers as important for their status as teleworkers, eg. (Bakke et al., 1998; Murphy, 1996; Forsebäck, 1995). This applies in particular to the decision authority part of the job control factors, but also to the others (see box).

The conformity of measures for psychosocial work environment between healthy work in British civil service departments and in Scandinavian, English and Californian teleworkers does not, of course, constitute evidence that the same evidence will be found in an investigation of the health of these teleworkers. But it does give reason to hypothesise that such effects might exist, and that an investigation of the health conditions of teleworkers might reveal some of the psycho-social dimensions of telework. This subject will be treated further in the discussion.

3 Background

3.1 Health, SES and the gradient

The results from the Whitehall studies referred above show rather unequivocally that the effect on health of the work environment is profound. This is in itself of importance for the discussion on flexible work. But the discussion may be enlightened if this is seen as only a special effect of a wider phenomenon.

It has been known since antiquity that there are health differences associated with socio-economic status (SES): well off people from good families tend to have good health and live long. This is usually attributed to the differences in living conditions; it seems only natural that people who are not well fed, live in inferior housing in dangerous neighbourhoods, etc., have more diseases and die younger than those who are well off.

This picture becomes more complicated when one looks at the gradient in morbidity and mortality over SES groups which exists in most countries. This gradient is not likely to be accounted for by behavioural risk factors, by medical care factors, by selection, by racial differences or personality differences (Haan, Kaplan, Syme, 1989).

A few diagrams illustrate these differences. As is seen in Figure 1, there is a stepwise change from better health in the higher SES groups to worse health in the lower, and this goes for all types of diseases shown. Figures 2 and 3 show gross mortality rates and morbidity for four serious diagnoses, which show the same main point: The differences in health are found not only between those at the top and at the bottom of the social ladder, but is distributed rather monotonously over all the intermediary groups. Thus, the evident differences between those at the top and those at the bottom do not explain the gradient; one does not find differences in life style and quality of dwelling between, say, the top and the second step on this ladder that explain the differences in mortality.

This naturally leads to the next question: if these differences in physical living conditions are not the explanation, what is? There are some simple conclusions to

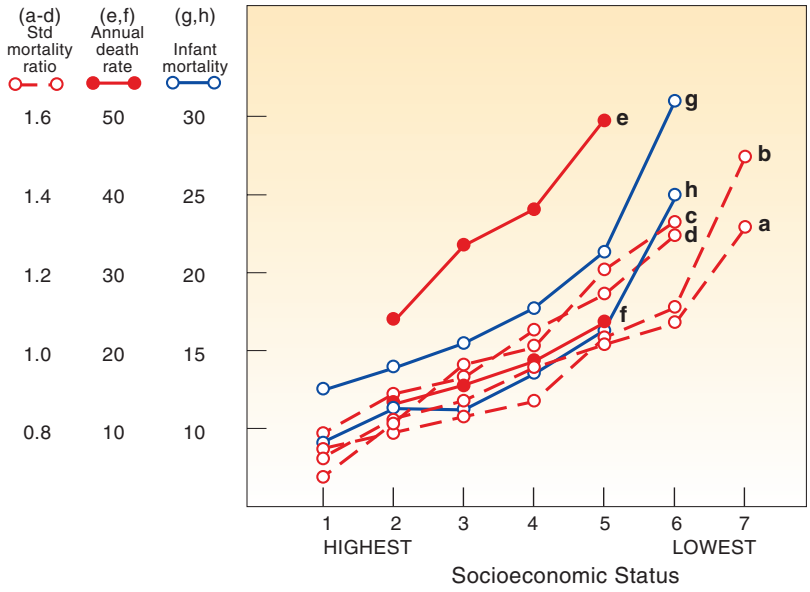


Figure 2 Mortality rate by socioeconomic status level

Note. (a) Standardized mortality ratio, observed to expected deaths (SMR) male (Kitagawa & Hauser, 1973). (b) SMR female (Kitagawa & Hauser, 1973). (c) SMR male (Adelstein, 1980). (d) SMR female (Adelstein, 1980). (e) Annual death rate per 1,000 (ADR) male (Feldman, Makuc, Kleinman & Cornoni-Huntley, 1989). (f) ADR female (Feldman et al., 1989). (g) Infant mortality per 1,000 live births (IM) male (Susser, Watson & Hopper, 1985). (h) IM female (Susser et al., 1985)

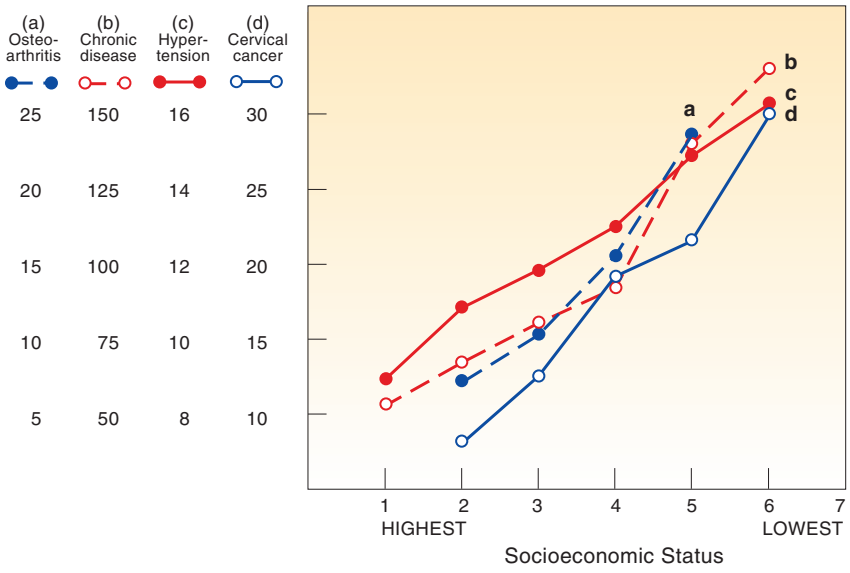


Figure 3 Morbidity rate by socioeconomic status level

Note. (a) Percent diagnosed osteoarthritis (Cunningham & Kelsey, 1984). (b) Relative prevalence of chronic disease (Townsend, 1974). (c) Prevalence of hypertension (Kraus, Borhani & Franti, 1980). (d) Rate of cervical cancer per 100,000 (Devesa & Diamond, 1983)

be drawn from a huge material: Variations in life style do not explain the variation, because the gradient is similar in different countries where the SES groups have different life styles. Variations in work type do not explain all, as the gradient also influences children who never entered a work place. Health related selection does not explain all, as groups with different SES show the gradient in morbidity and mortality even if they start out with no differences. So, the differences must be caused by several causes and mechanisms.

But the perseverance of the phenomenon, the fact that the differences in mortality persist in a similar pattern for a variety of causes, for men and women, at different periods of time, in different countries, indicates a general factor underlying this gradient. This factor cannot be dependent on specific factors in any country, but must be associated with rather general aspects of belonging to different social classes (cf. Erikson, 1998). This has resulted in a comprehensive national research programme in Sweden on inequalities in health, to promote understanding of the mechanisms that are in play and provide the basis for reasoned intervention. Work environment is mentioned as an important factor and an area needing further research, with particular emphasis on lack of job control and the associated increased risk of heart disease. We may expect to know more from this research about the mechanisms involved, and how they may be used for designing flexible work – including the 'off-work part' – to promote good health.

Job control

The literature on job control has become extensive. For further insight into what constitutes job control and how flexible work may influence it, consider the following summary of a discussion by Theorell (1989).

Workers from six different occupations were investigated: physicians, aeroplane mechanics, baggage handlers, air traffic controllers, waiters and symphony musicians. Theorell discusses two dimensions relevant to control: authority over decisions and skill discretion.

Authority over decisions

> The most direct feature of jobs that promote personal control is that they allow the worker to influence decisions regarding his or her job. These decisions could relate to work content (*what* is produced and what is the goal?) as well as to ways of production (*how* is it produced?). (Theorell, 1989 page 49.)

In Theorell's study, there were significant differences in authority over decisions between the six occupations, with

the physicians ranging highest and the symphony musicians ranging lowest.

Skill discretion

> This dimension is related to personal control *in the future*. It consists of questions relating to utilisation of workers' skills, their opportunities to learn new things at work and variety of tasks. The assumption is that workers who feel that their capabilities and ideas are used, that they constantly develop new skills and that their tasks vary, will develop a sense of mastery – whatever happens in the future they will be able to handle the situation. (ibid).

Again the difference in score between the occupations is highly significant. Theorell mentions that the two dimensions, authority over decisions and skill discretion are highly correlated, but finds striking exceptions to this rule: in the case of skill discretion, the baggage handlers scored lowest. They scored quite high on decision authority, and this is explained by their finding the work to be quite monotonous, but whenever a crisis occurred, they could influence the situation, eg. by having the supervisors send more men. The symphony musicians on the other hand claim that skill discretion is good, although their decision authority is low; ie. they have high autonomy in the performance of their work but little say in what to play, when to play, etc. These are interesting observations with respect to how teleworkers of various denominations may experience their work situation.

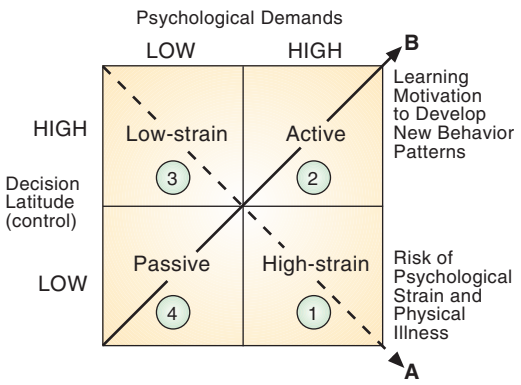


Figure 4 Psychological demand/decision latitude model

The respondents in this study were monitored for blood pressure at work and at leisure, for muscle tension and body mass index. There were strong indications that low skill discretion was associated with higher blood pressure and overweight, but not with muscle tension. Low authority over decisions was not associated with increased blood pressure or overweight, but with increased muscle tension index. Thus, the two dimensions of job control mentioned here may not always be correlated, and may have different effects on health.

In concluding his overview of several studies, Theorell states that 'skill discretion' has greater importance for health than 'authority over decisions', and that this may indicate that the longer perspective where the opportunity of learning new skills comes into play may be associated with the sense of mastery that promotes good health.

In considering the importance of this study for telework, it is worth mentioning that the author states that the model for discerning between the aspects of job control seems to fit white-collar workers considerably less well than blue-collar workers.

> "One reason for the difference between the upper and lower classes is that higher executives may not perceive lack of control or intellectual discretion as a problem. For instance, in the study of six occupations described earlier, physicians (both male and female) were the only group who reported 'too much complexity' to be a problem. This should be the subject of future research. However, regardless of kind of illness, age and social group, those who experienced a high level of personal control and support as well as a low level of psychological demands reported, on average, fewer illness symptoms of all kinds than others." (ibid).

3.2 Two job stress models

Karasek launched the job strain model in 1979 (Karasek, 1979). The main theme of this understanding is that the impact of demands on the person must be seen in connection with the person's ability to deal with the demands. This is in line with results from animal experiments: if one has control over the situation, one can deal with quite heavy demands without problems.

The model describes four distinctly different kinds of psycho-social work experiences generated by high and low levels of psychological demands and decision latitude (Figure 4). High demands and high control give active jobs with growth potential; low demands and low control give passive jobs without challenges, and may lead to atrophy. Low demands and high control give a low-strain situation, while high demands and low control give a high-strain work situation which leads to serious risk of psychological strain and physical illness. Karasek uses the term 'strain', in this meaning as a condition with imbalance between demand and control, in contrast to the term 'stress' which usually denotes characteristics of the demand component only.

The 'job control' of Karasek's model is composed of decision latitude and skill discretion of a fairly rudimentary nature, but the model has functioned well in the sense that the predicted effect of control and demand has been demonstrated in a number of cases. Although the model also has been contested (eg. Fletcher & Jones, 1993), it has become the most influential model in the research on psycho-social work environment since the mid-1980s.

Another, more recently developed job stress model is that of effort-reward imbalance (Siegrist, 1996). This model emphasises attributes of individuals, such as coping characteristics of high intrinsic effort as defined by the concept 'need for control', but also extrinsic efforts such as high workload. On the reward side, the model takes three types of reward into account: money, esteem and occupational status control, such as promotion prospects and job security. The focus is on a negative trade-off between experienced 'costs' and 'gains' at work, rather than on specific job task characteristics, as in the job strain model (Bosma et al., 1998).

With data from the Whitehall II studies, it was possible to examine whether the important components of the two models were independently associated with new reports of coronary heart disease. The findings support the predictive validity of the components of both models for coronary heart disease morbidity. It was also found that

> competitive, hostile and overcommitted subjects experiencing poor promotion prospects and blocked careers had

the highest risks. The association between this effort-reward imbalance indicator and the coronary heart disease outcomes was present after adjustment for employment grade level, negative affectivity and coronary risk factors, and was not significantly different in men and women. These findings corroborate the results found in male German blue-collar and middle management populations. In a previous paper based on the Whitehall II study, Ferrie and colleagues found adverse health effects from anticipation of job loss or job change (Ferrie et al., 1995). Their results may be interpreted as providing further evidence for the importance of "status control" (job insecurity, poor promotion prospects) in the effort-reward imbalance model. ... Our findings correspond to that in the review by Schnall and colleagues, in which they concluded that 17 of 25 studies that examined main effects found significant association between job control and cardiovascular outcome, whereas only 8 of 23 studies found significant associations with job demands. (Schnall et al., 1992) ... These results underscore the view expressed by Johnson and colleagues (Johnson et al., 1996) that in the job strain model, it is control over the work process rather than high job demands or job strain that increasingly emerges as the main critical component of a healthy job environment. (Bosma, ibid.)

Further demonstrations of association between work environment and health

The work of Bosma et al. referred to above shows the association between job control and heart disease. For a broader view, Marmot et al. (1995) demonstrate a strong inverse relation in the Whitehall II material between sickness absence and socio-economic status, measured by the grade of employment. Men in the lowest grade had rates of sickness absence six times higher than those in the highest grade. For women the corresponding differences were two to five times higher. In general, the longer the duration of absence, the more strongly did baseline health predict rates of absence. However, the health measures also predicted shorter spells, although to a lesser extent. The authors also report the not unknown phenomenon that job satisfaction was strongly related to sickness absence, with higher absence rates in those who reported low job satisfaction. After adjusting for health status the association remained for one to two day absences, but was greatly reduced for absences longer than three days.

For one specific diagnosis, back pain, Hemingway et al. (1997) report that absence from work due to this was strongly inversely related to employment grade. Also in this study, the effects of psycho-social work characteristics – particularly control – differed by grade and gender in magnitude and direction. The authors argue that the psycho-social work environment represents a potentially reversible cause of ill health, ie. changes in the psycho-social work environment could well reduce absence from work for this diagnosis.

Also from the Whitehall II studies, North et al. (1996) report that low levels of work demands, control, and support were associated with higher rates of short and long spells of absence in men and, to a lesser extent, in women. The differences were similar for the self-reports and external assessments. The authors conclude that these aspects of the psycho-social work environment predicts rates of sickness absence, and propose that increased levels of control and support at work could have beneficial effects in terms of both improving the health and well-being of employees and increasing productivity.

For heart disease, Marmot et al. (1997a) found that compared with men in the highest grade (administrators), men in the lowest grade (clerical and office-support staff) had an age-adjusted odds ratio of developing any new CHD of 1.50. The largest difference was for doctor-diagnosed ischaemia (odds ratio for the lowest compared with the highest grade 2.27). For women, the odds ratio in the lowest grade was 1.47 for any CHD.

Of factors examined, the largest contribution to the socio-economic gradient in CHD frequency was from low control at work, while height and standard coronary risk factors made smaller contributions. Adjustment for all these factors reduced the odds ratios for newly reported CHD in the lowest grade from 1.5 to 0.95 in men, and from 1.47 to 1.07 in women. The authors' interpretation of the findings is that much of the inverse social gradient in CHD incidence can be attributed to differences in psycho-social work environment.

Marmot & Shipley (1996) also show that socio-economic differences in mortality persist beyond retirement age and that the differences increase in magnitude with age. Social differentials in mortality based on an occupational status measure seem to decrease to a greater degree after retirement than those based on a non-work measure. The authors suggest that alongside other socio-economic factors, work itself may play an important part in generating social inequalities in health in men of working age.

4 Flexible work and health

Flexible work as practised encompasses a variety of work situations, work types, management styles, etc., as mentioned in the introduction. Often, the flexible worker has tasks that may be performed anywhere, and some tasks that must be, or best are, performed on the employer's premises, leading to a mixed work month of working at different locations.

For such flexible work – or telework – to function well for all involved parties, some semi-hard constraints may be stated (Bakke, 1998):

- Telework meets a need, both for the employer and the employee;
- Telework suits the individual teleworker, the type of work, the tasks and the company culture;
- Teleworker, colleagues and managers are positive to telework;
- All concerned parties, such as teleworkers, managers, trade unions are involved in planning telework;
- Telework is not permanent full-time home-based;
- Employer and teleworker trust each other mutually.

These constraints are designed to provide a harmonious work environment with few external stressors resulting from conflicts over telework, insecurity over status as teleworker, etc. Furthermore, in the Scandinavian countries, the legislation regulating employment and work is quite specific and comprehensive. It does not yet cover home-based telework in Norway, but extensions to the law to cover this are under consideration. It is expected that telework will be brought under the jurisdiction of the law for all relevant elements. Thus, well-designed telework under this regime must be

Case

La Dolce cooperativa

A study of two Italian towns suggests it is better to work in a co-operative.

A study by David Erdal presented at the annual International Employee Ownership Conference, held in Oxford, UK in January 1999, set out to test whether the quality of life in an egalitarian community was better than that of a conventional town. He compared data from two towns in Northern Italy, both of which are well off in this affluent part of Europe. One is Imola, a town of 60,000 inhabitants where 18 % of the working population is employed in co-operatives, and more than a third of the families have at least one member working in a co-op. The other is Sassuolo, some 60 km away, where no-one works in a co-op. Imola has no great divide between rich and poor; in Sassuolo the divide appears much greater.

One clear divide is mortality. Imola inhabitants live longer than those of Sassuolo, with a 14 % lower mortality rate over the past six years. Other, "softer" evidence points in the same direction, and although a more thorough investigation must be performed to validate these early findings, they seem to corroborate the evidence from the Whitehall studies where Michael Marmot has been central, as well as those of Wilkinson (eg. Wilkinson, 1996; Donkin,1999).

Organisation of Work (NORA; American Psychology Association)

Organisation of work refers to the way work processes are structured and managed. In addition to the long recognized job stress associated with aspects of work organization, studies are now identifying its contributions to other diverse health problems, including musculo-skeletal disorders and cardiovascular diseases. Research is needed to better understand how work organization is being influenced by the changing economy and workplace and what the potential effects are on worker safety and health. Research opportunities include surveillance, etiologic studies of risk factors and intervention strategies to mitigate adverse work organisation factors and outcomes.

Importance

The expression "organisation of work" or "work organisation" has come into increasing usage in the field of occupational health, but it lacks precise definition. In general, work organisation refers to the way work processes are structured and managed, and it deals with subjects such as the following: the scheduling of work (such as work-rest schedules, hours of work and shift work), job design (such as complexity of tasks, skill and effort required, and degree of worker control), interpersonal aspects of work (such as relationships with supervisors and co-workers), career concerns (such as job security and growth opportunities), management style (such as participatory management practices and teamwork), and organisational characteristics (such as climate, culture, and communications).

Many of these elements are sometimes referred to as "psychosocial factors" and have long been recognised as risk factors for job stress and psychological strain. But recent studies suggest that work organisation may have a broad influence on worker safety and health and may contribute to occupational injury, work-related musculo-skeletal disorders, cardiovascular disease, and other occupational health concerns such as indoor air quality complaints. For example, work organisation factors such as monotonous work, time pressure, and limited worker control have been linked to upper-extremity musculo-skeletal disorders in a number of studies. Similarly, it is widely believed that the combination of low worker control and high job demands is a risk factor for cardiovascular disease. However, the manner in which work organisation factors affect these types of health problems is not well understood.

Work organization is influenced by factors such as economic conditions, technologic change, demographic trends, and changing corporate and employment practices. Information and service industries are replacing manufacturing jobs. The workforce is ageing rapidly and becoming increasingly diverse. Reengineering and downsizing continue unabated, and temporary or part-time jobs are increasingly common. These trends may adversely affect work organization and may result, for example, in increased work load demands, longer and more varied work shifts, and job insecurity. However, the actual effects of these trends on the conditions of work and on the well-being of workers have received little study.

Research opportunities

Today's rapidly changing economy, with widespread corporate and government restructuring, has thrown the once low-profile issues of work organisation into high relief. If a factory or service operates around the clock to maximize productivity or attend to customer needs, what strategies will both assure productivity and prevent the adverse effects of night or extended shifts on injury rates or sleep disorders? What management approaches translate employer and employee concern about safety into actions that effectively prevent injury? What impact does the holding of multiple jobs (an increasingly common effect of low pay) have on workers' health and health care utilisation? How does it affect an industry's injury or illness rates? What biologic measures would indicate whether an employee's increased work load or reduced control over work is increasing his or her risk of cardiovascular disease? How do 12-hour work shifts or "de-skilling" of certain jobs affect rates of sick leave, employee turnover, workers' compensation, and health care costs? How can such costs be avoided? The limited research invested in work organisation has outlined a whole host of issues. Scientists need to establish ways of identifying industries, occupations, populations, and specific work sites needing evaluation and assistance. Definitive research is needed to clarify the relationship between psycho-social stressors associated with work organisation and safety and health concerns ranging from substance abuse to musculo-skeletal disorders. Also, a wide range of research is needed to identify successful interventions and models of work organisation that promote safety and health and that meet current and future demands for increasing productivity.

expected to foster a work environment that increases the teleworker's control over the work situation, and reduces the negative health impacts of traditional low control work.

It is further considered (ibid.) that a teleworker must want, or at least accept, a work environment that differs from the non-telework version by

- A higher degree of autonomy;
- Greater responsibility for the completion of work tasks, ie. take on certain aspects of management;
- A certain reduction in social contact and professional exchange with colleagues;
- Less secretarial and ICT user support;
- More use of ICT;
- A demand on his/her dwelling for home office space.

This points to work in the 'high demand – high control' part of the Karasek model, which gives low strain and has been demonstrated to have a reduced health risk. It may therefore be hypothesised that the practice of well-designed telework over years may result in improved health for the teleworker.

An obvious confounding factor to this would be the selection of persons for telework that show a propensity for autonomy and responsibility, or with reduced need for immediate social or professional contact; these might experience lower strain than average in any work environment. It would be interesting to perform research that would be able to distinguish this effect and reveal which personal characteristics must be present in a teleworker for the hypothesised effect to take place, and the occurrence of these characteristics in the working population. If these characteristics are prevalent, it could be expected that flexible work would indeed give positive health effects.

The discussion of the two models of job stress and the empirical studies implies that 'job control' is perhaps the most important factor influencing the health effects of the psycho-social work environment, and probably well-being and quality of life. Thus, several aspects of job control are being used:

- Control as an objective characteristic of the work situation, reflecting the extent to which the design of work tasks and the work environment more generally, allow opportunities for control;
- Control as a subjective evaluation reflecting an individual's judgement about the extent to which his or her situation is amenable to control;
- Control as a generalised belief on the part of the individual about the extent to which important outcomes (including, but not limited to, occupational outcomes) are controllable (Parkes, 1989).

Parkes summarises empirical findings relating to control at work, and finds that studies of worker participation and goal setting, which are central parts of our flexible work regime, demonstrate that such opportunities have favourable effects on perceptions of control and influence in the organisation, on affective well-being and on absenteeism, performance and turnover. Flexible working hours and other aspects of work scheduling generally enhance work satisfaction and reduce absence and sick leave, although the effects on other aspects of employee well-being are less consistent. (ibid:31). These finding thus support the notion that flexibility with the (tele)-worker in control has beneficiary effects.

4.1 Psycho-social factors outside the work situation

One effect of telework on health may also come from the fact that telework can contribute to a more manageable private situation. This is well known among two-career parents of small children, for whom telework may make the difference between coping and not coping with everyday challenges. Duxbury et al. (1998) describe how telework help working parents to balance competing work and family activities, by increasing control over job and family, ease the tension of combining career and family, and achieve better balance between work roles and family roles. For the teleworkers studied, the feeling of combining too many roles and of stress is reduced by telework, even for unchanged work time and overtime. Also other groups in the working population than two-career parents may find relief in the flexibility of teleworking so that their total psycho-social environment improves. A project is under way for investigating quality of life issues for a sample of European teleworkers (Julsrud et al., 1999).

4.2 Research questions

4.2.1 Stress and health: Problems considered – that are related to the central assumption

Some of these considerations point to broader questions: What is the mechanism in the relationship between SES and health, and between rank and health? Are they images of the same underlying mechanism? Could they have parts of a mechanism between them? Could this be used for building better lives for people?

4.2.2 Psycho-social potential of new work organisation, including telework

The potential for improving the work environment by utilising the knowledge gained from work research discussed here, was apparent already in Karasek's original work:

> Possibly the most important implication of this study is that it may be possible to improve job-related mental health without sacrificing productivity. It would appear that job strain can be ameliorated by increasing decision latitude, independently of changes in work load demands. If, as would be expected, work load is related to organisational output levels, these levels could be kept constant if mental health 'externalities' were improved. Changes in administrative structure would have to be made which improve the worker's ability to make significant decisions about his task structure, increase his influence on organisational decisions, and allow him discretion over the use of his existing and potential skills. ...
>
> These job design suggestions contradict major principles of job design as proposed by the father of "scientific management", Frederick Taylor. For a promised increase in economic compensation (by no means always realised), the worker allowed management to assume tight control of job-related decisions. While it was claimed that increased output would come from elimination of "wasted effort and unnecessary decisions", the overall workload probably increased in many cases. Not only have Taylor's policies probably led to mental strain that was overlooked when these theories were advocated, but in some circumstances demoralisation associated with these jobs may even cancel the presumed

productivity benefits. Policy decisions to centralise decision-making and job design expertise are often assumed to lead to the technological progress and production reliability that are needed for economic efficiency. However, unless these important economic linkages are re-examined in light of the effects of psycho-social mechanisms, many potentially more humane and productive forms of work organisations may continue to be overlooked. (Karasek, 1979 page 304)

The focus of Karasek, Theorell and others who have contributed to this research has to a large extent been on work in general, with the majority of studies on manual work. The Whitehall studies concerned the British civil service, presumably office work in a fairly traditional setting. For the work environment of post-industrial society in the 21st century, this vision may be necessary for survival:

"Social environments which are less divisive, less undermining of self-confidence, less productive of social antagonism, and which put greater resources into developing skills and abilities, may well turn out to be more innovative and better able to adapt to the environmental problems we face." (Wilkinson, 1994)

4.3 Summary

Several studies have demonstrated an association between job grade and health (Adler et al., 1993; Adler & Matthews, 1993; Townsend, 1980; Blane, 1985; Bunker, Gomby, Kehrer, 1989; Dutton & Levine, 1989; Marmot et al., 1997b). In the Whitehall II studies the connection between job control and health was examined explicitly, and a strong association was found which was independent of job grade. This leads to an understanding of work environment that implies that health is not destiny, but may be subject to intervention. The original observation, that health follows level in the hierarchy, excludes, according to conventional wisdom, that good health is available to all; the observation that good health follows common principles of good work organisation and management means, however, that everyone may enjoy the conditions conducive to good health. The ability to take the health effect out of these conditions may vary with the person, but with better knowledge of how these conditions influence people in their life cycles, with their dispositions and personality etc., one may maximise the 'health yield' of the work environment.

This will obviously have direct economic effects, such as reduced sick leave for the employer, enhanced health status and quality of life for the individual employee, and reduced health costs for society. Indirectly, one may also expect work environments conducive to good health to stimulate work performance as well. This is becoming more and more important in a work life yearning for competence, creativity and innovation.

5 Conclusions

Well-designed telework has potential good health effects; both for work and for the private and the public/neighbourhood sphere.

Trends in the organisation of work increase the importance of the psycho-social work environment: more flexibility with respect to where, when and how you work means higher rates of readjustment to the very issues that constitute job control; more change in the social relations of the workplace.

Increasing occurrence of chronic ailments; pain and musculo-skeletal diseases including back pains, are associated with the psycho-social work environment. Allergic reactions, complaints about 'sick buildings' and other non-specific problems may be attributable to similar conditions. This has large impacts on the economy and the quality of life of the persons involved.

Telework and indeed varieties of flexible work seem to be a fertile area for research on psycho-social effects in the work environment, which may open for new understanding of how people react to the new trends in work life.

6 References

Adler, N E et al. 1993. Socioeconomic inequalities in health : no easy solution. *Journal of the American Medical Association,* 269 (24), 3140–3145.

Adler, N E, Matthews, K. 1993. Health psychology : Why do some people get sick and some stay well? *Annual review of Psychology,* 45, 229–259.

Bakke, J W et al. 1998. *Håndbok i fjernarbeid.* Oslo, Arbeidsmiljøforlaget.

Townsend, P, Whitehead, M, Davidson, N (eds.). 1992. Inequalities in health. The Black Report. (1980). *The Health Divide.* London, Penguin.

Blane, D. 1985. An assessment of the Black Report's 'explanations of health inequalities.' *Sociology and Health Illness,* 7, 423–445.

Bosma, H et al. 1997. Low job control and risk of coronary heart disease in Whitehall II (prospective cohort) study. *British Medical Journal,* 314 (7080), 588–595.

Bosma, H et al. 1998. Two alternative job stress models and the risk of coronary heart disease. *American Journal of Public Health,* 88, 1.

Bunker, J P, Gomby, D S, Kehrer, B (eds.). 1989. *Pathways to health.* Menlo Park, CA, The Henry J. Kaiser Family Foundation.

Donkin, R. 1999. La Dolce cooperativa case. *Financial Times,* 22 Jan 1999.

Drever, F, Whitehead, M, Roden, M. 1996. Current patterns and trends in male mortality by social class (based on occupation). *Population Trends,* 86, 15–20.

Drever, F, Whitehead, M. 1997. *Health inequalitites decennial supplement.* London, The Stationery Office.

Dutton, D B, Levine, S. 1989. Socioeconomic status and health : Overview, methodological critique and reformulation. In: *Pathways to health.* Bunker, J P, Gomby, D S, Kehrer, B (eds.). Menlo Park, CA, The Henry J. Kaiser Family Foundation.

Duxbury, L, Higgins, C, Neufeld, D. 1998. Telework and the balance between work and family : Is telework part of the problem or part of the solution? In: *The virtual workplace.* Igbaria, M and Tan, M (eds.). Hershey, PA, Idea Group Publ.

Erikson, R. 1998. *Ojämlikhet i hälsa. Ett nationellt forskningsprogram.* Stockholm, Socialvetenskapliga forskningsrådet.

Ferrie, J E et al. 1995. Health effects of anticipation of job change and non-employment : longitudinal data from the

Whitehall II study. *BMJ,* 11, 311, 1264–9.

Fletcher, B C, Jones, F. 1993. A refutation of Karasek's demand-discretion model of occupational stress with a range of dependent measures. *J. Organiz. Behav.,* 14, 3319–330.

Forsebäck, L. 1995. *20 sekunder till jobbet. Distansarbete från bostaden.* Stockholm, Teldok.

Haan, M N, Kaplan, G A, Syme, S L. 1989. Socioeconomic status and health : Old observations and new thoughts. In: *Pathways to health.* Bunker, J P et al. (eds.). Menlo Park, The Henry J Kaiser Foundation.

Hemingway, H et al. 1997. Sickness absence from back pain, psychosocial work characteristics and employment grade among office workers. *Scand J Work Environ Health,* 23 (2), 121–9.

Johnson, J V et al. 1996. Long-term psychosocial work environment and cardiovascular mortality among Swedish men. *Am. J. Public Health,* 86, 324–331.

Julsrud, T et al. 1999. *The impacts of telework on a sustainable social development and quality of life.* Kjeller, Telenor R&D. (R&D research note N19/99.)

Karasek, R A. 1979. Job demands, job decision latitude, and mental strain : Implications for job redesign. *Administrative Science Quarterly,* 24, 285–307.

Karasek, R A, Theorell, T. 1990. *Healthy work. Stress, productivity and the reconstruction of working life.* New York, Basic Books.

Kristensen, T S. 1989a. Cardiovascular diseases and the work environment. A critical review of the epidemiologic literature on nonchemical factors. *Scand. J. Work Environ. Health,* 15, 165–179.

Kristensen, T S. 1989b. Cardiovascular diseases and the work environment. A critical review of the epidemiologic literature on chemical factors. *Scand. J. Work Environ. Health,* 15, 245–264.

Marmot, M et al. 1991. Health inequalities among British civil servants : The Whitehall II study. *The Lancet,* 337 1387–93.

Marmot, M et al. 1995. Sickness absence as a measure of health status and functioning : from the UK Whitehall II study. *J. Epidemiol. Community Health,* 49 (2), 124–30.

Marmot, M G, Shipley, M J. 1996. Do socioeconomic differences in mortality persist after retirement? 25 year follow up of civil servants from the first Whitehall study. *BMJ*, Apr 12, 314(7087), 1130.

Marmot, M et al. 1997a. Contribution of job control and other risk factors to social variations in coronary heart disease incidence. *The Lancet*, 350, 9073, 235–239.

Marmot, M et al. 1997b. Social inequalities in health : Next questions and converging evidence. *Soc. Sci. Med.,* 44 (6), 901–910.

Murphy, E. 1996. *Flexible Work.* Hemel Hempstead, Director Books.

North, F M et al. 1996. Psychosocial work environment and sickness absence among British civil servants: the Whitehall II study. *Am. J. Public Health,* 86 (3), 301–3.

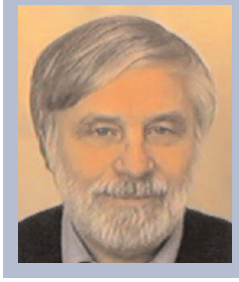
Parkes, K R. 1989. Personal control in an occupational context. In: *Stress, personal control and health.* Steptoe, A, Appels, A. Chichester, John Wiley.

Schnall, P L et al. 1992. Relation between job strain and ambulatory blood pressure. *Hypertension,* 19, 488–494.

Siegrist, J. 1996. Adverse health effects of high effort/low reward conditions. *Journal of occupational Health Psychology,* 1, 27–41.

Theorell, T. 1989. Personal control at work and health: a review of epidemiological studies in Sweden. In: *Stress, personal control and health.* Steptoe, A, Appels, A. Chichester, John Wiley.

Wilkinson, R G. 1994. The epidemiological transition : from material scarcity to Social Disadvantage? *Daedalus*, 124 (4), 61–78.



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Working with others: the virtual style

DIMITRINA DIMITROVA

1 Research on telework: current state of the art

Telework has fascinated social scientists and the public alike ever since the first handful of teleworkers appeared in the 1970s. Telework offered a glimpse into a future of virtual work and held the promise of a better, humanized workplace. Not surprisingly, telework has been the focus of extensive research. Several decades of empirical research have outlined the contours of the new workplace and the work style it fosters: spatial mobility, temporal flexibility, new supervisory practices, and a shift to mediated and formalized communications. At the same time, studies have made clear the complexity and diversity of the changes. Teleworking is not a unitary phenomenon and varies widely in different situations. Understanding telework is impossible without placing it into context and exploring the range of different forms it takes.

Despite the rich body of studies on telework, there is little systematic research on its work context. Few researchers examine the work process of teleworkers (Tippin, 1994) and its impact of their work practices (Perin, 1998). In turn, the lack of context-oriented research has contributed to overlooking the role of relationships and interactions in telework. Researchers of telework, with a few exceptions, treat teleworkers as atomized actors (Li, 1998). They emphasize the interdependence of telework and the low and intermittent communication of teleworkers. While teleworkers perform many tasks remotely, asynchronously, and in solitude, they are neither detached from organizational structures nor do they have self-contained work. Their work process is sustained by a web of relationships that have come to define – in the absence of spatial and temporal constraints – the very meaning of the term 'workplace'. Working remotely with others is at the heart of the work style.

This study sets to examine how different teleworkers work remotely with co-workers, partners, and clients. Its purpose is to capture different patterns emerging in distinct work settings.

2 Methods

Analytical approach

The study examines two aspects of the work settings: work process, ie. tasks and their organization, and work relationships arising in it, ie. who participates in work and what their role is. These aspects are interrelated. The work process brings together and defines the responsibilities of all the participants in the work. The nature of their tasks and the way they are organized determines who gets involved in the work and how, who teleworkers contact in their work and how they interact with them. The requirements of the work process are to a great extent 'translated' into mutual responsibilities of work participants and expressed in their demands, pressures, and expectations although relationships introduce additional nuances. These two aspects of the work settings determine how teleworkers work and interact with others.

Individual work processes and work relationships vary tremendously. To examine their variety and bring order into chaos, the analysis introduces the distinction between two contrasting types of work situations, or two types of work relationships. The first situation involves working in a group, the second – working on various tasks with different people. They correspond to the distinction between highly interconnected groups and loosely connected networks, developed by network analysts. Wellman has called them, respectively, 'fishbowls' and 'fishnets' (Wellman, 1997).

In highly interconnected groups (schematically presented in Figure 1*)), or fishbowls, relationships loop back into the group. People with such relationships are part of a small group and work closely together with their co-workers. Tasks are typically shared and collaborative.

In contrast, relationships in loosely connected networks (Figure 2*)) branch radially outward. Their members do not work together. Instead, work in such groups is fragmented and done by separate sets of people. People with such relationships work on various projects and tasks and complete each of them with the help of different co-workers.

These two types of work relationships, network analysis suggests, are systematically related to differences in the number of people involved in the work, strength of relationships between co-workers, their communications, and other characteristics. Differences in their communication patterns are especially relevant for telework. In groups with close working relationships, or fishbowls, communication consists of overlapping contacts among all group members, ie. everyone talks to everybody else. Communication is considerable and ongoing. Such communication characteristics do not fit well into teleworking arrangements. Fishbowl groups are usually co-located and commonly found in open offices (Wellman, 1997). In comparison, communication in loosely connected groups breaks into one-to-one contacts with separate co-workers and shifts in time. As workers with such relationships start a new task, they contact a different co-worker (or small sets of co-workers). These contacts lead to intermittent communication, which since Toffler on has been considered suitable for telework (Toffler, 1980).

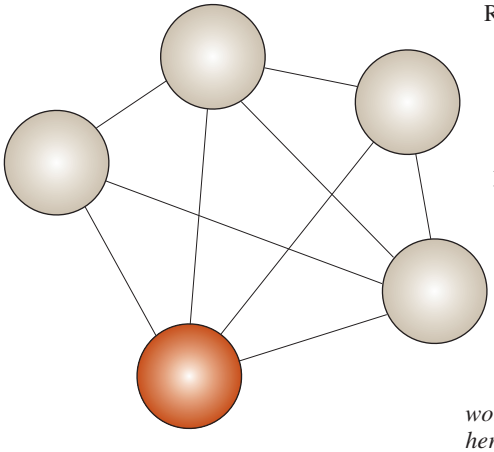

Figure 1 Fishbowl

Real networks, reflecting the complexity of specific work processes, may contain several segments and a mix of fishbowl and fishnet work relationships. The specific mix of work relationships sets the patterns of communications among co-workers that may facilitate or impede remote work.

*) *In Figure 1 and Figure 2, the red circle represents the teleworker, the rest of the circles – his or her coworkers, and the lines – the relationships among them.*

Research setting and data

The data for the analysis comes from a larger qualitative study on telework in a telecommunication company. Several years ago, the Company offered professional and managerial employees to move their jobs at home. Employees from various departments, work groups, and positions joined the trial, leaving their co-workers in the downtown offices. Telework was thus introduced into a range of different work settings. The researchers conducted a series of qualitative interviews with the teleworkers and their supervisors. The interviews covered the tasks of teleworkers and their organization, relationships and interactions with other participants in the work process, use of technology, supervision, and other data on work practices. The data were coded and analyzed with the help of qualitative data analysis software.

Teleworkers in the analysis

The teleworkers included in this analysis come from two work groups: Provisioning, where two employees telework, and Forecasting, where three employees telework.

Both Provisioners and Forecasters are home-based teleworkers but their jobs and work relationships are different. The function of Provisioners is to smooth down the process of installing equipment in the telephone exchanges from a particular territory. They have administrative and co-ordination tasks organized in recurring projects. Each project is guided by rules and procedures and has strict final deadlines, tight schedules, and well defined deliverables. Provisioners work mostly with co-workers from their projects who form a loosely connected fishnet. Forecasters, in turn, project the demand for telephone equipment and services in a particular territory. They have complex analytical work with fewer and more general rules and procedures. Their work results are less specified and they have only several benchmarks, ie. steps with fixed timing, throughout the calendar year. Forecasters work closely with their peers from the administrative group. In addition, they interact with partners, various internal clients, and numerous contact people providing information inside and outside the Company. Their work relationships thus include both a highly connected fishbowl – peers from the administrative group, and a loosely connected fishnet – partners, clients, and contact people. In short, Provisioners and Forecasters have different tasks organized in distinct work processes and fostering a different mix of relationships. The next sections describe the interactions of Provisioners and Forecasters with their co-workers and supervisors.

3 Working with others: Provisioners

All Provisioners in the Company are organized by territory and by equipment in several administrative groups. The members of the administrative groups and project teams do not overlap. Projects are based on functional diversity and bring together employees from various administrative groups and even outside the Company. Each project requires one Provisioner. The teleworkers included in this analysis are part of an administrative group in which all their peers provision different equipment.

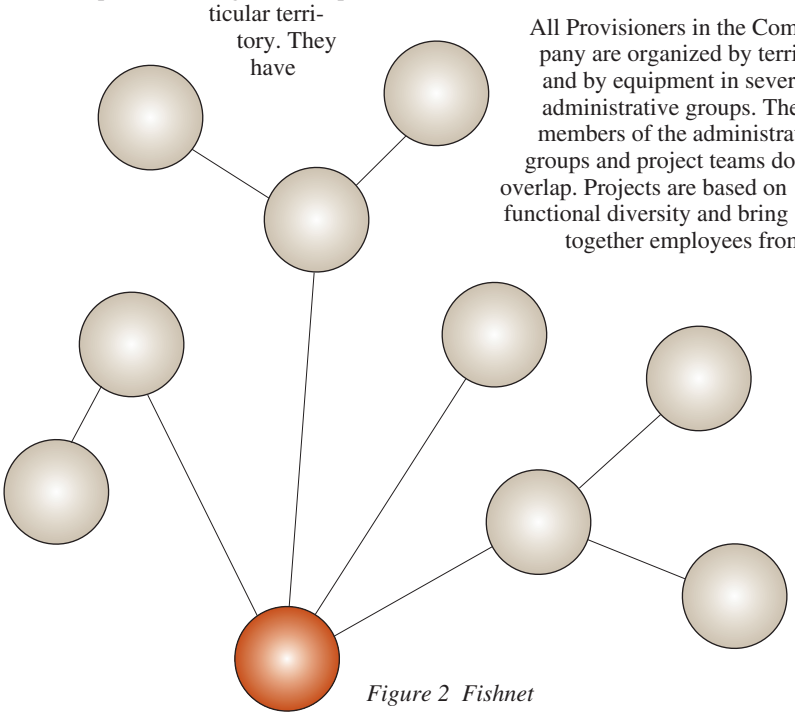

Figure 2 Fishnet

Peers

Peers from the administrative group do not play a significant role in the work of the teleworkers. They do not participate in their projects. In addition, because of their different equipment, peers lack the technical knowledge to provide information and advice. After teleworking started, teleworkers and their peers come together for weekly voice conferences of the group in which the supervisor passes down administrative information. They may occasionally bump into peers in their trips to the office, but they tend to treat this as interference in their work. Because of such encounters, one of them explains: "you don't get half as much done as what you thought." The relationships of teleworkers with peers are almost latent and interactions very limited.

The only active relationships of the teleworkers within their administrative group are with each other and with their supervisor. The two teleworkers function as a 'pair': each of them should be able to take over the other's projects. That is why they keep each other informed of their work, exchange technical information, discuss common problems, and work out common solutions. Says one of them: "Yeah, and make an agreement [how to handle a problem]. And make sure the other one is informed always".

To some extent, this working relationship is supported by administrative procedures. For example, the two Provisioners are required to attend together some project meetings, even though only one of them works on the particular project. In addition, once in three – four weeks, they schedule a meeting to formally update each other on the status of their projects. In such meetings, they:

> "... sit down and review everything that we've got on our plates, both of us, or when we were doing all that stuff at the end of the year we would review it together, make sure we covered all the angles, that type of thing."

But the contacts between the two Provisioners are not limited to the requirements of formal work procedures. They

try to co-ordinate their trips to the office to pick up their mail so that they can 'touch base' in person at least once a week. As they live close to each other, they sit together for the weekly voice conference in one of the home offices. Remote work nonetheless limits face-to-face interactions and they contact each other daily by phone, email, or fax. This relationship is to a great extent informal and the two Provisioners may "go out to a restaurant and sit and talk and we talk about a lot of personal things". But they do not consider each other 'friends' and do not socialize outside work. Their relationship remains a working relationship, albeit a close one.

In short, the pair of teleworkers interact daily with each other. To maintain their close working relationship from a distance, they initiate a lot of informal contacts using various communication media and weekly face-to-face meetings. The way they interact with each other differs sharply from their limited interactions with the rest of their peers.

Supervisor

Provisioners do not often contact their supervisor. The formal supervisory procedures involve weekly voice conferences of the administrative group and yearly evaluation of the work. In addition, Provisioners send monthly one-page report by email to their supervisor. This is routine information that does not require discussions. The reports contain logs of the hours Provisioners have worked on different projects. The same information they send weekly to the financial departments of the Company for internal billing purposes. This reporting procedure duplicates a step of the work process. The supervisor does not monitor work daily and, as Provisioners say, "he leaves you alone" to do your job.

This relaxed supervisory style is made possible by the strict rules and procedures and tight co-ordination of the work. Their specified deliverables and schedules make the results of work highly visible. Co-ordination, in turn, means that failing to meet a deadline or inadequate deliverables reflect immediately on co-workers from their projects and set off complaints to the supervisor. One of the Provisioners explains:

> "I mean if you're going to do shoddy work somebody's going to phone up [the supervisor] and say 'I don't understand anything she's issuing' or 'she's not issuing this and she should be' ... And he's soon going to complain. So it goes on to other departments after it's left us so ... [bad work will be known]".

Horizontal relationships with project participants substitute for monitoring by the supervisor. The need for direct interactions with him decreases. The supervisor intervenes only if co-workers complain. In turn, Provisioners phone him when they need help and keep him informed of major developments in their work by email. They try not to "garble his mailbox up with a whole bunch of junk" and details of routine daily work. Provisioners contact their supervisor once a week or even less frequently. The purpose of such contacts is to inform rather than to discuss or negotiate work so they are easily conducted over phone or email.

Project participants

The work of Provisioners is centered on the co-workers from their projects who form a loosely connected fishnet network. In the course of a project, Provisioners work with 25 to 30 employees from different Company groups, representatives of the supplier, and product developers outside the Company. Project participants do not work together as a group. Each of them contributes particular expertise and gets involved in specific project tasks. The Provisioner in a project, for example, confirms the location of the installation, schedules work, draws up a budget, develops equipment specifications, orders it, and pays the bills. While project tasks are interdependent, each task brings together only a few of the participants in the project.

Provisioners work on each of their tasks with different project participants. They schedule the project with the schedulers, draw up a budget after getting the prices from the Purchasing department, develop the equipment specifications with various technical experts, and pay the bills with the Budgeting Group and Accounts Payable department. Their tasks are sequentially organized and the interactions of Provisioners are closely aligned with the stages of the project. The contacts of Provisioners with each co-worker tend to be concentrated at a specific project stage(s) and then fade out until the cycle is repeated in the next project. Says one of them: "over the last two weeks I could have talked to one individual 20 months [until the next project reaches the same stage]".

Provisioners contact project participants mostly by email, phone, fax, or regular mail. Partly, this is due to the existence of rules and procedures: as deliverables are well defined and there are strict deadlines there is little need to discuss or negotiate them with co-workers. Contacts serve for information exchange and do not require face-to-face meetings. The fragmentation of communication in one-to-one contacts (instead of group meetings) further fosters the use of media. Face-to-face meetings are only needed, Provisioners say, for group discussions and presentation of visual material. Provisioners meet their co-workers in person only a few times during a project that lasts for several months. These occasions include a kick-off meeting officially launching the project that presents visual material, discussions of the "nitty-gritty technical details" of equipment specifications with a group of technical experts, and sometimes updates on the project status. These meetings are tied to specific project stages and scheduled well in advance.

The bulk of the numerous contacts on a project, however, are carried over media. Provisioners tend to use one and the same media to contact a particular project member. The more peripheral the involvement of a co-worker in their work, the more limited the ways and the more specialized the media Provisioners use to contact them. For example, Provisioners interact with schedulers and the software provisioners exclusively by email, meet developers outside the Company in person, and exchange faxes with Purchasing department.

Email messages and file transfers play a central role in the overall communication. Approving location, getting software reports, scheduling, and some of the accounting tasks are all done by email. The role of electronic technology is not limited to supporting contacts between project participants. Another function is to provide shared information spaces. Some of the deliverables of Provisioners, such schedules and budgets, end up on the mainframes of the Company and the Supplier. Project participants can then access it electronically for their interim deadlines and internal billing. In this case, electronic technology serves to bypass direct interaction. Further, some tasks are only done on-line. For example, although

Provisioners discuss the equipment specs and reach agreement with co-workers in a face-to-face meeting, their approval becomes official only after they input the specs on the mainframe. Electronic technology serves to formalize the result.

To summarize, Provisioners rarely meet co-workers in person and their communication is overwhelmingly mediated. Their few face-to-face meetings are scheduled around project stages. This enables Provisioners to complete their work remotely in spite of the tight coordination of their tasks and numerous interactions with project participants. Their limited and mediated contacts with the supervisors further facilitate remote work. The only relationship, characterized by daily contacts and frequent face-to-face encounters, is the relationship between the two teleworkers themselves. However demanding, it remains an exception among a multitude of other, easier to maintain, relationships. Their project based work and fishnet type relationships foster interaction patterns that are highly compatible with remote work.

4 Working with others: Forecasters

Forecasters belong to a small group with ongoing analytical tasks. They constantly analyze data crunching numbers on their computers, 'keep tabs' of the changes in their territory, update their databases, and deal with a steady stream of information from various sources. This work brings them into contact with people from various Company groups and outsiders, who provide information, confirm its accuracy, or use forecasting reports and analyses. Hence, their relationships outside the administrative group include partners, contact people, and clients.

Peers

Unlike Provisioners, Forecasters work closely with their peers. Preparing their reports is not a straightforward, software driven task. It requires interpretation and judgment in which advice from peers can help. Working together also helps them to keep their standards and criteria common. While Forecasters prepare independently their reports their results come together in the higher-level forecast where all numbers have to be justified, adjusted, and reconciled. If one of them works on a special project, they "are all helping out on this special project as well as doing little bits and pieces of it". Even the computerization of the work fosters interactions among peers. Their programs are developed in the group and to master the software, Forecasters rely on each other for help. All that makes their work "a total team operation". The relationships among peers approximate a well-connected fishbowl.

As a result, interactions in the administrative group differ markedly from those in the Provisioning group. Formal procedures prescribe a weekly voice conference of the group. In these meetings, Forecasters discuss 'hot' topics, such as opening up of the local market, new software, or breakdowns of the mainframe. "If there is a problem," one of the Forecasters says, "that's the day that we sort of talk or bring up the problem." The discussions from the meetings continue in email exchanges later. A Forecaster explains:

> "... we'll end up, because you can't spend too much time on it, we'll end up writing back and forth on the IIS [company email], copying everybody on it, you know, as the discussion sort of progresses on a topic on how we're going to handle it."

Forecasters phone each other between meetings for advice and information or to discuss more personal matters such as who is taking an early retirement package. In short, they "constantly talk to each other". Remarkably, for the three teleworkers in the group, even these contacts are not enough. Every week after the meetings is over, they drive a short distance to meet in person in a coffee shop and discuss work. "And that's," says one of them, "over and above [the meeting]. You're not going to do that on a conference call." They pick up their mail at one and the same time, drive together to the downtown office, and help each other with computer problems. They have also found an ingenious way to avoid isolation. On those days when they are stuck for long periods at home, they link up on three-way call and keep their lines open and "can hear any chit chat [in the home offices] back and forth. It's like the person is in the office."

The teleworkers in the Forecasting group thus form a smaller group with closer relationships and more extensive interactions. In addition to their already active interactions with peers, the three teleworkers have developed their own informal routines to increase further their opportunities for communication. Only a few of the actual contacts among the teleworkers are supported by formal procedures. The common teleworking status quite likely contributes to these closer relationships and extensive interactions. Our data also points to the critical role of physical proximity: a fourth teleworker, located in a different area, could not cope and left the teleworking trial.

Supervisor

Like Provisioners, Forecasters are not monitored daily and the contacts with their supervisor are limited. The formal supervisory procedures involve weekly voice conference and annual evaluation. In addition, Forecaster tour once a year their territory together with the supervisor. Daily work is independent. As one of them puts it:

> "Most of us have so much service and when you come to [that level] ... you are operating on your own ... You're running your operation."

The supervisor intervenes only if their work is not satisfactory and clients complain:

> "If he [the supervisor] heard something from one of my [client] groups, from one of his counterparts about me doing something wrong, well, he would be on my tail every day, you know."

However, their work is not as readily visible as the work of Provisioners. Because of their complexity deliverables cannot be well specified and clients cannot easily judge their quality. Neither can work be gauged by the few deadlines. Unlike the supervisor of Provisioners, the supervisor of Forecasters cannot rely on horizontal relationships for monitoring and feedback. He makes extra efforts to monitor work using mainframe databases. Forecasters submit monthly updates and reports on-line. The purpose is to allow internal clients to access them. Once on mainframe, their reports are also available for their supervisor who checks them and makes sure their numbers are not "totally off". This monitoring does not take the form of a formal reporting procedure but nonetheless serves as a control mechanism. Difficulties in measuring and monitoring work thus require more efforts by the supervisor.

Not surprisingly, their supervisor worried when they started teleworking. At the

beginning, one of the teleworkers recalls, "he [the supervisor] used to phone, like, he had a bad habit of phoning at around 4:30 to see if you had goofed off at the end of the day." After a month or two, things went back to normal and interactions decreased. Apart from the weekly voice conference, Forecasters "hardly ever" talk with their supervisor and use phone and email to keep him informed and ask help in case of problems.

Partners, contact persons and clients

In addition to peers, Forecasters interact with partners, clients, and contact people from various internal groups or outside the Company. Forecasters contact them for specific tasks and work "on different jobs at different times with different people". These people are not closely involved in the work of Forecasters. They provide information, confirm and approve it, or request specific analyses or presentations. However, much of the information Forecasters need is either on-line or its delivery is pre-arranged. Further, Forecasters submit their regular reports on-line. This organization of tasks decreases direct contacts.

Forecasters work most closely with the planning and access engineers from their territory. Forecasters update their databases touring their territories and collecting information. Formal procedures require that this information is discussed and approved by the planning and access engineers before Forecasters input it in their databases. To speed up work, Forecasters try to tour their territory together with the engineers. These common trips help them to reach an agreement and avoid "a sit down, full blown meeting for a whole day which is wasted [time]." Getting the approval after a common trip is only a formality handled by regular mail. Before Forecasters started teleworking, they could occasionally meet the engineers in the office. Teleworking replaced such encounters with phone conversations between trips.

During a trip, Forecasters also contact planners, architects and builders from the municipal government, private constructors, or real estate agents. These are always face-to-face meetings. Without any formal authority over them, Forecasters prefer to drop by in person and get the information they need.

The rest of the interactions of Forecasters are directed to a myriad of internal clients and information sources. Mainframe databases and their role as shared information spaces decrease direct contacts but do not eliminate them. When contacts do occur, they are unexpected. A big client leaving the Company, an offer for partnership, or a big government order not only affect the analyses of Forecasters but also require pooling the expertise of Company employees to handle the crisis or take advantage of the opportunity. Such contacts are dominated by phone and voice mail. Rare face-to-face meetings, organized once a year, bring together Forecaster and members of Installation, Engineering, Building, Sales, and Planning groups.

These patterns of interactions are similar to the interactions of Provisioners with their project participants. Forecasters have mostly one-to-one contacts anchored in specific tasks. The interactions with a particular client or contact person are concentrated in one point of time and then fade out until the next emergency or tour. Mediated contacts predominate. However, there are some differences. First, the contacts of Forecasters with people outside the Company pull the balance between mediated and face-to-face interactions towards more face-to-face meetings. Second, because the work of Forecasters is not project-based, their contacts are not neatly arranged in recurring cycles as the contacts of Provisioners. Unexpected tasks enhance this variability in the timing of interactions. As a result, many face-to-face contacts are not scheduled at all or scheduled on a short notice. Even when Forecasters use communication media, it is harder to reach people on short notice and communication may be delayed. The interactions of Forecasters, hence, require more efforts.

Such difficulties result in occasional problems. Forecasters have fewer problems working with co-workers whom they have known for years. In such relationships they have developed mutual trust and understanding. In that sense, one of them cautions:

> "... a new person [coming into forecasting] would have to make the effort of going out to the office more and talking face to face and having little meetings that maybe weren't totally necessary but you would have to do it to build up the confidence in the people."

However, most of the work relationships of Forecasters are short-lived. Even if Forecasters have been on the job for years their clients and contact people change. Reaching such co-workers and getting them to act upon a request is not always successful. An irritated Forecaster complained: "of course with all these big changes [in the Company] that are going on now, you'd no sooner talk to somebody and they were off on another job." These complaints were triggered by her unsuccessful efforts to involve someone from the sales group in a partnership with a local builder.

In short, Forecasters need more efforts and have more difficulties working with contact people and clients in spite of the intermittent communication and extensive use of media. In addition, they have more active interactions with peers from the administrative groups and especially with other teleworkers.

5 Conclusions

This study set to examine how teleworkers work remotely with others. It argued that the work process and the work relationships of teleworkers affect the way they interact with others and impede or facilitate remote work. The study hypothesized that the teleworkers who are part of a group and work closely with their co-workers (fishbowls) have ongoing communication. Telework either requires more efforts or is impossible. Teleworkers who work with different coworkers on each task (fishnets) have intermittent communication that facilitates telework.

The analysis confirms these expectations. Both Provisioners and Forecasters have fishnet relationships. For Provisioners, they make up the majority of their relationships at work. For Forecasters, they are only a part of their work relationships. In both groups, teleworkers interact with such co-workers one-to-one and at different times, ie. communication is intermittent. In both groups, teleworkers use extensively communication media to reach such co-workers. Their interaction patterns are compatible with telework. Intermittent communication, however, does not guarantee problem-free teleworking. Provisioners work effortlessly with all their co-workers from the fishnet. In the case of Forecasters, the combination of short-lived relationships, more contacts with outsiders, and lack of schedules leads to more efforts and difficulties in communication.

Group work, as the work of Forecasters with peers shows, requires more frequent ongoing communication and more efforts to maintain them. The closer the work relationships the more face-to-face meetings they require. This is especially salient in the interactions among the teleworkers from the Forecasting group and between the pair of teleworking Provisioners. In both groups, close work relationships have increased the communication load but has not precluded telework. Our data set does not allow further exploration of the impact of fishbowls on remote work. Nonetheless, the characteristics of the data set are suggestive. In the Company, there are no teleworkers with only fishbowl type relationships. Interviews with some Company managers who opposed the introduction of telework in their groups show that their employees work closely together.

Group work and close work relationships foster actual contacts that are, to quote a Forecaster, "over and above" the interactions supported by formal procedures. To maintain such relationships, teleworkers develop informal communication routines. Organizations, hence, cannot mold such interactions easily by changing procedures. If such close fishbowl relationships are disrupted by telework organizations cannot recreate them easily. Our previous analyses of sales groups showed that introducing telework in a group with strong fishbowl type of relationships caused considerable problems. Teleworkers struggled to rebuild old patterns of interactions that provided them with important resources for work (Salaff et al., 1998). The managers had to increase face-to-face group meetings to overcome the difficulties.

All the interaction patterns emerging in the analysis can be traced back to the interplay of work relationships and work process. Understanding the way teleworkers work with others starts with exploring what they do and whom they work with.

References

Li, Feng. 1998. Team-telework and the new geographical flexibility for information workers. In: Igbaria, M, Tan, M (eds.). *The virtual workplace.* Hershey, US, Idea Group Publishing, 301–18.

Perin, C. 1998. Work, space and time on the threshold of a new century. In: Jackson, P, Wielen, J (eds.). *Teleworking : international ierspectives.* London, Routledge, 40–56.

Salaff, J, Wellman, B, Dimitrova, D. 1998. *There is time and place to telework.* Presented at the Third International Workshop on Telework, Turku, Finland.

Tippin, D. 1994. *Control processes in distance work situations : the case of satellite offices.* Presented at the Annual Meeting of the Canadian Sociology and Anthropology Association, Calgary, Alberta, 11 June 1994.

Toffler, A. 1980. *The third wave.* NY, Bantam Books.

Wellman, B. 1997. An electronic group is virtually a social network. In: Kiesler, S (ed.). *Culture of the Internet.* Mahwah, NJ, Lawrence Erlbaum, 179–205.

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Telecottages and other work centre experiments

WALTER PAAVONEN

In the late 1970s it was quite obvious that the way we were organizing society in the industrialized countries implied not only increasing our standard of living and wealth, but also some major problems in the cities as well as in rural areas.

In the demographically and economically growing urban areas the method to separate the place of living from the place of work had caused increasing difficulties in traffic congestion and negative impact on the environment.

In the rural areas – and especially in the sparsely populated regions – the structural transformation and centralisation of societal services and functions caused impoverishment of the service standard in villages and smaller towns. When banks, post offices, shops, health care and public service were withdrawn from the villages, the work opportunities, particularly for women, were strongly reduced [2, 7, 13, 14].

In the 1980s the appearing information and communication technologies (ICT) provided promising solutions to many of these problems. The place of work and the place of living could be connected to each other by means of ICT. Commuting could be replaced by teleworking – allowing people to remain in villages and suburbs and still work – now by using the new technologies [4, 13].

The neighbourhood work centre in Nykvarn

In order to explore these new ideas of organizing work, an experiment on teleworking from a neighbourhood work centre – "en grannskapscentral" – was set up in Nykvarn in 1982. The experiment was part of a larger research project and the duration of the experiment was to be two years.

Nykvarn is a suburb to the city of Södertälje – some 14 kilometres from the city and 50 kilometres from Stockholm. As part of the municipality of Södertälje, Nykvarn is a typical dormitory town with two thirds of the employed inhabitants commuting to Södertälje, Stockholm, etc. At that time the population was about 6,000 – with just over 2,000 households [1].

The characteristics of Nykvarn fitted very well with the aims of the project. It is relatively close to Stockholm and many of the inhabitants of the residential areas of Nykvarn could be categorised as information workers. In addition, one of the researchers lived in Södertälje and had good knowledge of the local conditions and had the contacts needed for local support. As she was living in Södertälje she was also able to locate her own work to the work centre during the experimental period.

In 1980, when the planning of the project started, it had also been decided to expand the community centre laying out of Nykvarn with premises for commerce and other activities. This provided an opportunity to the project management to participate at an early stage in the design work and present special requirements on the work centre premises.

The Nykvarn neighbourhood work centre was run by Nordplan from autumn 1982 until 1 May 1984. Before that time there was period of more than one year of planning, preparation, recruitment work, installing and furnishing work. The total time and efforts spent on the experiment were far beyond the original plans and budgets. After 1 May 1984 the centre was in operation for another year – now as part of a telework project initiated by the Swedish Employers Confederation.

The approach of the project was to establish a full scale experiment on the work of the approaching information society. The information technology had started to be introduced in the offices, and employees working with common office tasks were facing new work methods and new ways of organizing work. Many of them were already familiar with main frame computers, but now the computers could be made small, personal and simple to use. The pioneers argued that the technology would very rapidly change the work, the way of organizing work and ultimately the entire society.

But in spite of its small size and simplicity, the new technology was expensive. A desktop computer with very modest capacity and a printer those days cost up to 50,000 SEK, and a workstation with a communication unit, screen, keyboard and modem was even more expensive.

At the same time as recruitment of employers and employees who were willing to participate in the experiment went on, extensive work was carried out to collect funds for IT equipment, furniture and other things necessary for a functioning work place. The research grants from the Jubilee Fund of the Bank of Sweden and the financial support from the National Council for Building Research were dedicated solely to research and could not be used for hardware, rent or communication costs. The solution to the financial problems appeared in sponsoring. Several companies within the Ericsson Group, Control Data, Esselte, IKEA, Televerket, the Municipality of Södertälje, the owner of the premises and a number of suppliers of interior fittings, textiles and light fittings turned out to be interested in supporting the experiment by lending or donating equipment and other necessities. In October 1982 the neighbourhood work centre was ready for moving into, and the official opening was on 1 November [5].

The neighbourhood work centre was situated in the very centre of the community and in connection with shops, library, bank, post office, church, health care centre, social security office, coffee shop and village hall.

The work places were arranged in an open office landscape. An open space in the middle of the landscape for meetings, visitors, lunch and coffee breaks was separated from the working space by green plants and mobile screens. Wall covering curtains, carpets and a noise-absorbing ceiling made the internal atmosphere very silent and peaceful. In connection with the office section there were a kitchenette, toilets, cleaner's cupboards, cloakroom and a room for all modems and communication equipment [3, 5, 6].

The ten work places were furnished with equipment in accordance with the wishes of the employees, equipped with telephones, desk calculators and typewriters, but also with memory diallers, advanced telephone answering machines, desktop computers or visual display terminals and printers. Of the six linked work stations three were connected through fixed line to the main frames, which at that time was the safest way to transmit data in networks using analogue technology. Available for common use were also a telefax machine, a copier, a couple of PCs and a paper shredder. Apart from the more technical equipment, the individual office areas were furnished with adjustable desks and chairs, lock-up cabinets, terminal desks, fittings for desks and terminals, etc.

The combination of high-tech working tools, modern furniture, matching textile colours, advanced alarm systems and exciting work assignments successfully presented a vision of a work place of the future.

During the pilot period of about 30 months a total of 20 employees from 10 organizations took advantage of working at the neighbourhood work centre. Some of them used the premises and the equipment very occasionally, but organizations such as Scandinavian Enskilda Bank, Östra Sörmlands Sparbank, the local administration of Södertälje, Specialdatautrustning AB, Televerket, Paavonen Consulting AB, AB Astra and Nordplan most of the time had one or two permanent work places at the centre. The two banks, however, were not involved in the project at the same time.

The work tasks performed at the centre were deliberately chosen to be of various types and qualification levels. The representatives of the banks locally developed and tested new banking concepts and services including financial advice and legal assistance to private customers and small businesses. The local administration of Södertälje occupied two work places at the centre for demographic planning and for statistical and administrative tasks. Specialdatautrustning AB was an enterprise in the business of data services, and the two employees at the centre carried out registration work and data entry.

Two employees of Televerket worked with local project engineering and revision of public net functions. Paavonen Consulting AB started up business at the centre. During the project the business was changed from systems analysis to the area of organizational changes due to the introduction of new technologies, to distributed work and teleworking, which still – 17 years later – is the main speciality of the enterprise.

AB Astra, a major Swedish pharmaceutical company, participated in the project with two software developers and one production planner who shared one workplace. They carried out parts of their ordinary work at the centre, but also often special tasks like program testing, remote supervision and control of new system applications or periodical inventory measures. These tasks often had to be done at night or during weekends, and it was convenient to carry out this type of work at the neighbourhood centre close to home.

The Nordic Institute for Studies in Urban and Regional Planning (Nordplan), the owner of the project, had a work place at the centre for the management and administration of the project – in combination with on-site research work. The research activities included daily documentation of events, problems, attitudes, etc., carry out analysis on the basis of questionnaires and interviews within the scope of the project and follow up relevant literature, reports and articles. The on-site project administration included organization of numerous visits and informing interested organisations, other research institutions, the media, etc.

Researchers, consultants, programmers, private economic advisers and clerical workers shared the office and together created an inspiring work environment. As they all represented different organizations and different occupations, they had very little in common with regard to work-related matters. On the other hand, they had many private things and living conditions in common, which made the social interaction fruitful [5, 6].

Being the first experiment of this kind in operation, the Nykvarn project aroused enormous public interest – especially among the media which disseminated information about the experiment through TV, radio, articles in magazines and newspapers pretty well across the whole world. During the first years of the project some 60 articles were published in major newspapers and magazines, and the centre was a subject in several radio and television programs. In addition, many research papers reported about the Nykvarn experiment and teleworking. The neighbourhood work centre also became a favourite subject in many critical labour union debates [5, 6].

G-centre – Datacottage – Telecottage

The neighbourhood work centre in Nykvarn, which primarily was a telework application aimed to reduce commuting in an urban region and to find out potentials of the new technology, became a source of inspiration also for other purposes. In 1985, a work and service centre designed for small villages and sparsely populated areas was drafted on the initiative of the Rural Area development Committee in the Ministry of Industry. The 'Glesbygdscentral', as it was called, could easily be associated with the 'Grannskapscentral', and the short name 'G-central' pointed out the similarities between the two applications [4].

The drafted key objectives for the first G-centre were:

Preserve a living countryside. The strategy was to reduce the removal from the rural parts of Sweden by keeping up and improving the public services and consistently looking after local work opportunities. With the support of local communities, regional development funds and employment authorities trainee and apprentice programmes could be established in order to stimulate entrepreneurship and employment. A G-centre could provide premises for new businesses and also for decentralised public services. Service functions which had been withdrawn – or were threatened – as a result of a declining population, could be co-located in the G-centre and in this way the costs of the services could be reduced.

Increased vitality for the existing businesses. Local entrepreneurs and businesses could be enriched by competence and functions outside the local community. The expert services on marketing, finance, business development and administration could be channelled through the G-centre to the local businesses. The G-centre could be an important help-desk to the local businesses and the total costs could be kept down as the facilities could be shared by several different services.

Creating new jobs. In rural, sparsely populated areas there are many poorly utilised knowledge and competence assets. The main reason for this is the imbalance between the Swedish education system, which provides qualified education also in rural areas, and the labour market, which is concentrated to the urban areas. By bridging between the rural area labour force and the remote labour markets, though, teleworking at the G-centres could reduce this imbalance.

Drafted activities in a G-centre:

Office space for teleworkers:

- Permanent work places for teleworkers employed by non-local organisations;
- Work places for disabled people and others who are unable to commute;
- Temporary work sites for private or public experts and service providers;
- A stationary basis for mobile workers;
- Temporary work sites for tourists and visitors.

Small scale service and support:

- Small scale post office in combination with other services;

- Place of purchase of commodities which are not supplied locally;
- Certain health care services;
- Certain social welfare services;
- Bank services;
- Information spot for local government.

Visitors services:

- Tourist information;
- Accommodation booking;
- Bus station and transportation co-ordination services.

Training and culture:

- Library services and mediation of literature, videos, music;
- Co-ordination spot for cultural events;
- Premises for distance education and training;
- Social meeting-place.

Very soon after the launch of the 'G-central' idea, three centres were established in the Province of Jämtland – in Vemdalen, Strömsund and Stugun. In the very beginning they were called 'Datastuga' (Data cottage), later on 'Telestuga' (Telecottage), and were adjusted to local preconditions and needs. The telecottage in Vemdalen very soon took a lead in the development process. The activities were focused on training and dissemination of the telecottage idea to other regions – even to other countries.

At the telecottage in Stugun – another small village – the activities also included some training, but were in the first place focused on providing services to local enterprises and the local administration.

The telecottages in Vemdalen and Stugun both had some elements of teleworking, but the main activities were however directed towards local markets.

The approach in Stömsund, a town in the northern part of the region, was more distance bridging. A local entrepreneur started up a business on telemarketing. The only training activities in this telecottage was aimed at preparing own staff for the telemarketing job [9].

The telecottage idea became part of a national campaign for revitalization of rural regions and was supported by regional as well as national agencies and funds like Televerket, the Swedish national telecom operator.

The number of telecottages increased in Sweden and the concept was also disseminated to other countries. In 1989 the number of telecottages in Sweden was around 40, and the year after the telecottages had the opportunity to collaborate in converting the parish registration into a modern national register administrated by the tax authorities.

Since 1990 the number of telecottages has declined. Financial difficulties and problems related to marketing of the services provided by the telecottages reduced the number to 25 in 1993, and in 1997 the members of the Swedish Telecottage Association were about 10.

In 1998 the Swedish Telecottage Association was discontinued after some internal conflicts. Some of the telecottages continued the co-operation however, but now on a more business oriented basis [12].

Whilst the number of telecottages declined in Sweden during the 1990s, it still seems to be increasing in other parts of Europe. In Ireland and the UK for example, the total number of telecottages has increased from around 130 in 1994 to approximately 200 in 1998.

Services and telework applications at the telecottages

Particularly in rural areas, the dependence on small businesses is crucial.

To the economy in these areas it is important that enterprises are able to follow the technological development and do not lag behind their competitors, regardless of whether the issue is market knowledge, access to information or organizational skills. The telecottages were regarded as a means to meet these requirements and the main focus turned out to be to provide appropriate office space, ICT equipment, training and advisory support, primarily to entrepreneurs and new enterprises.

Seen over time, the provision of office services and business support have been important activities for the Swedish telecottages – including services like [12, 16]:

- General computer training, Internet training, other training;
- Access to equipment;
- Photocopying;
- Internet access, web-site development & maintenance;
- Word processing, desktop publishing;
- Data entry and digitalisation of maps and documents;
- Language translation;
- Bookkeeping;
- Consultancy and project management.

Competition in these areas surely is a great challenge as the technology develops very fast and forces even small companies to continuously renew technology and maintain skills.

Under these conditions, the only way to generate revenues enough to survive was to approach larger markets far away by using communication technologies, doing business with far-away partners, building networks to be able to act as a larger organization. The idea was that when distances are no longer measured in miles or kilometres, but in fractions of a second, the rural area enterprises had essentially reduced their competitive disadvantage.

What was wrong with the Swedish telecottages?

Now, almost 15 years later and having seen the outcome of the 'Telecottage movement', some retrospective questions must be asked: Why could not the telecottages become strong enough to survive and develop their activities? Were there some fundamental weaknesses in the telecottage idea? What could have been done better?

Probably the number of answers would equal the number of telecottages. One common answer, however, is that many of the actors at the time when the first telecottages were established, were too optimistic and had too much confidence in the potentials of the technology. They were impressed by the technical facilities and paid much too little attention to business issues, potential difficulties and their business concepts. At that time there was an obvious 'IT euforia', not only among entrepreneurs, but also among authorities and other actors in society.

Probably the most important explanation to the unsuccessful long-term result of the telecottage movement is the failure of the public actors to understand the

G-central/Datastuga/Telecottages as elements in a new infrastructure – aimed at strengthening regions regarding public and private services and introducing the new technical facilities.

If local, regional and national actors had been able to regard the telecottages as parts of an infrastructure which enables the provision and improvement of knowledge dissemination, services, business support and competitiveness rather than new businesses, they should have realized that this infrastructure must be maintained, adjusted and developed. The societal engagement and responsibility for these new elements should have been quite different. Probably a more far-seeing societal attitude would have dramatically improved the long-term conditions for many of the Swedish telecottages as well as the future prospects of the labour force in the sparsely populated regions.

It is true that many actors in the Swedish society saw the telecottages as a means to raise awareness and knowledge about ICT among people living in districts and villages who risk lagging behind in the progress of the information society. Demonstration, training and education were accepted in the beginning as elements in this context, and the first telecottages were favoured by considerable support from society. Especially as ongoing training seemed to be needed throughout people's lifetime, the telecottages could serve the people in the sparsely populated regions in a similar way as schools and vocational training institutions did in cities and urban areas.

Education and training are surely valid for all modes of future work, but still, if you live in a place where there are no jobs, no training or education – lifelong or not – will help you unless you are ready to move to a place where you can find a job.

When the telecottages failed to meet the expectations of a growing number of new jobs, the financial support from society gradually dried up.

Another important explanation to the difficulties of the Swedish telecottages is the nature of the activities that many telecottages had to choose when the societal support was insufficient.

Comparing the telecottages with the first neighbourhood work centre the conditions were quite different. At the work centre in Nykvarn most activities were parts of various information flows which were necessary activities within the operation of the participating organisations. There were no discussions as to whether or not the tasks at the work centre were needed or whether they could be carried out by somebody else. In other words, their organisational status were very much like traditional functions in the organisation with no direct competition from alternative ways to do the same task. The main difference was the longer physical distance regarding links to earlier and later stages in the information or value added chain. The activities in the first telecottages became much more oriented towards different markets – local or others.

Very soon many telecottages realized the insuperable problems of chasing clients across a distance and convincing them that their needs could best be solved by people at some remote telecottage. Those telecottages which focused their activities on education and training on a local market were very soon facing the problems of a very limited market of a small neighbourhood and the incessant need for renewal of knowledge and technology. The problems related to the smallness of the home market and the long distances to other markets were often understated.

A third explanation is that the Swedish telecottages failed to establish sustainable relations with clients and partners across distances. In this sense the term 'telecottage' may sometimes be misleading as it may associate to 'telecommunication, telework and telebusiness'. The prefix 'tele' in telecottage can be understood in the same way as in TELEvision, TELEfax, TELEgram, TELEscope, TELEphoto, TELEphone and TELEpathy, which is a Greek word for 'far off' or 'distance'. The prefix can, however, also be used as an abbreviation for telecommunications or telephony [10].

Whether 'tele' in telecottage associates with a distance or with telecommunications, it often conveys a false image of distance bridging activities and use of advanced communication technologies. As a matter of fact the activities in most telecottages did not have very much to do with work or services across distances, but were rather related to the local needs of services and the local market for training. This does not apply only to the Swedish telecottages, however. A study among British and Irish telecottages for instance revealed that only one out of five included some form of teleworking [15].

Future prospects for work centres

The difficulties experienced by the Swedish telecottages were, however, to some extent foreseen when drafting the first versions of the G-centre. The combination of private and public services, work places for teleworkers and training activities was aimed at creating an interesting and inspiring technological environment, but also to allocate the costs and the risk amongst several functions, of which only a small part was dependent on the successful actions of a market.

Working at a remote work centre deserves a much better fate than indicated by the present number of existing work centres. Working at 'satellite offices', 'telecentres', neighbourhood offices', 'electronic village halls' or 'telecottages' is far less controversial than working at home as many of the work conditions closely resemble the traditional office.

These types of work places also have other advantages compared with working at home. Usually they are designed and built for the purpose. Safety requirements, work environment and space requirements can be met in a better way than in many apartments, which in the first place are planned for the needs of family life.

A telecottage, a satellite office or a neighbourhood work centre provides a social environment which in many ways is similar to that of a traditional office. This is to many people a very important aspect as it surely is an important part of the working conditions. In the case of a remote office which is shared by different organizations and various activities, the social environment can even be more interesting than in traditional offices, which are normally very homogeneous as to the organizational culture, working patterns, style of interaction, etc. [13, 14].

In most cases the work centre does not fully eliminate commuting in the same way as working at home, but the distance and the commuting time can be shortened considerably. The problem with work centres is the cost – whether you call them telecottages or neighbourhood work centres. This was the crucial problem with the neighbourhood work centre in Nykvarn, and seems to be the main problem also with later attempts. There may be many good reasons for work centres, but all too often they appear to be

too expensive to the organization when compared to home-based solutions. The economic conditions may be improved if the premises and facilities can be shared by several activities and functions. Work centres may prove to be interesting even to employers and other parties if the cost of working space at a work centre in one way or another can be balanced against the real costs of transport infrastructure and commuting [13, 14].

So, as long as teleworking is an atypical way of working, and the norm is work at the employer's premises, there must be some very good reasons to make exceptions to the norm acceptable. This is not an easy job. It may require a strict concentration on the targets and the strategy chosen.

Sometimes the scope of the telecentre projects is too ambitious and extensive: trying to reduce removal, to create work for the unemployed, to train low-skilled unemployed people, to make use of unoccupied offices, to disseminate technology and at the same time to create a new and outstanding work environment for the people at the centre. Often this is simply too much – but if it succeeds it would be wonderful! The risk is, however, that the initiative falls between two stools and there is just another remote work centre with no future.

In spite of the disappointing outcome of the Swedish telecottage movement, there are still strong arguments for not stopping the experiments with new methods for work, business and new models for infrastructure. We must go on trying to find organization models which make organizations and individuals more competitive, which facilitate the renewal of the working life and which open new ways for improved quality of life even to people living in disadvantaged regions.

Actually there are in Sweden and in other Nordic countries two interesting alternatives to the 'old telecottage'. One is the village work centre which has emerged as a collective approach among the villagers and which is based upon the very experienced needs of the local inhabitants. Byssbon in the Province of Jämtland is a good example of a successful implementation of ICT in order to create jobs and optimism in co-operating small villages in one of the most sparsely populated areas [13, 14].

Another interesting approach is the experiments on enhanced democracy and the 'civic offices' (*medborgarkontor*) which are aimed at improving the public information service and offering citizens the opportunities of richer participation in the political process [11].

In these experiment processes the experiences from the 'old telecottages' and other types of work centres may turn out to be extremely valuable.

References

1 Ljungberg, C et al. *Grannskap 90*. Stockholm, Nordiska Institutet för Samhällsplanering (NORDPLAN), 1982.

2 Paavonen, W. *Distansarbete*. Stockholm, SAFs Allmänna Grupp och Trygghetsrådet SAF-PTK, 1983.

3 Ranhagen, U et al. *Bostadsnära arbetsplatser med ny teknik – Grannskapscentralen i Nykvarn och andra visioner.* Stockholm, Swedish Council for Building Research, 1985. (R121:1985.)

4 Paavonen, H, Paavonen, W. *Glesbygdscentral*. Nykvarn, Industridepartementet, Glesbygdsdelegationen. 1985.

5 Engström, M-G, Paavonen, H, Sahlberg, B. *Grannskap 90 : närarbete på distans i informationssamhället.* Stockholm, 1985. (Teldok rapport no. 16.)

6 Engström, M-G, Paavonen, H, Sahlberg, B. *Tomorrow's work in today's society.* Stockholm, Swedish Council for Building Research, 1986. (D4:1986.)

7 Paavonen, W. *Distansarbete*. SAFs Allmänna Grupp och Trygghetsrådet SAF-PTK. Stockholm, SAFs Förlag, 1987.

8 Paavonen, H, Paavonen, W. *Informationsteknologiska strategier för glesbygd. Strategier för tekniskspridning till glesbygd – några nordiska exempel.* Stockholm, Glesbygdsdelegationen, 1987

9 Wiberg, U. *Vägar till glesbygdsutveckling i informationssamhället.* Stockholm, CERUM, Umeå Universitet, 1988. (Glesbygdsdelegationens skriftserie nr. 5.)

10 Paavonen, W. *Arbete på distans – förutsettningar och konsekvenser.* Stockholm, University of Stockholm, Företagsekonomiska Institutionen, 1992.

11 Östberg, O. *Danmark : Framgångsrika medborgarkontor och hög "IT-temperatur" i enskilda företag och regioner.* Stockholm, Telia AB, 1993. (Teldok Rapport 82.)

12 Holloway, L. *Telestugor, telearbete och distansutbildning.* Stockholm, Telia AB, 1994. (Teldok Rapport 90.)

13 Paavonen, W, Paavonen, H (eds.). *Telework – good practice for the future.* Stockholm, NUTEKs Förlag, 1998.

14 Paavonen, W, Paavonen, H (eds.). *Att arbeta på distans – nya arbetsformer i IT-samhället.* Stockholm, NUTEKs Förlag, 1998.

15 Murray, B, Comford, D. *Telecottage & telecentre survey.* Working paper, 1998

16 Bertin, I, Denbigh, A. *The teleworking handbook.* 2nd edition. Selwood, TCA – the Telework, Telecottage and Telecentre Association, 1998.

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Telework: complexity and life forms

LARS QVORTRUP

The following article presents and discusses two hypotheses: First, that telework is part of a much larger trend in organisational development: The trend towards higher complexity capacity. Second, that in order to understand the attitudes to telework, one must include the social position of teleworkers, eg. their life form. In this paper, I will first present these two hypotheses, then I will discuss them within the context of two recent Danish experiments with telework: a project at the Danish Board of Industrial Injuries, and a project at the "ATP-House", the private organisation that administers the Danish labour market pensions. Finally, I will present a number of wider perspectives.

Telework takes off

There is little doubt that telework is taking off rapidly: From being a phenomenon with limited impact it is currently growing rapidly. In the European Union there were between 1 million and 4 million teleworkers in 1997; 1 million being a very conservative figure, only including "formal" teleworkers or so-called "corporate telecommuters", eg. employees who would otherwise be office based; 4 million being a figure based on a wider definition of teleworkers, including formal teleworkers as well as employees who telework by personal arrangement with their manager, self-employed people who connect with clients and customers from their home, etc. (cf. European Commission, 1998, page 28). 4 million teleworkers represent more than 3 percent of the total workforce, twice as many as in 1996.

This trend is particularly pronounced in Denmark. A few years ago only some 5–10,000 workers were categorised as teleworkers. In 1997 both government and trade union analyses concluded that there are between 50,000 and 100,000 teleworkers, and that the realistic potential for telework will amount to approximately 250,000 at the beginning of the next century (cf. PLS Consult A/S et al., 1996; and Andersen Management International, 1997). Thus, between 2 and 4 percent of Danish workers are teleworkers, the realistic potential being approximately 10 percent.

Social complexity and organisational flexibility

Why does telework develop so quickly? Normally, telework is analysed outside its social and organisational context, being looked at as some kind of comet from the outer world. However, in order to understand the potentials and the organisational rationality of telework it is important to analyse telework in its wider context. Within this perspective, telework is not primarily a result of new technological opportunities, neither is it a result of individual demands. Basically, telework and organisational decentralisation is an organisational and technological tool aimed at handling the problem of bounded rationality in a social world of increased complexity.

Social complexity and organisations

For me, there are two major explanatory factors regarding the growth of telework and its increasing popularity.

Partly, in our current hypercomplex society there is a growing need for organisational flexibility (cf. Qvortrup, 1998). Currently, in a social environment characterised by increasing spatial and temporal complexity (with the development of information and communication systems – global television systems, Internet, etc. – the number of observable social actions grow, and so does the speed of change), organisations cannot survive unless they are constantly prepared to adapt to new social conditions.

Partly, there is a growing demand for flexibility among employees. In a modern family with both parents being in the labour market, there is a need to adapt work life to everyday life conditions. Furthermore, in a wider perspective, the required work contents and qualifications change several times during a normal working career. Consequently, the demand for flexibility is expressed by wage earners and is increasingly articulated by trade unions. The concern of employees has changed from a focus on rights to a focus on opportunities and adaptability. This latter trend may well constitute a new framework for social dialogue concerning telework.

The background for these organisational trends can be found in the nature of the current society: That it is a hypercomplex society which cannot be managed by traditional, centralised organisations. This was already realised in 1945 by the American information theorist Herbert A. Simon. In his book *Administrative Behavior* (1997) he presented the concept of "bounded rationality" as an alternative to the traditional belief in unlimited human rationality. He realised that the complex environment cannot be managed by a single human's rationality, but that we are always in a position of a deficit of rationality: That the complexity of an organisation's environment always exceeds the management capacity of the organisation. Consequently, the basic function of an organisation is to reduce complexity, and the challenge of management centres is to develop complexity management strategies and structures.

This idea was further developed by the German sociologist Niklas Luhmann, with explicit references to Simon (cf. Luhmann, 1964; and 1968. See also Detlef Horster's interview with Luhmann, in Horster, 1997 page 34f). According to Luhmann, the phenomenon of formal organisation – a phenomenon which is conceptualised during the eighteenth century – develops as an answer to an increasingly functionally differentiated society: *"In complex societies a (...) type of social systems gains increased importance, a system which in several areas of social life so to speak squeezes itself in between the social system and the individual interaction system, ie. the social system type organisation."* (Luhmann, 1975 page 12.)

How should the concept of organisation be defined? According to Luhmann definitions based on goal oriented behaviour, division of work, hierarchical structures, etc. are much too narrow. For him, an organisation is a social system, ie. a closed system based on self-reference, whose function is to reduce societal complexity – a complexity which cannot be managed only by ad hoc interaction groups – and whose borders are based on the question of membership: A social system is "organised" if "... membership is coupled with certain conditions, ie. if entry and exit is formally conditioned." (Ibid. See also Luhmann, 1975 page 99; Luhmann, 1984 page 268f; Luhmann, 1991 page 202.)

According to Luhmann, the way in which complexity is reduced cannot be predicted. On the contrary, it must be expected that with changes in the social environment, new complexity reduction strategies will be developed.

Toward increased organisational flexibility

For many years after the publication of Simon's book the principle of bounded rationality was neither understood nor practised. In organisations the first reaction to the growth of environmental complexity was to increase internal bureaucracy. Private enterprises developed horizontal specialisation and vertical layering, and public institutions created detailed rules and procedures in order to select external complexity.

Only during later years have other organisational strategies been put on the agenda. Instead of developing an endlessly growing capacity for complexity management in one unit, complexity has been managed through decentralisation. Instead of establishing an increasing number of rules as a sort of complexity filters, organisations have experimented with flexibility based on the philosophy that pressure from the environment should not necessarily be answered by filtering, but may also be met by adaptability. Instead of observing an organisation's internal and external environment through one code – the economic code of gains and losses – the economic account has been supplemented with ethical accounts, ecological accounts, qualification accounts, etc. One code has been replaced by several codes for environmental observations and adaptations. Instead of one decision centre, which has been put under increased pressure, organisations have experimented with decentralised, but mutually co-ordinated decision centres. Instead of inflexible principles based on strong traditions, procedures based on organisational learning have been put on the agenda, because mutual learning is a precondition for adapting to a complex and changing social world. And even learning must be flexible, ie. based on flexible learning procedures. As a consequence learning procedures based on self-observation – second-order learning – have been introduced. Instead of centralising many production units within one organisation, production is being based on networks of small production units, managed as just-in-time production, outsourcing, enterprise clusters, etc.

Telework

Within this context, telework can be analysed as yet another tool for increasing organisational complexity capacity. First, telework supports the flexibilisation of an organisation, because decision making is distributed from the organisational centre to its individual untis. Second, telework represents an increase of the organisation's information absorption capacity, because external information can be accessed by individual employees instead of being filtered through a central information unit. Third, learning and adaptation to the environment is a local and not a centralised issue. However, the impact of these changes is that an increasing comlexity management burden is put on the shoulders of the individual employee, and that the behaviour of the central management must be changed from control to support of decentralised management procedures. Also, there is a need to compensate for the potential loss of internal information exchange and co-ordination facilities.

The Danish Board of Industrial Injuries

As I have already said, the introduction of telework represents one way of increasing an organisation's complexity management capacity. Thus, telework is neither a goal in itself, nor is it a result of new technology. Let me present one concrete example of the change of organisations toward greater flexibility from the public administration sector, in which telework plays a major role: the Danish Board of Industrial Injuries. By tradition, public service administrations have functioned as bureaucracies with a high degree of vertical and horizontal specialisation. As a result these bureaucracies have had limited flexibility and user-friendliness with the "case" – and the end-user – as the changeable element within a stable organisation: Users have been forced to adapt to the public service organisation, not vice versa, and as long as it did not result in legitimation crises this of course represented a very effective complexity reduction strategy.

However, with the introduction of information and communication technologies in such organisations, and with the experiments with telework, these conditions have changed. Examples in Denmark have demonstrated that public service organisations can be organised in relation to the individual customers, and with the organisation as a dynamic, case-oriented network. Again, however, it is my assumption that the structural change of such public service organisations did not occur as a result of new technologies. Rather, new information and communication technologies represented one important tool in answering the public sector's legitimation problems during the 1980s.

The telework experiment at the Danish Board of Industrial Injuries represents a particularly interesting case. The example is relevant because it demonstrates the potentials of telework for changing the "organisational nature" of public bodies: It has become much more customer-friendly, because it is now centred around the case of the user, and it has become much more employee-friendly, because it is organised around case-oriented work teams.

The project took place at one of seven customer-related offices of the Board of Industrial Injuries, and it was concerned with the opportunity to establish home offices. However, the particular relevance of the project was based on the fact that at the same time traditional paper-based case-work was transformed into electronic case-work, the so-called Image project. The project was evaluated by Andersen Management International (cf. Andersen Management International, 1997). The basic opportunity of the telework project was that all work accident reports (from employees, employers, general practitioners, insurance companies, etc.) from having been paper-based were written in an electronic format, some of the hand-written files being scanned. Consequently, all relevant material concerning a specific case became directly accessible from a computer independently of the caseworker's physical position. With the electronically based distributed work structure, a specific case can be accessed from the head office, from the home-based work station, and even by the many external experts, etc. This makes it possible to organise work from being hierarchical and highly divided (the individual case moving from one expert office to another, and from one organisational level to the next) into being organised around the particular case. Internal staff, homeworkers, and external experts can access the case and each other within virtual, ad hoc work groups.

The perspective is the following: By tradition, the Board of Industrial Injuries (and many similar public bodies) is based on a vertical and horizontal division of employees. They are distributed vertically according to decisional competence

of individual offices and departments, and horizontally according to their speciality, see Figure 1. In relation to this division of work the paper-based case must flow from one office to the other. The result of this work procedure is an organisational system of highly specialised, and mutually not co-ordinated functions and a relatively slow case-work, in which the consumption of time is very much caused by transaction costs, ie. from transporting the relevant papers between offices. On the other hand, the way of organising work seems to result in a strong identification among employees with their total organisation.

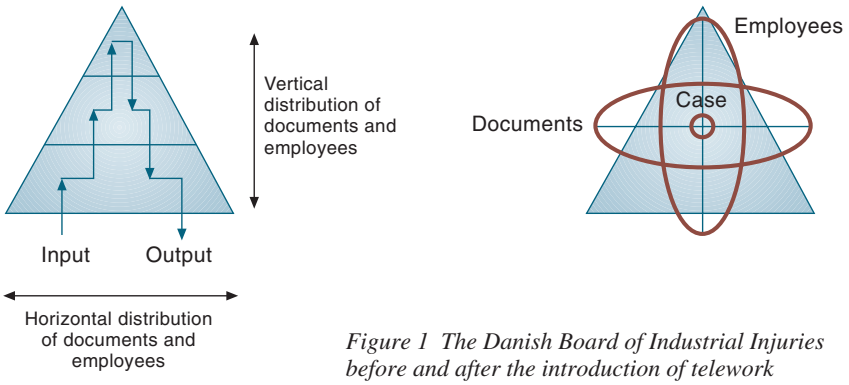

Figure 1 The Danish Board of Industrial Injuries before and after the introduction of telework

As a result of external pressure – increasingly, this "old-fashioned" working procedure was considered to be unacceptable by end-users – and with the adoption of new technological potentials the working procedure can be transformed into a work structure based on case-organisation. The individual case is now represented in electronic format, which means that all relevant collaborators and documents can be organised in relation to – and with access to – the currently relevant case. This implies that the consumption of time caused by the transportation of documents from one office to another can be radically reduced, that the identification of cases and of related documents is easy, and that work can be organised in teams defined by the actual case or case domain. In addition to the reduction of time and the increase of efficiency one important outcome seems to be a stronger identification with the (virtual) team to which the individual employee is attached.

The basic conclusion concerning this section is that telework must be seen as one element of a broader organisational development trend with great potential impacts for private as well as public service oriented enterprises.

Telework and life forms

Until now, I have looked at telework in its organisational and social context. Although this explains its social and organisational raison d'être, it does not account for the individual attitudes to telework. This is however another important aspect that we must understand: that different individuals have different attitudes to telework. While some see it as a tool for realising their need for greater self-management, others look at it as an attack on well-established trade union achievements. Furthermore, this is not only the result of contingent individual differences, but reflects a larger pattern: The pattern of different life forms.

Life forms

Many definitions and categorisations of telework are not based on any explicit rationality, but often mix different (technical, organisational, and social) criteria. Here, I suggest that the generic term telework should be divided into three subcategories: electronic homework, telecommuting, and flexiwork. However, the inherent idea of this tripartite definition of telework is that categorisation of telework should build on a social rationality. Each of the three basic categories of telework is related to a basic life form in modern society. This implies that one type of telework is related to one social category, while others appeal more to other social roles and positions. However, again and again we have seen that telework has been identified with only one of the above sub-categories, thus narrowing the scope, and we have seen that unconsciously one social group has used their own socially implicit definition of telework, thus subsuming others under their specific favourite type of telework, and under their (but not necessarily others') most appropriate organisation of telework.

In modern society basically three historically rooted life forms can be identified ((cf. Højrup, 1983 and 1984; and Højrup and Rahbek Christensen, 1989); the idea to combine life form analysis and sociological analysis of information technology was introduced by Storgaard and Jensen (1991), and the following analysis is very much based on their categorisations): the self-employed person's, the wage earner person's and the career oriented person's life form. The self-employed person's life form is of course most dominant among people who are associated with self-employment: farmers, artisans, shop-keepers, manufacturers. The wage earner person's life form is, as indicated by the term, tied to being a wage earner. The career oriented person's life form refers to occupational groups aiming at a career, especially within larger enterprises and organisations. (Storgaard and Jensen, 1991 p. 124.)

The basic idea of these "life form" categories is that the form of work is closely related to the whole life form. Thus, all

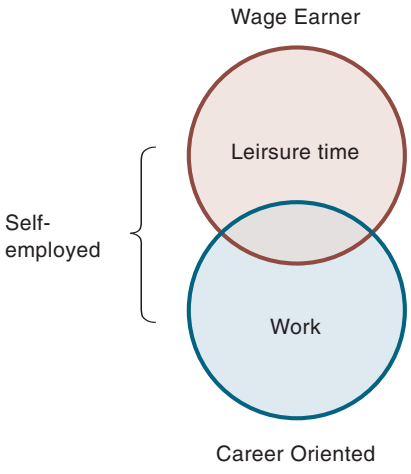

Figure 2 The three basic life forms

Table 1 Telework and life form categories

Category	Definition	Life form
Electronic homework	Work at home delivered through telecommunications to an external customer	The self-employed person's life form
Telecommuting	Work for an employer performed on distance, using computers and telecommunication	The wage earner person's life form
Flexiwork	Work performed "everywhere" (at the office, at home, on travel), using computers and telecommunication	The career oriented person's life form

three categories can be defined by the way work and leisure times are related. While wage earners place leisure time above work, career oriented persons prize work above leisure time. In comparison, self-employed people are reluctant to draw a line between working hours and leisure time, see Figure 1. They cherish other values, such as running their own farm or firm, and they do not experience any significant conflict between family life and working life. (Storgaard and Jensen, 1991 page 125f.)

This also implies that different life form representatives have different attitudes to work. For career oriented people, work is a goal in itself (you live to work), while for wage earners work is rather a means to improve family life and leisure time (you work to live). While the former go to work in order to work, for the latter the social and interactional qualities of work are important: having a job is a key to social interaction at the work place. Finally, the self-employed cannot really tell the difference between leisure/family time and work.

In addition, these life forms have different historical roots and interactional relations. The self-employed person's life form is rooted in traditional (rural) society and is related to stable, positional interaction relations. The wage earner's life form is rooted in modern society with its urbanised personal interaction relations. Finally, the career oriented person's life form is related to hyperpersonal interaction patterns and connotates post-modernity.

Based on this analysis three different forms of telework can be identified. These three sub-categories can be defined as specified in Table 1.

From the analysis it is obvious that these three telework categories have different historical and ideological roots, and thus that they attract different types of persons: *Electronic homework* has clear political connotations, both critical (being sent back home to old-fashioned isolated cottage work) and positive (the idyllic electronic cottage (cf. Toffler, 1980), reminding us of Laura Ingalls Wilder's little house in the forest); thus the term evokes clear pre-modern associations. *Telecommuting* focuses on the wage-earner's commuting problems; normally it does not include independent, home-based micro-enterprises, and its main rationale lies in society's reduction of transportation time and traffic pollution, and in the individual employee's interests in making his or her working-life more flexible; here, the dominating connotations include modernity's separation of workers and means of production, and its dream of creating a rationally planned society. Finally, *flexiwork* is of a more recent origin; it reflects current organisational changes, while also having obvious connotational advantages, for instance in a European Commission Telework Programme context; the term arouses post-modern associations.

Also, the three telework categories call forward different types of attitudes: While the traditional industrial wage-earner focuses on the potential reduction of the working day and the potential increase of wages, the career oriented "flexiworker" is oriented toward the work content. Thus, there is a clear ideological impact of being a flexiworker, which also influences telecommuters, because they as well become relatively self-organised.

The ATP-House telework project

The ATP-House

In Denmark, the "ATP-House", the private organisation which administers the Danish labour market pensions, has been one of the front-runners regarding experiments and participatory development projects with telework. There are 550 employees at the ATP-House. Out of these, 90 persons are employed at the systems and computer department. In the mid 1990s, a small group participated in a pilot project regarding telework, and in 1998 a new project was launched with 35 persons working part-time from home based on telework. At ATP, telework is organised as electronic homework based on the condition that one is only allowed to work one or two days at home per week. The project was evaluated by a group of MA students from Aalborg University – Søren Bjerg Pedersen, Peter Rosendal Frederiksen, Ulrik Toft, and Morten Berg-Christensen – under the advisory direction of Henrik Bøggild and the author of the present article.

The general result of the evaluation study was very positive. Among the participants the large majority presented a supportive attitude to the telework experiment: 90 % wanted to continue as teleworkers after the project ended, while 10 % said "don't know" and nobody was against telework. Among the group of persons at the department who had not been offered the opportunity to telework, 63 % wanted to become teleworkers in the future, while 22 % preferred to continue with the traditional work organisation.

Three main reasons were given for assessing telework positively: Telework increases work efficiency; it increases the flexibility of everyday life; and it increases the opportunity to concentrate on a given piece of work. As a result, more than 55 % thought that the pleasure taken in their work had increased.

The basic benefit of telework seems to be that it gives the teleworker a better opportunity to co-ordinate private life and working life. When the project was launched, the employees at the department could apply to become participants, and it was obvious that people with partners and children were attracted by the telework opportunities. Actually, 97 % of the project participants were married and/or lived together with a partner, while only 3 % were single. On average, the participants had two children living at home.

The project evaluation confirmed that part-time telework is beneficial to family life. Basically, the telework days were planned in accordance with professional demands at the place of work, and actually all respondents answered that they sometimes (3 %), often (40 %), or always (57 %) planned their days working at home in accordance with professional activities at the ATP-House. However, 89 % of the teleworkers also responded that they sometimes (53 %), often (25 %), or always (11 %) planned their days working at home in accordance with other family activities, while 34 % said that they sometimes, often, or always planned their days working at home in accordance with social activities at their place of work. Thus, the opportunity to adapt working life to private life is a basic benefit of telework, an opportunity that becomes increasingly important as long as both parents are employed. Thus, a critical social complexity factor in a modern society is the complexity of organising private and family life in accordance with the demands of the professional careers, institutional child minding, etc. Consequently, the structure of the working day changed during the telework experiment: 60 % of the teleworkers say that they do not conform to an 8 till 16 working-day structure. A majority often work in the evenings and/or during the weekends.

Thus, it is clear that complexity management plays an important role among teleworkers in the Danish project at the ATP-House. However, it is also significant that the traditional wage earner attitude is transformed into a more career-oriented life style. 40 % or the respondents answer that they have got longer working hours after the introduction of flexible telework, and as a matter of fact only 63 % say that all extra working hours are entered as overtime. Also, more than 60 % of the teleworkers say that they have fewer respites from their labour when working at home.

Conclusions

Putting the results from the projects at the Danish Board of Industrial Injuries and at the ATP-House together with the theoretical considerations discussed above, there are three conclusions:

First, that telework is a tool for organisational management of the increasing level of complexity in the social environment: particularly, the Danish Board of Industrial Injuries had to radically reorganise their work structure in order to adapt to current customer demands.

Second, that telework is also a tool for private families' complexity management. In our current everyday life where normally both parents are employed and where children's lives are structured according to complex patterns of institutionalised child minding activities, the need for flexible working hours is great.

Third, that one of the outcomes of this trend is that the life style of teleworkers is more oriented toward a career life form than toward a wage earner life form. A basic explanation of this trend is that teleworkers experience labour not as working hours but as work tasks. Consequently, instead of experiencing a labour market conflict between employees and employers based on buying and selling of labour time, teleworkers tend to identify with their work tasks, which they feel responsible to finish within a given working period.

Flexible work opportunities

A new framework for social dialogue

As we have seen, the impact of telework is not just increased organisational flexibility but also increased opportunities for employees to self-organise their everyday life. This has been realised by a growing number of employees in Denmark, and it has been increasingly articulated by trade unions. The concern of employees has changed from a focus on rights to a focus on opportunities and adaptability. Not least because of the growth of the number of female workers, families demand that they can organise their work in a flexible way, being able to take care of their career as well as their family life. From earlier days' North-European 8 till 16 working-day rhythm, modern families demand that they themselves can organise their work and family life. Generally speaking it is preferred to work according to flexible working hours, and as a compensation to continue work at home during the evening or to take a day off and finish work in the weekend. Even more importantly, in a modern working environment based on skilled symbol-oriented work (the writing of reports, planning of procedures, etc.) there is a great need that the work environment is adapted to the work contents. Typically, a workweek is divided between 3–4 days of meetings, customer contacts etc., and 1–2 days of concentrated individual work. Consequently, a much more flexible working environment is needed, and here telework defined as flexible work (work at home, during travels, and at the office) is a natural option.

After some hesitation this widespread demand for flexibility has been taken up by the trade unions. However, it has been emphasised that although flexibility is demanded by many employees it can also be mis-used by the employers unless a list of concerns is established. While flexible work cannot be organised within a strict line of rules, a framework must be built within which individual telework contracts can be made. This latter trend which has concerned the Danish labour market during the latest couple of years may well constitute a new framework for social dialogue concerning telework.

Issues raised by Danish trade unions

I think that the following list of issues summarises the main concerns of Danish trade unions within this emerging social dialogue:

- It is important that the decision to accept telework for an already employed person is voluntary and that it can be withdrawn by the employee within a certain period of time (eg. 6 months). In certain cases it has been observed that while personal freedom and flexibility is attractive during the first period, the disadvantages only become visible after a while. Consequently, within a large organisation it may be an advantage to introduce telework as an experiment in a pilot group.

- Individual agreements concerning telework should be made within the context of collective bargains. The most popular model seems to be that collective bargains function as frameworks within which specific local or individual agreements can be made. As part of the framework it has been emphasised that wage and work conditions must not be depreciated as a result of the introduction of telework. Also, employees are warned against "informal" agreements, which cannot at a later stage be changed.
- Sometimes, the introduction of information and communication technologies at the workplace is combined with the introduction of uncertain and unusual working conditions such as work for more than one employer, outsourcing of work functions from an existing organisation, or so-called "flexible employment models" such as freelance models. It is however important to recall that the contractual relationship between employee and employer is not necessarily related to the technological organisation of work, and that flexibility in working time and place does not imply an increased flexibility in the contractual situation. As a rule-of-thumb the introduction of telework in an organisation should not be combined with a change of employment contract.
- It is important that teleworkers have the same career opportunities as their colleagues, and the same access to job training and courses. Particularly, one should pay attention to so-called informal job-training being a result of day-to-day co-operation at the place of work.
- For teleworkers it is important that they can maintain their contacts to their colleagues, and to their trade union, their shop stewards, etc. As one example it should be recalled that the information and communication technologies used for work issues can also be used for work related social and organisational communication. Not only should this be allowed, but one should bear in mind that this kind of communication is important for the maintenance of a productive work environment.
- There must be clear rules for data protection and the sanctity of private life, for instance as a right not always to be connected to the central organisation. In some labour market agreements a differentiation between fix time (the time in which the employee is accessible and connected) and flex time (the time in which the employee works without being disturbed) has been specified. Also, clear rules for electronic control must be established in order not to mis-use the electronic access to the employee.
- Often, telework is more naturally connected to wage as a function of work products rather than working time. Instead of defining a working-day as eg. 240 minutes, a working-day may be defined from the expected working output: 10 cases finished, one report written, etc. Consequently, the introduction of telework is often followed by a change of principles regarding wage agreement.
- There is a risk that increased flexibility may benefit male workers, while worsening the situation for female workers, for instance in relation to the division of family work. Therefore it may be beneficial to combine the introduction of telework with campaigns regarding equal opportunities among the sexes.
- In Denmark as a result of the above list telework as electronic homework has normally been limited to a maximum of two days per week.
- However, the issues within this list must not overshadow the fact that the basic benefit of telework is that it represents a means towards increased flexibility regarding organisation and self-organisation of work. If too specific rules are aimed at, the baby will be thrown out with the bath water.

Wider perspectives

While it is of course important to bear in mind the specific issues regarding the introduction of telework it is equally important not to forget the wider perspectives of telework. Here, telework can be understood as a symbol of and as one of the means for radical changes of society and of the way in which labour organisations are structured. In this final section I will summarise a number of these issues.

From hierarchical to networking based forms of organisation

One impact of the trend of development symbolised by telework is that the traditional hierarchical organisation with a central management centre is being replaced by organisations in which the basic principle is networking based information flows among a large number of distributed management units.

From management as centralised privilege to management as distributed function

If the traditional hierarchical and centralised organisation is on its way toward a networking based form of organisation, as a consequence the concept of management will be changed. Management will develop from being a centralised and personalised privilege into becoming a distributed function, ie. a framework for coordinated development processes in an organisation, which in practice are taken care of by a large number of persons. Consequently, management will develop into management of management or second-order management. The art is to create frameworks within which specific management functions can be practised. These specific management functions will typically be practised as mutual observational operations within general frameworks of observation. Examples are the so-called "ethical accounts" or "ecological accounts" (or, with a wider concept, holistic accounts) which in reality represent generalised frameworks of observation within a large, distributed organisation. The constitution of such "holistic accounts" represents one way to practice second-order management.

A precondition for distributed management: toward new structures of loyalty

One of the preconditions for the distribution of management functions and the transformation of directive management into self-management is that new structures of loyalty will develop. Traditionally, work organisations were based on the so-called "natural" opposition between egotism and common interests, ie. they were based on the opposition between self loyalty and common loyalty. The precondition for distributed management is that loyalties regarding work, career and organisation mutually support each other.

Toward new forms of division of labour

Few years ago it was still the assumption that telework would particularly concern traditional secretarial functions, which could be organised as home-based electronic work, while top-managers and middle-managers represented the basic

staff of an organisation. Currently this image is being turned upside down. Secretarial work is developing into co-ordination and management work, and typically the secretariat constitutes the central point in relation to which other functions of the organisation are co-ordinated. Compared with this, other staff functions are organised as mobile or flexible work functions, often realised as telework. In order to realise this major trend of division of labour new qualifications are demanded for major parts of the administrative employees.

The appearance of "virtual organisations": from complexity to hypercomplexity

Already today we see the first signs of new "virtual organisations", ie. new organisations whose borders are not physically represented by buildings, entrances, gatekeepers, etc., but are maintained only through computer mediated communication (cf. eg. Barnatt, 1995. For a more critical analysis see Amin, 1994). This represents a new phase in the development of formal organisations:

- The first phase was represented by the classical hierarchical organisation from the first half of the twentieth century, known as the so-called "fordist organisation". Here, the organisation is characterised by an internal command structure and by a relatively closed border toward the environment; most tasks are taken care of within the organisation. From a technological perspective this type of organisation reflects the first generation of computer systems, centralised around one large mainframe and with an almost total lack of user-friendly interfaces.
- The second phase is represented by the so-called flexible specialisation characterised by "outsourcing" of a number of traditionally integrated functions to specialised sub-suppliers and by a greater responsiveness toward the market. Internally in the organisation the computer system increasingly supports individualised activities represented by an interface based on the "desktop metaphor". The computer is primarily an "office machine". In order to support external relations during the 1980s and 1990s inter-organisational standards are being developed, cf. the work concerning Electronic Data Interchange, EDI.
- During the 1990s we are entering a third phase, the emergence of so-called "virtual organisations". Here, outsourcing and flexible specialisation are developed into networks of mutually integrated and overlapping organisations in relation to which the individual organisation reproduces its borders through computer-mediated communication. Organisational borders tend to be represented symbolically and not physically, and thus an important function of computer systems is the interface-based support of the reproduction of organisational loyalty and co-ordination. This implies that traditionally separated intra- and inter-organisational IT-systems are becoming mutually integrated. Also, the traditional "desktop" interface which supports the function of the individual office, is being replaced by "orgware" interfaces in which the dominating metaphor is not the individual employee's interface to his/her work desk, but the individual employee's interface to his/her organisation and to the global network.

Globalisation trends

Although there has for many years been a trend toward globalisation of the labour market, this trend is speeding up as a result of new telework opportunities. Due to the increasing independence of the geographical location of digital service provision a computer consultant in Norway may today compete with a similar consultant in India.

From time-based to task-based work

While a few years ago work was characterised by being time-based, information and communication technology supported distributed work will increasingly become task-based. The way in which a task is solved depends on the planning of the individual employee, and consequently wages are based on tasks rather than on the number of working hours.

Lifelong education

The development of work symbolised by telework implies that employees continuously update their qualifications. Here, it is a point that the same information and communication technology which supports distributed work can also support access to distributed training and education. As a matter of fact it may be difficult to separate work and learning, because these two activities occur side by side and through the same media.

Toward a multi-flexible knowledge-society

In order to summarise these trends a scheme can be presented which presents some of the keywords of the industrial society which we are about to leave and the information society (or, more precisely, the hypercomplex society) which we are about to enter (see Table 2).

Table 2 Key aspects of the industrial and the information society

Industrial society	Information society
Mass culture	Networking culture
Mass production and mass consumption	Individualised production and consumption
Rule-based equality	Demand for flexibility and opportunities
Wage earner life form	Flexible life form
Standardised mass production	Flexible knowledge-based production
Capital and machinery as basic resources	Knowledge as basic resource

References

Amin, A. *Post-Fordism. A Reader.* Oxford, Blackwell, 1994.

Andersen Management International. *Analyse af den potentielle udbredelse af hjemmebaseret telearbejde i Danmark.* Copenhagen, Forskningsministeriet, 1997.

Barnatt, C. *Cyber business. Mindsets for a wired age.* Chichester, Wiley, 1995.

European Commission. *Status report on European telework. Telework 1998.* Bruxelles, 1998.

Horster, D. *Niklas Luhmann.* München, Verlag C.H. Beck, 1997.

Højrup, T. *Det glemte folk. Livsformer og centraldirigering.* Hørsholm, The Danish Building Research Institute, 1983.

Højrup, T. Begrebet livsform. En form-specificerende analysemåde anvendt på nutidige vesteuropæiske samfund. In: *Fortid og Nutid*, 31, 194–218, Copenhagen 1984.

Højrup, T, Rahbek Christensen, L. Introduktion til livsformsanalysens grundbegreber. In: Rahbek Christensen, L (ed.). *Livsstykker*. Ringe, Kulturbøger, 1989, 155–168.

Luhmann, N. *Funktionen und Folgen formaler Organisation.* Berlin, 1964.

Luhmann, N. *Zweckbegriff und Systemrationalität über die Funktion von Zwecken in sozialen Systemen.* Tübingen, 1968.

Luhmann, N. Interaktion, Organisation, Gesellschaft. In: *Soziologische Aufklärung 2.* Opladen, Westdeutscher Verlag, 1975, 9–21.

Luhmann, N. *Soziale Systeme. Grundriss einer allgemeinen Theorie.* Frankfurt a.M., Suhrkamp Verlag, 1984.

Luhmann, N. Organisation. In: Küpfer, W and Ortmann, G (eds.). *Mikropolitik: Rationalität, Macht und Spiele in Organisationen.* Opladen, 1988, 165–185.

Luhmann, N. *Soziologie des Risikos.* Berlin, Walter de Gruyter, 1991.

PLS Consult A/S, Center for Tele-Information, DTU, Institut for teoretisk og anvendt informatik, Danmarks Miljøundersøgelser. *Distancearbejde og teleindkøb – konsekvenser for transporten. Transportrådet.* Notat nr. 96, 09, December 1996.

Qvortrup, L. *Det hyperkomplekse samfund. Fjorten fortællinger om informationssamfundet.* Copenhagen, Gyldendal, 1998.

Simon, H A. *Administrative behavior.* New York, The Free Press, 1997.

Storgaard, K, Jensen, O M. Information technology and ways of life. In: Cronberg, T et al. (eds.). *Danish experiments – social constructions of technology.* Copenhagen, New Social Science Monographs, 1991, 123–140.

Toffler, A. *The third wave.* New York, William Morrow and Company, 1980.

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Distributed teams and the individual:
ICTs for dealing with challenges of new work arrangements[1)]

SIGMUND AKSELSEN

Introduction

Until recently, when you said that you worked with someone, you meant by implication that you worked in the same place for the same organisation. Gradually, this has changed, people no longer must be in the same place – co-located – in order to work together. Nowadays many people work in teams that transcend distance, time zones, and organisational boundaries. And, today's trend is expected to become tomorrow's reality: ie. that most people will work in distributed teams at least for some part of their work. Further, this trend indicates that work to a higher degree will be carried out from a number of places, including: the office, at customer premises, at home, on the road, and so on.

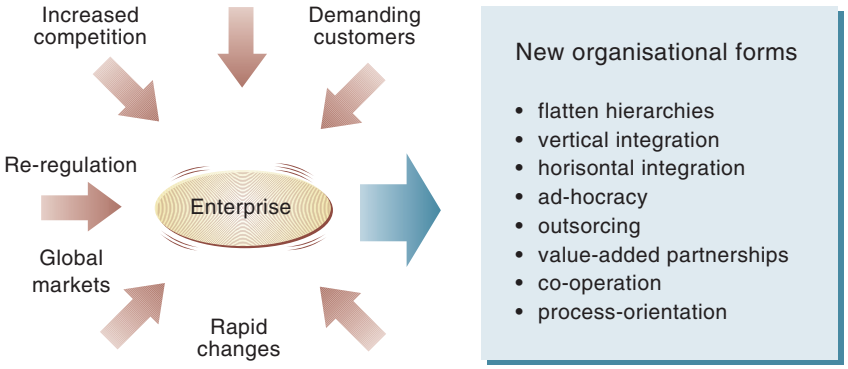


Figure 1 Forces leading to restructuring and new organisational forms [3]

This paper focuses on the challenges for enterprises and especially for the individuals involving themselves in distributed teams as part of new network-based organisation of work. First, some reasons for companies to restructure and form distributed teams are introduced. Second, some challenges that the new work arrangements pose on the organisations and the people who work in them are identified. This identification has been guided by existing research on group psychology and dynamics. The further discussion of ways in which information and communication technologies (ICTs) can meet these challenges is made from a group-perspective. Finally, some possible impacts of these technologies are related to the more general challenges posed on the employees of tomorrow's companies.

Why distributed teams have become more popular

The operating environment of organisations has changed considerably during the last three decades. Organisations face more global competition, deregulated markets, increased customer selectivity on price, quality and service, environment protection issues and rapid technological development. In response to these forces many companies are restructuring their organisations to become more flexible and dynamic [1, 2], see Figure 1.

The resulting new organisational forms have been described using a variety of terms and metaphors, eg. [2]:

- Organisations as hospitals/symphony orchestras [4];
- VAP – value added partnerships [5];
- Dynamic networks [6];
- Solar-system organisations [7];
- Meta-businesses [8];
- Adhocracies [9];
- Cluster organisations [10];
- Virtual co-operations [11];
- Overnight organisations [12];
- Type-D organisational structures [13];
- Terminator II organisations [14].

Here it should be noted that it is hard to find evidence that the changes are actually happening. The descriptions are to a large degree based upon what others have asserted, not facts.

A common feature of the organisational forms is that they often involve a creation of social networks, both within an organisation and across organisational boundaries [15, page 2]:

> *"If the old model of organization was the large hierarchical firm, the model of organisation that is considered characteristic of the New Competition is a network of lateral and horizontal interlinkages within and among firms."*

Nohria (ibid.) further argues that it is recent technological developments, specifically the integration of information and telecommunication technologies, that have made possible an entirely new set of more disaggregated, distributed, and flexible production arrangements, as well as new ways for firms to organise their internal operations and their transactional ties to external firms.

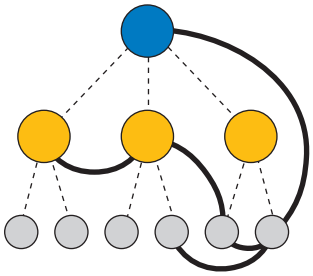
Figure 2 illustrates inter- and intraorganisational collaboration and their focus.

Teams are increasingly being established on the basis of the knowledge needed, and not necessarily on organisational or geographical location. The formation of teams and networks implies an integration across formal boundaries that can be fruitful. Inter-organisational co-operation is often motivated by a need for numerical or functional flexibility. Through partnerships it is possible for small and medium sized enterprises (SME) to compete with larger players (numerical flexibility). In addition, similar partnerships can be used to complete a product offer in order for the organisations in the partnership to face their customers as a provider of complete or total solutions (functional flexibility). Outsourcing or in-sourcing of functions seems to have gained in popularity lately.

The above discussion has dealt with the needs of enterprises for increased organisational flexibility. Parallel to this, individuals also seek flexibility to deal with their daily duties. To these individuals telework or flexible work options offer alternative approaches to getting work done through non-traditional work hours,

[1)] *This paper is based on research done within the NETTO project conducted at Telenor R&D's unit in Tromsø. For more details see http://www.tft.tele.no /netto.*

- Intra-organisationel
  - Focus on processes
  - Co-operation
  - Team



- Inter-organisational
  - Numerical/functional flexibility
  - Integration of value chains
  - Outsourcing

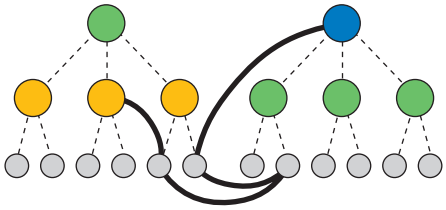


Figure 2 Networks and teams are a distinct characteristic of new organisational forms [3]

locations, and/or job structures. Flexible work options respond to significant changes at work and at home. Examples of these changes are [16]:

- Women with young children are the fastest growing segment of the workforce. Men are more involved in family and home care responsibilities. Eighty-five percent (85 %) of all workers have family care responsibilities.
- Our society is ageing. Twenty-five percent (25 %) of all workers have elder care responsibilities.
- More focus is being placed on work and personal goals and responsibilities: "people want everything – at the same time".

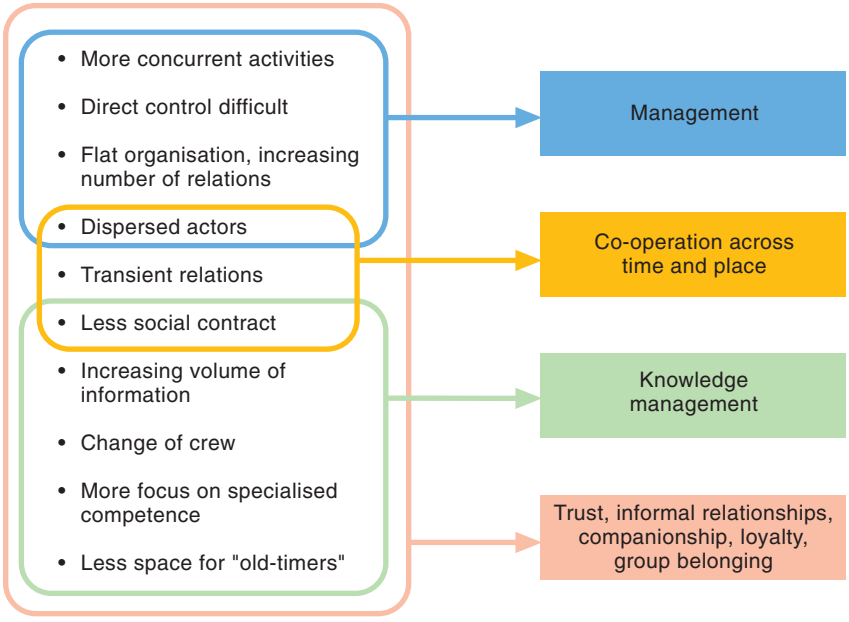


Figure 3 Challenges for companies when turning to new organisational forms [17]

An additional force driving the development of distributed teams is the increased value of the knowledgeable worker. She controls the production means (sits between her ears) and can voice her needs for flexibility with more power. Also the knowledge worker needs to feel comfortable and free to be creative, and more flexibility supports this need.

In summary, there are various forces related to both enterprises and individuals that drive a need for flexibility with concern to organisation – when and where to work. This again is leading to more people working in distributed teams.

Challenges to the enterprise

Companies that turn to network-based organisations of work will face a number of challenges, among others within the areas of co-ordination and management, co-operation, organisational memory and learning, and underlying these, the building of trust, informal relationships and companionship (see Figure 3).

These challenges arise in particular in network-based work arrangements because the organisation(s) must relate to several and shifting actors which may be both geographically and organisationally dispersed. Also, the relations are often of a temporary character. Flatter organisational structures imply broader contacts and increased amounts of information for each unit. Less daily face-to-face contact and more dynamic staffing of tasks (new 'crews' relieve old ones on milestones, outsourcing and more specialisation) make it difficult to utilise the organisations' total knowledge and experiences. Direct control is seldom feasible and this imposes therefore other demands for quality assurance and management. Network-based work arrangements finally imply a dispersion of customer relations, which challenges the organisation's ability to 'face' their customers in a uniform way.

Challenges to the individual

The challenges to the individuals are really to take the opportunities provided by an increased flexibility to improve their quality of life and to avoid the pitfalls of the flexible work options (cf. [18]).

Many workers, especially parents, emphasise better quality of life as a consequence of flexible work due to the freedom it gives them in organising the work. The possibility to work without interruptions is also commented as very positive. For some, increased leisure time due to reduced travelling is important. Flexible work options also give new possibilities to choose where to live when the spatial dimension is no longer dominant. Instead of breaking the family members' social networks by moving, the family can continue to live in the environment they find attractive even if one member of the family wants to change job.

On the other hand, the social and professional fellowship at work is important for the quality of life. A flexible worker might lose this fellowship and the feeling of isolation might occur. Another effect is that your work becomes 'invisible'. Your boss and co-workers cannot actually see your efforts when you are not visible in your office. This might give you less chance than your colleagues to be promoted [19]. Some people also have problems sorting out work and spare time and experience psychological problems due to constant bad conscience in relation to both family and work [20].

Figure 4 lays out these challenges in some detail.[2)]

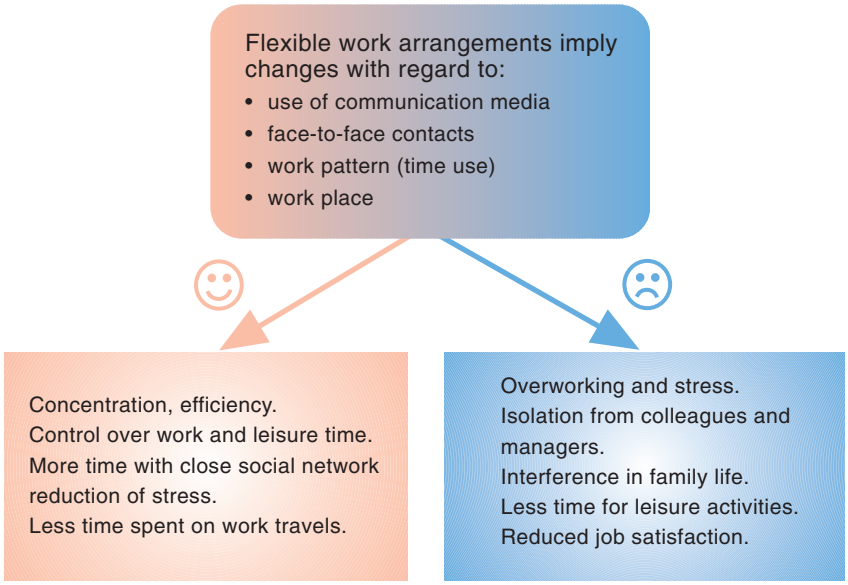


Figure 4 Opportunities and pitfalls from flexible work arrangements to the individual (adapted from [21; 22])

Challenges at the team level

Even though information technology in some sense can overcome time and space constraints on group collaborative efforts, the loss of daily co-located activities in distributed teams (eg. face-to-face conversations and the regular strolls through corridors scanning the presence, activities and availability of co-workers) often cause problems.

These problems relate to the team's overall functioning and in particular the three goals that people who work in groups within organisations must achieve to be successful [23]:

- *Production* – write reports, make decisions, construct software, allocate budgets, defend clients, ...
- *Member support* – support needs so that members feel satisfied with their work, relationships and membership in the group (point out that members are making useful contributions and that their contributions are recognised).
- *Group well-being* – recruit and socialise members, keep them happy enough so that they want to maintain membership, garner external resources, other activities to ensure the group's continuing survival ...

These goals are according to McGrath's TIP theory carried out by activities in one or another of four modes [24]: Inception of a project (goal choice), solution of technical issues (means choice), resolution of conflict (ie. of political rather than technical issues), and execution of the performance requirements of the project; see Table 1.

In distributed teams the lack of physical proximity causes problems related to all three functions. Figure 5 outlines a theory of how this lack relates to factors needed for fulfilling the three goals.

Table 1 Modes and functions of McGrath's TIP theory [24]

Modes/Functions	Production	Member support	Well-being
Inception	Project selection/assignment	Member participation choice	Group interaction choice
Problem solving	Technical problem solving	Position/status attainments	Role network definition
Conflict resolution	Policy conflict resolution	Contribution/payoff relationships	Power/payoff distribution
Execution	Performance	Participation	Interaction

[2)] *These issues are addressed in more detail in the EURESCOM project P904-PF "The impacts of telework on a sustainable social development and quality of life", see http://www.eurescom.de/Public/Projects/P900-series/p900.htm.*

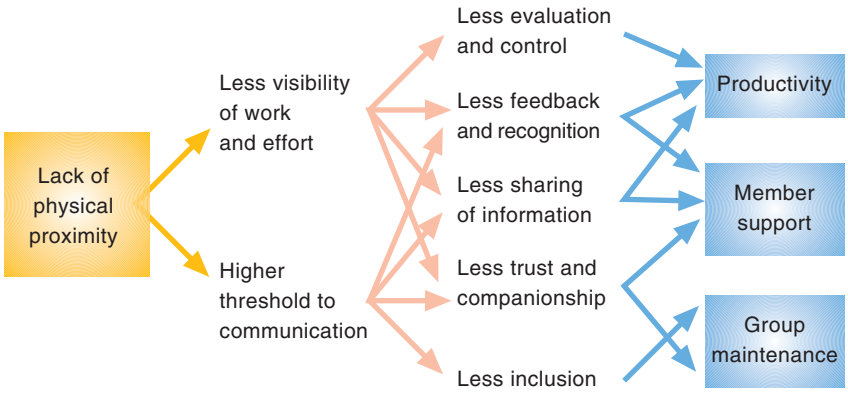


Figure 5 Some of the factors influencing on a distributed team's success and their possible relationships (further developed from [25])

Part of this theory is supported by [26] who focuses on the importance of physical proximity (a proxy for frequent and informal communication) and claims that as the opportunity for informal communication with colleagues increases, so does one's familiarity with them and their work. Thus, it is a powerful facilitator for successful working relationships and collaborations in that it allows members to: seek information from and dispense information to appropriate parties; share a similar perspective, context and working culture; and appreciate one another and the work each one does in order to maintain the working group and continue successful collaboration over time. This is also in line with [27] holding that relatively unstructured and informal communication is at the basis of social processes, such as personal perception and liking, which are the basis of group maintenance and member support.

Lippnack and Stamp [28] argue that everything that goes wrong with in-the-same-place teams also plagues distributed teams – often more so. Egos, power plays, backstabbing, hurt feelings, low confidence, poor self-esteem, leaderlessness, and lack of trust all weaken distributed teams. When communication breaks down, it requires people to take measures to repair it. It is just more difficult to communicate across distances and organisations.

Relations between members of established networks are regulated through market-oriented, organisational and social mechanisms [29]. Still, trust and inter-human obligations lie behind any relationship – formal as well as informal, and cannot be overestimated in building and maintaining networks and teams. Trust is a recurring theme in discussions about governing office presence, continuous visibility, awareness, productivity, authority and so on. An alternative focus on performance and results, contrary to the appearance, could help reconstruct the meanings of autonomy and trust in salaried professionals' employment relationships [30].

Different aspects of trust are being emphasised in different theories. In Figure 5 the term trust refers to the expectation one holds to a partner in a relation:

> *"A shared expectation that the partners' actions should be in conformance with any agreements and obligation, and that the partners in no way will act to cause oneself any harm"* [31, page 113].

Trust and loyalty are even explanation factors in discussions around why networks and distributed teams come into being. The building and maintenance of trust in an environment with limited physical proximity is an issue that needs to be studied further.

With regard to the productivity issue, an interesting phenomenon termed social loafing seems to occur in some situations. Social loafing has been described as the phenomenon in which participants who work together generate less effort than do participants who work alone [32]. Subsequent research [33, 34] has shown that a particular aspect leads to social loafing. When participants 'work together', their outputs are pooled so that evaluation of individual output is not possible and thus they can receive neither credit nor blame for their performances.

While those studies focused on how social loafing can be reduced, Bronner and Mellewigt [35] emphasised the role of individual differences in loafing. In this study, they tested whether participants with different levels of achievement motivation perform differently in a 2 (high/low achievement motivation) x 2 (high/low identifiability) factorial design. They found that participants with a high level of achievement motivation worked just as hard when their output was identifiable as when their output was pooled. However, performance of participants with a low level of achievement motivation dropped significantly. They loafed when their output was pooled. The connection to Figure 5 is that less visibility of work in distributed teams might imply less evaluation and control, and thus more social loafing.

Some of the relationships in Figure 5 have been studied through prototyping, pilot, case and longitudinal field studies by [25, 36, 37]. Results from these studies have informed the points made in the subsequent sections.

Dealing with the challenges

Observing the development of new organisational forms laid out above, a growing concern of how to deal with the changes has appeared. A common solution has been a quest for new management skills, where supervisors manage employees by results, communicate expected outcomes clearly, and control products and quality rather than time spent and processes used to achieve them [38]. We agree that new skills are required for managing distributed as compared to traditional teams. Still we argue that this is but one small step in the right direction. If management is based entirely on results, the valuable follow-up and guidance underway in the solution of a task is lost. An example of this would be the experienced and well informed manager who is able to direct her team member in some direction or to someone who has struggled with the similar problems as those the team member faces at a certain moment.

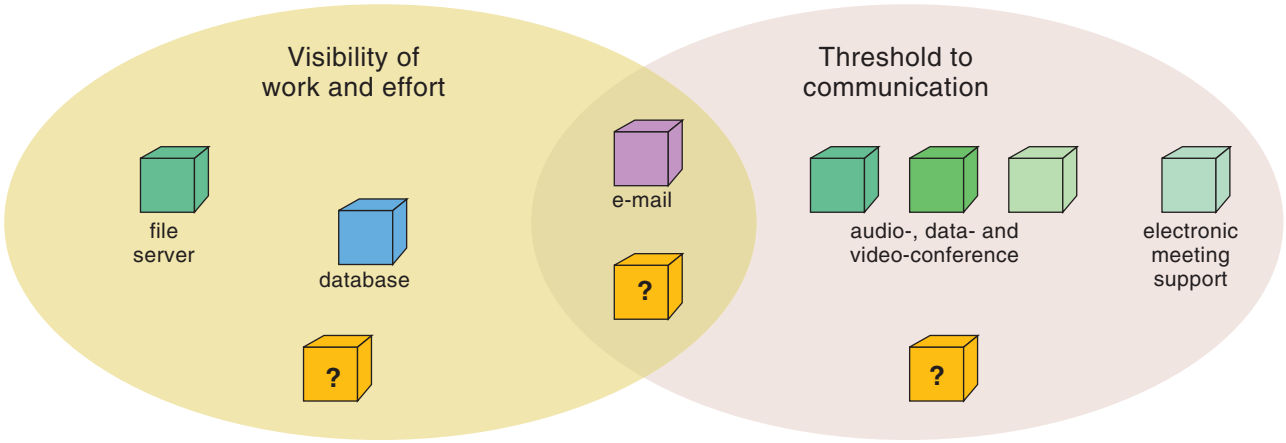


Figure 6 Technologies for dealing with the lack of physical proximity in distributed teams

For some time a number of technologies for groups have been available (Figure 6). These include shared file servers, databases (like Lotus Notes) and e-mail, which all provide some visibility of the work and efforts made by members of distributed teams. E-mail together with audio-, data- (eg. MS Netmeeting) and videoconferencing systems and, electronic meeting systems (eg. Group Systems) all can be viewed as aids to increase communication in such teams.

While all these tools are helpful, we argue that they only partly meet the root of challenges to most problems faced by distributed teams, namely the lack of physical proximity. What is needed in addition, is tools that better visualise presence, activities and results of team members, eg. through providing awareness and availability information, stimulating communication and providing a shared space for collaborative activities. These applications correspond to the question marks in Figure 6 and will be described in more detail below:

- ICT for providing awareness and availability information (what are the others doing – question mark to the right in Figure 6);
- Electronic team rooms (shared space for collaborative activities – question mark to the left in Figure 6); and
- Social agents for stimulating communication (– question mark in the middle of Figure 6).

ICT for providing awareness and availability information

The awareness of activities within a group has been recognised by the CSCW community as one of the most important components of collaborative work. Early examples of systems built to investigate this matter include among others Cruiser [39] and VideoWindow [40]. A broad definition of the term awareness has been proposed by Dourish and Bellotti [41] as *"the understanding of the activity of the others, which provides a context of your own activity"*. More specific elaboration on the concept is given by Moran and Andersson [42] who use the term peripheral awareness and address the importance of signalling availability of information and people in a way that uses the human capability to peripherally process non-attended aspects. The term social awareness has been used to refer to *"awareness about the social situation of the members, ie. awareness about what they are doing, if they are talking to someone, if they can be disturbed, etc."* [43, page 298].

The NETTO project has addressed the need for awareness information through the development of VISAM, a "virtual co-location" web-based application especially targeted at distributed product development projects in Telenor [44]. The research prototype, VISAM, provides information on team members' activities and availability. The challenge of having a shared space for collaborative activities has been addressed by integrating an existing state of the art desktop conference application and access to a shared project workspace (archive).

The basic idea is to achieve consciousness of the presence of other group members. This is the same type of consciousness that evolves during a stroll down the corridor. To dynamically indicate the presence of distributed group members, activity on their PC keyboard is monitored and conveyed to the VISAM server. Keyboard activity as an indicator should only be regarded as an example (other indicators could be included). In the VISAM client, all group members are represented by their pictures. Based on the information on keyboard activity, each picture is embedded in a frame with a colour reflecting the time since last monitored activity. The colours change through nuances of green to white as time elapses, Figure 7. In this way, a glance at the row of pictures, gives an "artificial proximity" to the rest of the group and an easily available overview of who is present and who is not; Figure 8. Unavailability can also be set manually by the members by accessing their own picture frame. This is indicated explicitly with a red icon to the other members.

The choice of representing members by their images (instead of say, a light bulb) is motivated by the idea that this would foster more "opportunistic conversations", one of four conversation categories described by [26]:

- *scheduled* – a conversation that was previously scheduled or arranged;

- *intended* – a conversation in which the initiator set out specifically to visit another party;
- *opportunistic* – one in which the initiator had planned to talk with other participants at some time and took advantage of a chance encounter to have the conversation;
- *spontaneous* – a spontaneous interaction in which the initiator had not planned to talk with other participants.

Often people feel a need to consult with a colleague, but other events or thoughts intrude and the conversation is put on hold. When the person later on comes across the colleague in the hallway (or at the computer screen), two phenomena occur: i) associative mechanisms remind of the original need and sometime even reinstall the original context; ii) simultaneous presence lower the cost of communication (one sees whether the colleague is available and has a clear channel).

Having achieved an indication of the availability of the group members, it became natural to include the possibility to communicate with the members as well. As can be seen from Figure 8, the group members are located in a 'virtual environment' including mailboxes, a telephone and a meeting table. These symbols represent existing communication applications as the company's e-mail system, the telephone network and MS NetMeeting. By selecting one or more group members and a communication medium, a communication link is established, be it the sending of an e-mail, a third party CTI call or a desktop conference.

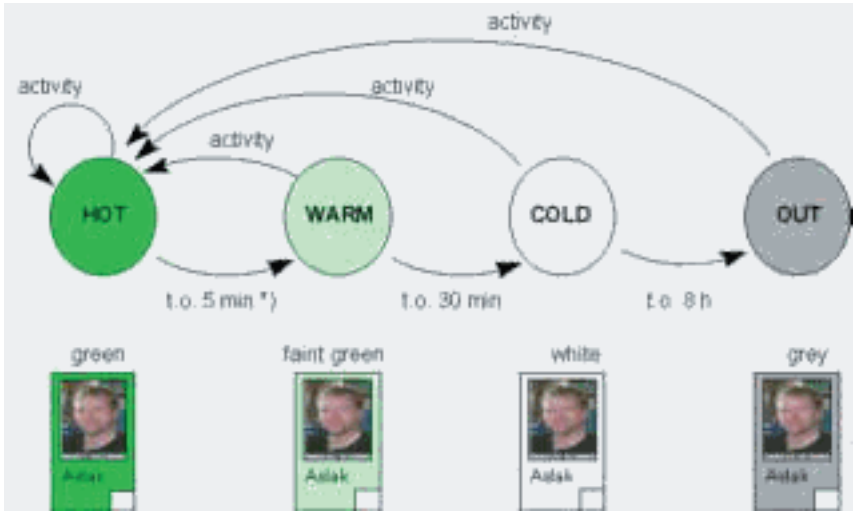


Figure 7 State transitions for presence indication [44]

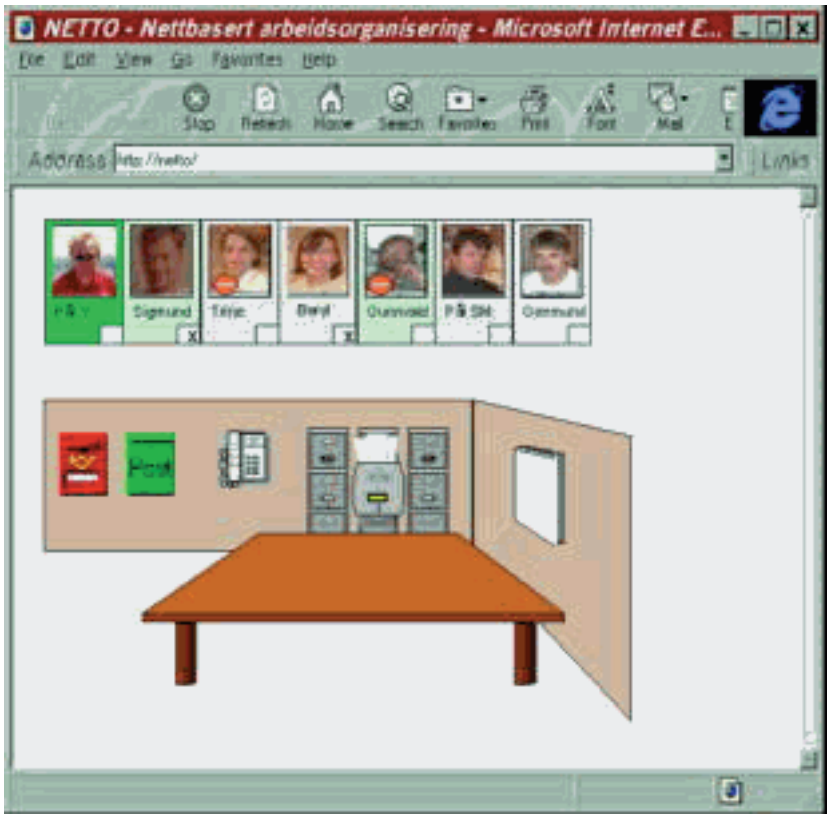


Figure 8 Screen dump of VISAM [44]

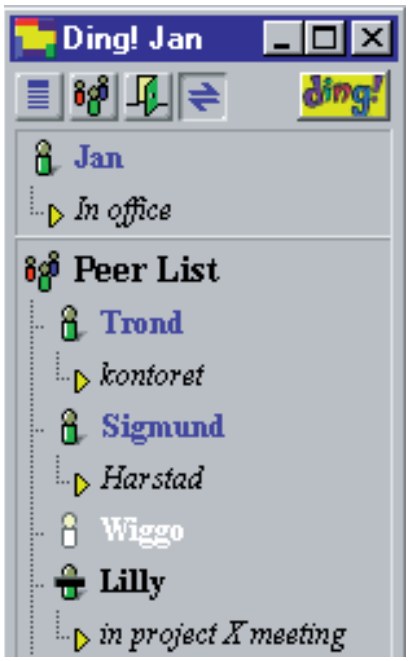


Figure 9 A snapshot of an awareness application showing Jan's Peer List with online (Trond and Sigmund), busy (Lilly) and offline (Wiggo) peers [37]

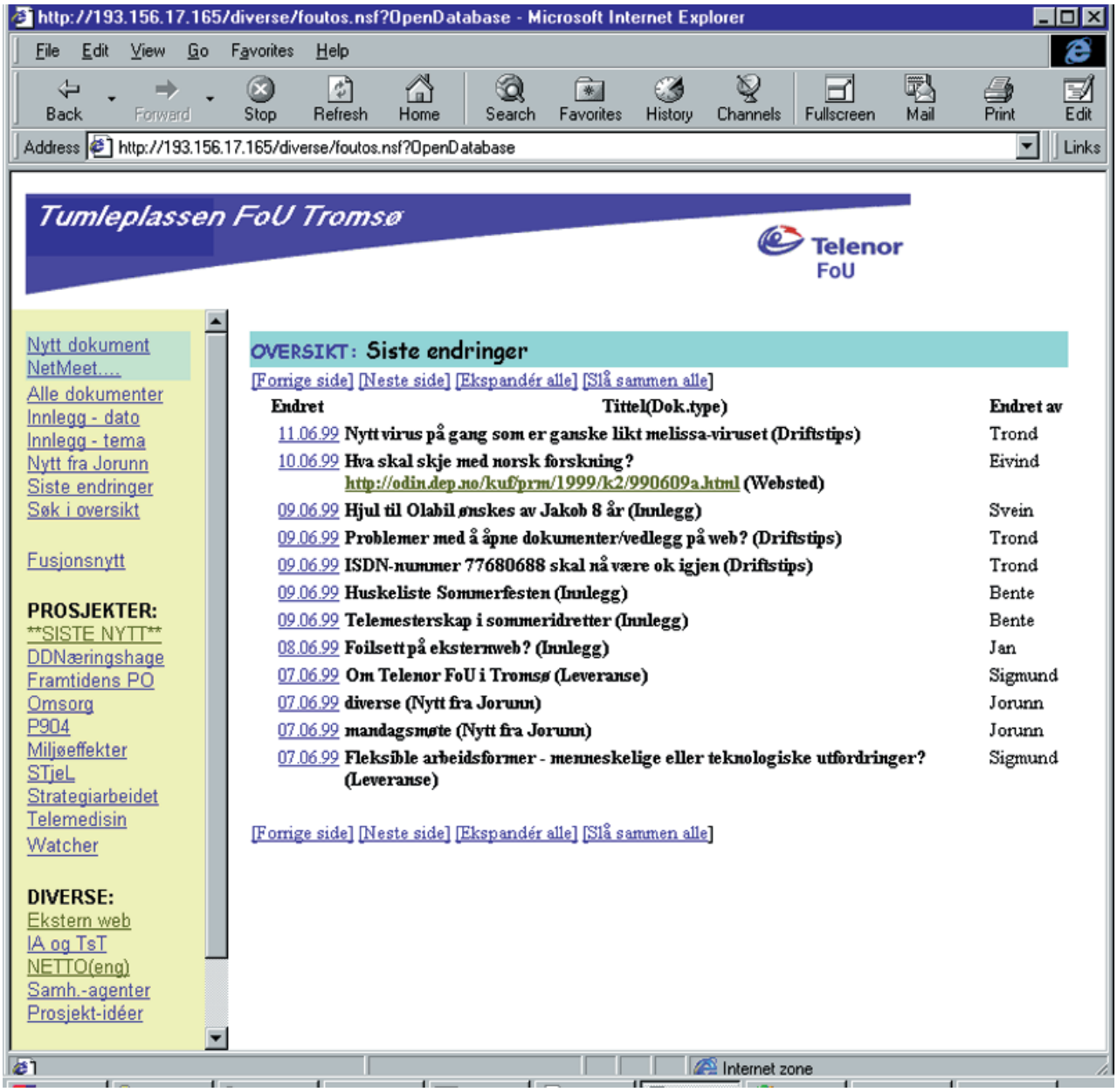


Figure 10 A snapshot from the electronic team room of the Telenor R&D unit in Tromsø counting around 25 people

A shared document archive is accessible from the VISAM interface. The archive is based on Lotus Notes/Domino and allows for web-based uploads and downloads of documents. This system also works as an arena for discussions and co-authoring and thus contributes to the shared space for collaborative activities by visualising group activity and results (see section on electronic team rooms below).

Work on the VISAM prototype was terminated as commercial software started to appear. An example of such a product is Ding! (see http://www.activerse.com/) that was used in a study of user experiences towards awareness information provided by a 'buddy-list' application [37]. In Ding! an online user creates a personal Peer List of people he/she has chosen. The list shows both online (grey Peer Icons) and disconnected peers (white Peer Icons), with the option of showing a 'doing field' of all online peers (see Figure 9).

Lessons from our studies with awareness applications are that they have come some way in design and functionality, but that there is room for improvements especially with regard to the cost of entering the information into the system, the balance between manually and automatically provided information and, the reliability of the information [37, 45].

Electronic team rooms

The need for a shared workspace can be met by providing electronic team rooms as referred to in the section above. Whereas awareness applications provide information about members' current activities, whereabouts and availability, electronic meeting rooms keep a record of what has happened (decisions made), what is going on (longer term activities) and what has been produced.

Figure 10 illustrates this kind of application through a snapshot of the Telenor R&D in Tromsø unit's electronic team room. This room is common for a unit counting around 25 people, and is used for general information and discussions, both professional and social. The navigator to the left in the figure among other things gives access to the particular projects' team rooms. A typical number of members in each project is 3–5. These project rooms include documents such as agendas, minutes of meeting, project plans, reports, discussion items, hints (links to literature, web-sites), ideas or more informal stuff that the team members wish to communicate to the rest of the group. A snapshot of the NETTO project's team room is given in Figure 11.

Bergvik [36] presents user experiences from use of the NETTO team room based on interviews of the five project participants and participatory observation. The general experiences from using these kinds of applications were positive, both as electronic archives, but also as tools supporting communication and collaboration during the working process. User participation, high quality technical support during the whole project period, mutual understanding of the use and the purpose of the application and explicit guidelines for use based on consensus are considered as critical for the positive experiences. Bergvik also carries on an interesting discussion on whether to give colleagues being external to a project access to the project room, or restricting it to project members only. A somewhat surprising finding in this connection is the potential negative effects such ICT-solutions might have with regard to the organisation, social networks and group identity, showing as fractionating, ie. appearance of strong in-/out-groups [36].

Social agents for stimulating communication

In this section we pose the question of how existing awareness applications can be improved? The simple answer is of course by providing more information about the other members' current and past activities, not restricted to the on-going project. And further, that this information should be gathered, processed and presented in a proper manner.

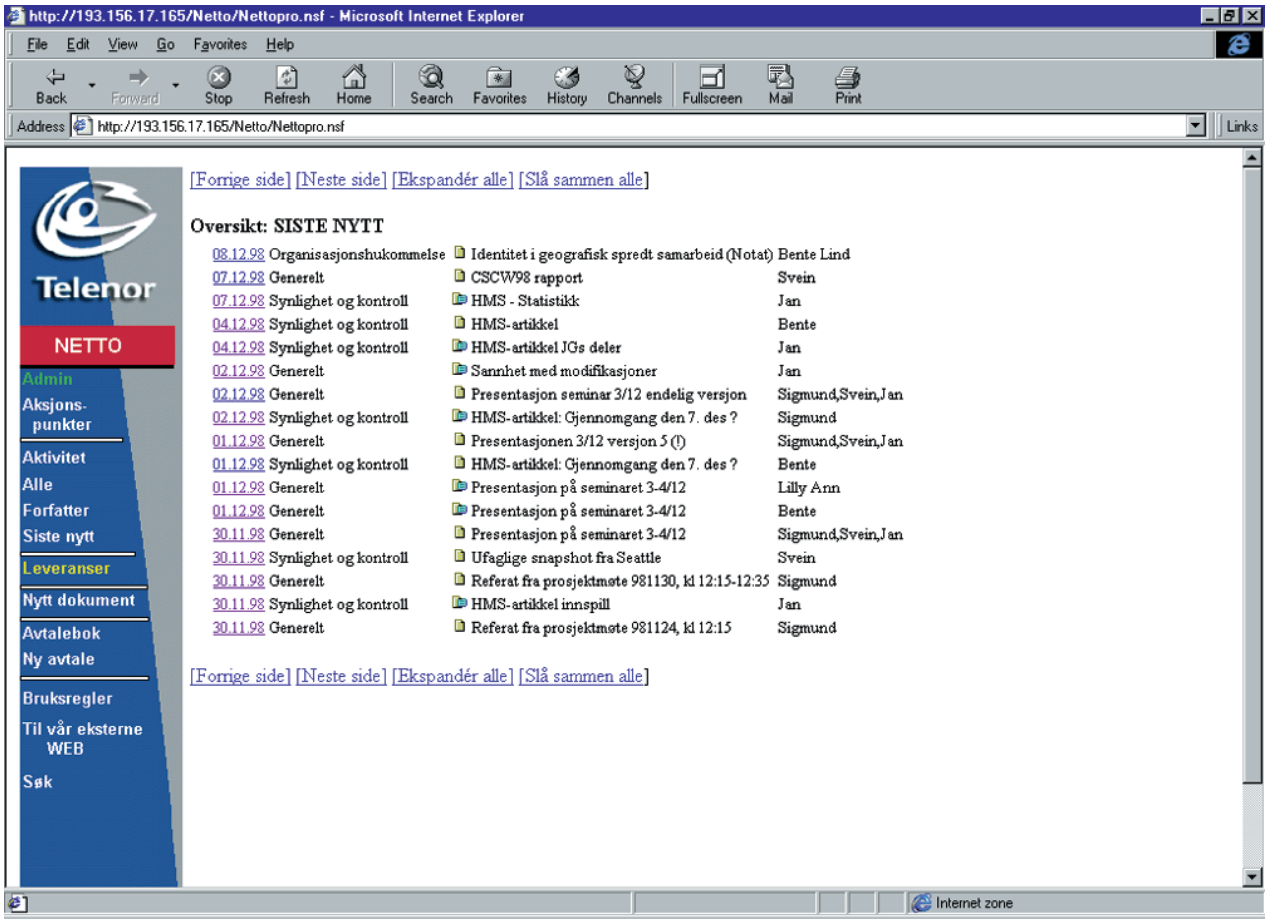


Figure 11 Electronic meeting room for the NETTO project [36]

As an example, this could be done by introducing agents that keep track of the activities of their 'owners' and in a sense serve as gatekeepers to the organisation's memory [46]. This could include categorisation of tasks to the extent that agents are able to interact on similarities in their 'owners'' tasks, and if appropriate, present this information. Typically, it could be informing a group member upon initiating a new task, that a similar set of problems already has been addressed by another person in the group. In Figure 12, agent A is informing agent B that 'owner' A may be able to provide valuable help to 'owner' B's problem.

In the distributed artificial intelligence (DAI) community a multi-agent system (MAS) has been defined as "a loosely-coupled network of problem solvers that work together to solve problems that are beyond their individual capabilities" [47]. These problem solvers, often called agents, are autonomous and may be heterogeneous in nature. MAS can include both artificial agents (software modules) and human agents (users). Moulin and Chaib-draa [48] distinguish between reactive, intentional and social agents:

- A reactive agent reacts to changes to its environment or to messages from other agents. It is not able to reason about its own intentions (goal manipulation);
- An intentional agent is able to reason about its intentions and beliefs, to create plans of actions and to execute those plans;
- A social agent possesses explicit models of other agents in addition to intentional agents' capabilities. Hence, it must be able to maintain these models (updating beliefs and plans), to reason on the knowledge incorporated in these models (intentions, commitments, expectations, anticipated reactions, and hypothetical behaviour), to make its decisions and create its plans with respect to other agent models.

The example sketched above requires the capabilities of social agents. The main questions that can be examined for the realisation of such agents include [48]: knowledge structures and knowledge maintenance, reasoning abilities, learning abilities and agent architecture.

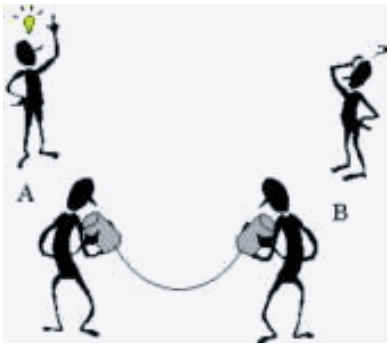


Figure 12 Agents communicating on 'owner's' activities [44]

Discussion

Based on the challenges to distributed teams identified above, and the theory of factors influencing on a team's success in Figure 5, we have presented three applications for visualising distributed team members and their presence, availability, activities and results. We argue that this visualisation is addressing the root of a lot of the problems that distributed teams experience, namely the lack of physical proximity. These applications of ICT also bring additional promises of structuring of communication, motivation, follow-up, recognition, and sharing of experiences that go beyond the 'being there' situation [49].

Problems that teams encounter are ancient in nature. Long time face-to-face exchanges inform most of our collective experience, tools, techniques and lore. Therefore, training together, not just in the tools, but the use of them for particular tasks, including providing feedback, self-presentation, and so on, is essential for building a mutual understanding and promoting successful teamwork with technology. Other aspects of the implementation of technology for distributed teams are discussed in [50, 51].

Visibility versus privacy

We would like to focus the rest of this discussion on the question of how much and what kind of awareness information should be shared among project participants. There will always be a tension between the need for privacy versus the need for awareness, availability and accessibility.

The choice of availability indicator in VISAM reflects this tension. We have suggested keyboard sensing and the opportunity to manually set availability as a starting point for investigations on the provision of awareness information. In the end, the level of monitoring will be an empirical question of how to provide valuable information without being too disclosing.

Introna [52] suggests a thought experiment to help clarify the impact of a loss of privacy on social relationships by proposing a world of absolute transparency:

> *"Imagine a world where there is a comprehensive and complete lack of privacy, complete and immediate access, complete and immediate knowledge, complete and constant observation of every individual. There would be no privacy thoughts and no private places ... What will there be to exclusively* share *since everything is always already known to every 'other'? It seems that in the transparent world notions such as getting to know someone, or being intimate with someone, or sharing yourself with someone just fade into obscurity ... From this thought experiment it is clear that all social relationships, relationships of collaboration or of competition, require at least some level of privacy."* [53, page 487–488].

This thought experiment also sheds some light on the possible limits of the provision of awareness information in teamwork. There is a limit for how much should be provided and the consequences of breaking this limit might be that the links between team members get weaker.

Summary and conclusions

The operating environment of organisations has changed considerably during the last three decades. Organisations face more global competition, deregulated markets, increased customer selectivity on price, quality and service, environment protection issues and rapid technological development. In response to these forces many companies are restructuring their organisations to become more flexible and dynamic. The resulting new forms often involve inter- and intra-organisational collaboration. We believe that we are still in the early phases of the

transformation from hierarchy-bureaucracy to networks and that distributed teams will expand as a key way to work.

This transformation puts challenges on both the enterprise, the individual and the team level. We have put forward a theory of how the success of a team is influenced by the lack of physical proximity often present in the new organisation of work (networks and distributed teams). This theory holds that the two main sources of problems caused to distributed teams are a "higher threshold to communication" and "less visibility of work and effort". We have argued that ICTs have the potential to create a kind of virtual proximity, through visualisation of presence, availability, activities and results. This argument has been exemplified by three kinds of applications:

- ICT for providing awareness and availability information (what are the others doing);
- Electronic team rooms (shared space for collaborative activities); and
- Social agents for stimulating communication.

We have indications that these applications imply positive effects on distributed teams with regard to both group belonging, the members' degree of satisfaction and the groups productivity. Today, commercially available software for providing some of this information is starting to appear (ie. awareness information given by so-called buddy-lists). The functionality of these however can be considerably improved, especially with regard to quality, precision, intrusion (automatic/manually provision) and integration with other communication software. Further, we have argued that this kind of visualisation will play an important role in the management of distributed teams (as management of distributed teams has to be based more on observation of results than observation of presence). These effects have also to some extent been confirmed in the NETTO project's studies of real groups over time. A bit surprising in this connection is the potentially negative effects such ICT-solutions might have with regard to the organisation, social networks and group identity, showing as fractionating, ie. appearance of strong in-/out-groups.

For the worker in tomorrow's organisations, awareness of issues for a team's success will be important. But, even more important will be the mastery of tools for dealing with "out of sight – out of mind" problems (eg. promotion, assignment of interesting work tasks).

We believe that the topics discussed in this paper contribute to the insight into problem areas that only to some extent have been reported before, and that our findings make a good basis for further studies. Also, the findings could be useful in the planning and implementation of network-based work arrangements in organisations that are currently in the process of restructuring their operations.

Suggestions for further studies

Based on our experiences, we list the following topics as interesting ones for further studies:

- How can ICTs support management in distributed teams?
- How to build and maintain trust in network-based work arrangements?
- How to provide awareness and availability information (functionality and form)?
- How should the tensions between privacy and the need to make work visible, inform our design and use of ICTs?
- Which (other) mechanisms for shaping the individual, the group and the organisation's identity (self-presentation/impression management), exist when part of the work takes place at electronic arenas – compared to traditional face-to-face interactions?
- In what way might the "meaning of work" change for the individual and for the organisations (cf. individuals gained control over the production means, changes in working location, project organisation, loyalty, companionship, mobility, ...)?

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References

1 Hammer, M, Champy, J. *Reengineering the corporation : a manifesto for business revolution.* New York, Harper Business, 1993.

2 Munkvold, B. *The structure of tomorrow's organization.* Kjeller, Telenor Research and Development, 1995. (R&D report R 46/95.)

3 Akselsen, S et al. *NETTbasert ArbeidsOrganisering – En presentasjon av NETTO-prosjektet.* (Network-based organization of work – A presentation of the NETTO-project.) Kjeller, Telenor Research and Development, 1997. (R&D note N 51/97.)

4 Drucker, P J. The coming of the new organization. *Harvard Business Review,* 66 (1), 45–53, 1988.

5 Johnston, R, Lawrence, P R. Beyond vertical integration – the rise of the value-added partnership. *Harvard Business Review,* Jul-Aug, 94–100, 1988.

6 Miles, R E, Snow, C C. Organizations : new concepts for new forms. *California Management Review,* 28 (3), 62–73, 1986.

7 And now, the post-industrial corporation. [Special report.] *Business Week,* 3 Mar 1986, 60–63.

8 Keen, P. *Shaping the future. Business design through information technology.* Boston, Harvard Business School Press, 1991.

9 Bennis, W G. *Changing organizations.* New York, McGraw Hill, 1966.

10 Applegate, L M, Cash J I, Mills D Q. Information technology and tomorrow's manager. *Harvard Business Review,* Nov-Dec 1988, 128–136.

11 The virtual corporation. [Cover story.] *Business Week,* 8 Feb 1993, 36–41.

12 Malone, T, Rockart, J. Computers, networks and the corporation. *Scientific American,* 265 (3), 92–99, 1991.

13 Vitalari, N P. Exploring the Type-D Organization : distributed work arrangements, information technology and organizational design. In: *Research Issues in INFORMATION SYSTEMS – an agenda for the 1990's.* A M Jenkins et al. (eds.). USA, W C Brown Publishers, 1990, 101–134.

14 The search for the organization of tomorrow. *Fortune*, 18 May 1992, 66–72.

15 Nohria, N. Is a network perspective a useful way of studying organizations? In: *Networks and Organizations : Structure, Form, and Action.* N Nohria, R G Eccles (eds.). Boston, MA, Harvard Business School Press, 1990.

16 University of Pennsylvania. *Flexible Work Options, Introductory Guide 1999.* See http://www.hr.upenn.edu/quality/flexoptions/flexguide99.htm

17 Evjemo, B et al. *IT som støttepillar i nettbasert arbeid. (Challenges related to network based organization of work – an information technology perspective.)* Kjeller, Telenor Research and Development, 1996. (R&D report R 31/96.)

18 Van Sell, M, Jacobs, S M. Telecommuting and the quality of life : a review of the literature and a model for research. *Telematics and Informatics,* 11 (2), 81–95, 1994.

19 Perin, C. Electronic social fields in bureaucracies. *Communications of the ACM,* 34 (12), 75-82, 1991.

20 Rognes, J et al. Paradoxes and some unexpected consequences in telecommuting. In: *Proceedings from Telecommuting'96,* Jacksonville, Forida, 1996. Accessible from http://www.cba.uga.edu/tc96/proceedings.html

21 Akselsen, S. Telecommunications and social sustainability. *ETNO 2nd European Conference on Telecommunication and the Environment,* Turin, 19–20 Nov 1998. Available from URL http://www.etno.be/

22 Akselsen, S et al. *Sustainability with respect to social and economic impacts of telecommunication services – implications for TelCos and suggestions for further work.* EURESCOM P802-GI, Deliverable 1, (including 7 Annexes), 1998. Confidential.

23 McGrath, J. Time Matters in Groups. In: *Intellectual Teamwork. Social and Technological Foundations of Cooperative Work.* J Galegher, R E Kraut, C Egido (eds.). Hillsdale, NJ, Lawrence Erlbaum, 1990, 23–61.

24 McGrath, J E, Hollingshead, A B. *Groups interacting with technology. Ideas, evidence, issues, and an agenda.* Thousand Oaks, CA, Sage Publications, 1994. (Sage library of social research; 194.)

25 Evjemo, B et al. *Ute av syne, ute av sinn? Erfaringer fra bruk av IT for å synliggjøre aktivitet i distribuerte grupper. (Out of sight – out of mind? Experiences from using IT to visualize activity in distributed groups.)* Kjeller, Telenor Research and Development, 1998. (R&D report R 04/98.) Available from http://www.tft.tele.no/netto

26 Kraut, R E et al. Informal communication in organizations: form, function, and technology. In: *People's Reactions to Technology.* S Oskamp, S Spacapan (eds.). Newbury Park, CA, Sage Publications, 1990, 145–199.

27 Festinger, L, Schacter, S, Back, K. *Social pressures in informal groups : a study of human factors in housing.* Stanford, CA, Stanford University Press, 1950.

28 Lippnack, J, Stamp, J. *Virtual teams.* New York, John Wiley and Sons, 1997.

29 Haugland, S, Reve, T. *Organisering og styring av bedriftssamarbeid.* [In Norwegian.] Bergen, Norsk senter for forskning i ledelse, organisasjon og styring, 1992. (LOS-senter notat 12/92.)

30 Perin, C. The moral of fabric of the office: panopticon discourse and schedule flexibilities. *Research in the Sociology of Organizations,* l, 8, 241–268, 1991.

31 Lunnan, R. *Tillit i nettverksorganisasjoner.* [In Norwegian.] Bergen, Stiftelsen for samfunns- og næringslivsforskning, 1992. (SNF-rapport 81/92.)

32 Latane, B, Williams, K, Harkins, S. Many hands make light the work : the causes and consequences of social loafing. *Journal of Personality and Social Psychology,* 37, 1979, 823–832.

33 Harkins, S, Jackson, J. The role of evaluation in eliminating social loafing. *Personality and Social Psychology Bulletin,* 11, 457–465, 1985.

34 Williams, K, Harkins, S, Latane, B. Identifiability as a deterrent to social loafing : two cheering experiments. *Journal of Personality and Social Psychology,* 40, 303–311, 1981.

35 Bronner, R, Mellewigt, T. *Social Loafing and Achievement Motivation : do high achievers loaf?* Johannes Gutenberg-Universität Mainz, Fachbereich Rechts- und Wirtschaftswissenschaften, Lehrstuhl für Allg. BWL und Organisation, 1993. (Working Paper 1993.)

36 Bergvik, S. *Elektronisk samhandlingsarena i Netto-prosjektet. (User experiences of a Notes application for supporting cooperative work in a research project.)* Kjeller, Telenor Research & Development, 1998. (R&D Note N 61/98.) Available from http://www.tft.tele.no/netto

37 Stenvold, L A, Grav, J, Bergvik, S. *User experiences of workgroup awareness information provided by a "buddy list" application.* Kjeller, Telenor Research & Development, 1999. (R&D Report R 21/99.)

38 Shirley, S, Collins E G. A company without offices. *Harvard Business Review,* 64, 127–136, 1986.

39 Root, R. Design of a Multi-media Vehicle for Social Browsing. In: *Proceedings of CSCW'88* (Portland, OR). ACM, 1988, 25–38.

40 Fish, R S, Kraut, R E, Chalfonte, B L. The VideoWindow System in Informal Communication. In: *Proceedings of CSCW'90* (Los Angeles, CA). ACM, 1990, 1–11.

41 Dourish, P, Bellotti, V. Awareness and coordination in shared workshops. In: *Proceedings from CSCW'92* (Toronto, Canada). ACM Press, 1992, 107–114.

42 Moran, T P, Andersson, R J. The Workday as a Paradigm for CSCW. In: *Proceedings from CSCW'90* (Los Angeles, California). ACM Press, 1990.

43 Tollmar, K, Sandor, O, Schömer, A. Supporting Social Awareness @Work – Design and Experience. In:

Proceedings from CSCW'96, (Cambridge, MA), 298–307. ACM, 1996.

44 Akselsen, S et al. Virtual co-location of distributed teams through social agents. *ECSCW '97 Workshop on Social Agents in Web-Based Collaboration.* Lancaster, UK, 7 Sep 1997. Available from URL http://www.tft.tele.no/netto

45 Munch-Ellingsen, A et al. *Managing awareness information in workgroups through handheld computing.* Position paper for Workshop on Handheld CSCW at CSCW'98, Seattle, 14 Nov 1998. Available from http://www.tft.tele.no/netto

46 Walsh, J, Ungson, G. Organizational Memory. *The Academy of Management Review,* 16 (1), 57–91, 1991.

47 Durfee, E H, Lesser, V R, Corkill, D D. Trends in Cooperative Distributed Problem Solving. *IEEE Transactions on Knowledge and Data Engineering,* 11 (1), 63–83, 1989.

48 Moulin, B, Chaib-draa, B. An Overview of Distributed Artificial Intelligence. In: *Foundations of Distributed Artificial Intelligence.* G M P O'Hare, M R Jennings (eds.). New York, NY, John Wiley, 1996.

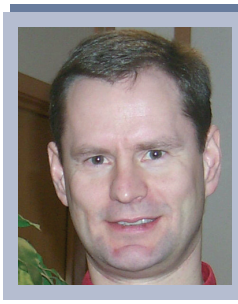
49 Hollan, J, Stornetta, S. Beyond being there. In: *Proceedings from CHI 92. ACM conference on human factors in computing systems.* Reading MA, Addison-Wesley, 1992, 119–125.

50 Munkvold, B. Challenges of IT Implementation for Supporting Collaboration in Distributed Organizations. Experiences from Four Implementation Teams. In: *Proceedings of the Fifth European Conference of Information Systems,* Cork, Ireland. Cork Publishing Ltd, 1997, 497–510.

51 Munkvold, B E. *Implementation of information technology for supporting collaboration in distributed organizations.* NTNU Trondheim, Institutt for industriell Økonomi og teknologiledelse, April 1998. (Dr. Eng. thesis 1998:40.) Press release available in Norwegian. More information about the thesis from URL http://www.krs.hia.no/~bjornem/Avhandling.htm

52 Introna, L D. *Privacy and the computer: why we need privacy in the information society.* London, London School of Economics, 1996.

53 Introna, L D, Whitley, E A. Imagine : thought experiments in information systems research. In: *Information Systems and Qualitative Research.* A Lee, J Liebenau, J DeGross (eds.). London, Chapman Hall, 1997, 481–496.



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Telework and reduction of travel: Analysis of potential in two Norwegian conurbations[1)]

TOM ERIK JULSRUD

1 Introduction

One of the most significant characteristics in the growth of the modern society has been the increased physical mobility. Trains, boats, cars, aircraft and other transport media have been decisive for this century's economic development in the western society. In the course of the last 50 years it is especially the private car which has caused the record growth in transport, see Figure 1. Access to private transport has resulted in our spending our lives more on the move than ever before. While in 1960 Norwegians travelled on average around 4 km per day in private cars, this has increased to ca. 27 km per day in 1990 (Høyer, 1996). We have, in fact, become more nomadic in our lifestyle.

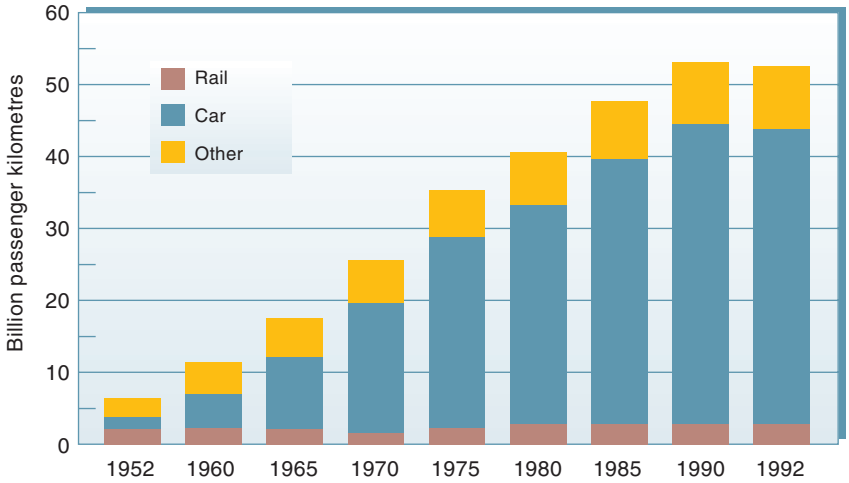

Figure 1 Private transport in Norway 1952 – 1992 (Ministry of Communication and Transportation, 1998)

The car is a powerful symbol of the growth in affluence that Norway and many other Western societies have experienced in the last 50 years. It is however also a symbol of the *ambivalence* that colours our relationship to all technical development. The car is a benefit that most of us use daily, but most of us also understand the serious disadvantages and dangers which are connected with it. In urban conurbations and towns, the increase in car traffic is a direct or indirect cause of serious health problems, traffic accidents and environmental destruction. It has been calculated that some 260,000 Norwegians are seriously affected by noise from traffic in their home environment (Ministry of Environment, 1996). On both national and global levels car traffic contributes to an increased release of pollutants such as CO^2 which contribute to increased global warming.

Telework – an action to reduce traffic

One of the most important motives for using private transport is daily travel to and from work. It is possible to roughly calculate that ca. 20 % of daily traffic is due to this sort of commuting (SOU, 1998). Approximately 60 % of daily car traffic in and out of the city of Oslo is work related travel (Hagen, 1996). The negative effects of these journeys are reenforced by their being concentrated in the mornings and evenings. Reduction in this traffic is therefore especially effective if we wish to minimize the negative effects of car traffic.

Telework has since the first half of the 1970s been held up as one of several activities to reduce this travel. The main consideration has been that if employees can communicate with their main place of work via telecommunications, they could avoid travelling to work at least one or two days per week. When we talk of reduction in travel to work the expression *telecommuting* is used instead of the umbrella expression of *teleworking*.[2)]

Telecommuting is used today as a supplemental environmental action in larger cities in the USA and Europe, where it is desirable to minimise the increasing problem of queueing at rush hour. In particular in the Dutch national transport plan there is a target set for reducing rush hour traffic by car by 5 % before 2015 (Hamer et al., 1991). In Norway the use of telecommuting is little exploited with regard to traffic, even if there is encouragement to do so in the latest statements on use of IT within Norwegian commerce.[3)] Meanwhile, no attempt has been made to measure the possible effects of telecommuting as a national traffic limitation activity.

This article aims to clarify and hypothesise the likely effects to be expected from telecommuting within a Norwegian scenario. Based on calculations of the teleworking potential in two Norwegian conurbations – Oslo and Bergen – it is argued that telecommuting could have a noticeable effect on reducing rush hour traffic, if it is combined with other types of initiative.

2 Two scenarios for teleworking in 2010

The starting point for calculations which are presented in this article is the deduction of possible consequences of teleworking increasing in scope in the course of the next 15 years. Obviously it is difficult to say what is a realistic estimate of the future development of teleworking in the future. Prognoses in this area have

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1) *The article is based on a study carried out by Telenor R&D in co-operation with the Institute of Transport Economics in Oslo (cf. Jacobsen et al., 1996).*

2) *Telecommuting can be defined as a situation where tele and data technology completely or partially replace travel to and from work (Nilles et al., 1976; Mokhtarian, 1991). Linguistically telework can be regarded as a subdivision of the more general term teleworking which covers all types of work carried out at a distance from employer or contractor, with a possible support of telecommunication technologies (cf. Di Martino et al., 1990; Huws et al., 1990; Bakke et al., 1998).*

3) *This is valid eg. for "Den norske IT-veien. Bit for bit" from the ministerial committee for IT and "Norge – en utkant i forkant. Næringsrettet IT-plan for perioden 1998–2001" from the Ministry of Trade and Industry (Communications Department, 1996; Ministry of Trade and Industry, 1998).*

changed from being very optimistic, to being more moderate and restrained in the course of the last 15 years.[4)] To illustrate two different directions for development we present here calculations within two possibilities or scenarios.

Presuppositions for the calculations

In the two scenarios there is a basic presumption that either 10 or 20 % of the workforce will be teleworkers within 15 years. By teleworking we here mean "paid work which is carried out at a distance from the office, with or without regular use of IT". In the first scenario – *teleworking as a supplement* – it is presupposed that little is done to control the development. Here we see a general growth in flexible working, but little telecommuting, ie. teleworking which replaces travel to work. In the second scenario however – *teleworking as a substitution* – it is presupposed that teleworking is used as a tool in environmental politics. Working at a distance is here more actively promoted by organisations and the statutory authorities. Teleworking will therefore be more widely used at work, including outside the central conurbations.

Within these two scenarios it is also not only the scope which is in focus, but also the composition of the different types of teleworking. This is important, for not all types of teleworking are substitutes for business travel. In this relation there is a division between the three main types:

- *Flexible working*; ie. work which occurs outside normal time and workplace, without it replacing any travel between home and workplace;
- *Telecommuting*; ie. work which occurs at home or in locations near the home, instead of at the workplace;
- *Full-time homeworking*; ie. work which is completely carried out at home instead of at the employer's premises.

To what degree telecommuting will actually develop in accordance with these principles is obviously something to be discussed. The probability of the quantitative estimates however is in this relation subordinate to trying out the effect of two possible lines of development in travel habits in the Oslo and Bergen areas.

Scenario A: Teleworking as a supplement

Up to the year 2010 there has been a strong growth in communications technologies which has made it possible to perform information based tasks with less dependence on time and place. The number of people who will use flexible time and place agreements at work will approach 50 % of those in employment. The discussion here is largely about extra work shifts in the evening and at weekends, as well as various "mobile solutions" where work is done in hotel rooms, airports and cars. Some of these people are also able to work one or two days at home – ie. telecommute – but this is not more than 7–8 % of the total.

The trend for sub-contracting will have continued in large parts of business. An overwhelming majority of part-time teleworking will be carried out by one-man businesses which have sprung out from a larger company, and who now sell services at a unit price. Almost all those who will work at home full-time are independent, and consist as a whole of 3 to 5 % of the workforce.

Flexible working meanwhile occurs within all professions which in some way or other exploit information processing in their daily work. Among the majority of those employed in industrial and service professions it will be the rule and not the exception to take work home. However there are neither laws nor general guidelines as to how employers are to conduct themselves regarding the desire to have paid work at home. Most large organisations and the civil service will be sceptical to permanent agreements in this area for ordinary employees. Among employees it will only be those with a high degree of independence at work who can choose to telecommute, that means work at home one or more days per week.

A typical telecommuter in these organisations has an education and income which lies well above the average. Most telecommuters are to be found among managers in industry and trade, within consultancy firms, higher clerical levels in private companies, university and college teachers, and not least, computer programmers. The number of working days at home will be handled differently, but more than one day a week will not be the norm.

The motivation for using telecommuting in companies will be to increase availability of employees, and to strengthen access to skills. Middle management will be expected to be available whether they are at home, on holiday or in the car. At the same time flexible access to a workforce will be achieved by hiring remote employees at busy times, or on a contract basis. Leading edge skills will be bought in from countries such as Japan, USA or Thailand. However, there will not at that stage be any motivation for making permanent remote working agreements for employees. The individual motivation for working at home will for the employee be primarily connected to the desire for peace and the opportunity to carry out tasks which require a large degree of concentration.

Most of the telecommuters, however, will be resident in the suburbs around the larger cities without too far to travel. The number of Norwegian private cars, however, will have risen to near three million, and queuing problems will be considerable at rush hour. Many are therefore thankful to avoid some journeys to work.

Scenario B: Teleworking as a substitute

Teleworking has developed into a recognised and accepted work form in large parts of the working life. This is valid both for work at home, and also for work at teleworking centres near the home. A contractual framework has been developed between the most important parties in the working life, both with a view to controlling irregular home working as well as being a possible environmental plus.

Extended telecommuting will first of all be seen in the shape of new transport patterns within city centres and associated suburbs. Traffic in cities and towns will still be high, but there will be reduced rush hour traffic. Electronic information

[4)] *Estimates of the number of employees who could use teleworking in the future however vary very much in the references. The California Transport Dept. estimated in the early 1990s that the potential was nearly half of the American workforce (Lagg, 1994). A more recent European analysis made by the reputable analysis company Empirica, is much more cautious in its calculations. Based on investigations among decision makers and employees in five European nations, the potential is estimated to lie between 17 and 21 % of the workforce (Korte et al., 1996).*

networks will be well developed, and there will be few problems connected with communicating with audio and pictures via the PC. Gradually, as parts of the workforce to a greater or lesser degree work from home, many organisations will develop into "virtual organisations", where the majority of normal work travel is gradually eliminated.

It is estimated that 18–20 % of the total workforce will telecommute by working at home, or near home, at least one day a week. In addition many will achieve "sabbaticals" at home, eg. when they have to carry out more comprehensive tasks requiring high concentration or when they wish to be near the children. Regulation of homework will have stopped much of the informal extra working at home, even though a relatively high number of flexible arrangements will still be found. The number of people only working extra in the evenings, etc. will be approx. 20 %.

Some individuals will also have chosen full-time remote working so that they can move from the city centre and live in idyllic countryside in other parts of the country. The number of people who are full-time teleworkers will nevertheless not be greater than 7–8 %. The majority of these are well paid self-employed people, even if this category also includes ordinary employees.

Within the employment market the service sector will have grown in scope parallel with the skills intensive sectors of industry. A relatively large proportion will, within these sectors, have taken up different flexible agreements in relation to the time and place for working. But even for this type of distance workers tailored agreements will be developed, so that this can be credited in the same way as other work. Within typical information based professions, such as banking, insurance, research and development, education, publishing, etc., carrying out work at home will, on the other hand, be considered an acceptable alternative. Teleworking arrangements internally to an organisation will be very common within all "independent professions", such as managers in commerce, researchers, journalists, teachers and computer programmers. But even for mid-level managers and executive officers, and some types of ordinary employees, such solutions will be widespread. This will include secretaries, data punchers, (telephone) sales people, proof readers and translators. In addition, a strong growth will be found in the number of homeworkers within the public sector, which will have come a long way in developing clear work agreements.

There will also be many who do paid work at home under short-term contracts and part-time agreements; often mothers with young children. Temporary arrangements will exist which will ensure allowances for possible financial, psychological or physical strains as a consequence of part-time homework. This will have eliminated large sections of that homework which was done without formal work contracts. Development in the direction of electronic workplaces will have paved the way for more, new information based businesses. Among the employees who work at home full-time, there will be different types of "information brokers" who buy and sell information, a large number of consultants, as well as specialised computer engineers who give technical service and software via the telenetworks.

Within both the private and the public sectors there will be active encouragement to reduce business travel, both nationally and within enterprises. Organisations who manage to channel parts of their workforce into homework agreements will be rewarded with tax advantages. Employees will regularly receive offers for homework arrangements, where they themselves are involved in setting up contractual frameworks for tasks, deadlines, milestones, etc. In addition to tax advantages, companies and organisations will be motivated by the desire to strengthen their environmental profile. The individual motivations will be directed towards achieving both a quieter working day and a greater or smaller financial advantage. The financial advantages will be direct rewards as well as reductions in travel expenses. Key aspects of the scenarios are summarised in Table 1.

Table 1 Two scenarios for the spread of teleworking in Norway, 2010 (summary)

	Telework as supplement	Telework as substitution
Percent of flexible work	50 %	20 %
Percent of telecommuting (1–2 days per week)	7 – 8 %	18 %
Percent of full time home working	3 – 5 %	7 – 8 %
Main motive	Availability, access to skills	Fewer journeys, environment
Scope, region	In central areas	In central and regional areas
Scope, professions	Private sector managers. Employees in education and research. Consultants and programmers	Private sector managers, as wells as middle management and clerical staff. Employees within education, sales, programming, media, consultancy. Large groups in the public sector

3 Transportation consequences of the scenarios

The scenarios sketched above point to largely different development paths for teleworking in Norway. In one scenario the number of people with workplace flexibility increases a lot, but little is done to establish permanent contractual and organisational frameworks around the activity. In the second scenario, however, much of the distance work in the organisations is aimed at reducing business travels. The percentage working at home full-time is here relatively larger. The question is then, what consequences might each of these scenarios have with regard to reducing travelling. In this section is presented a general model for calculating the scope of teleworking, based on the structure of professions and travel patterns. The model is then applied to the two Norwegian conurbations of Oslo and Bergen.

The two regions

The Oslo region is the most populous area in Norway with a population of about 950,000. Bergen, which is Norway's second largest city, has an esti-

Table 2 Inhabitants of Oslo and Bergen by area

	Oslo region		Bergen region	
	Inhabitants	Employed	Inhabitants	Employed
City centre	461,000	190,000	213,000	78,000
Local area	266,000	114,000	51,000	18,000
Remote area	231,000	86,000	34,000	10,000
Total	958,000	390,000	298,000	106,000

mated population of ca. 300,000, including the peripheral boroughs. In order to calculate telecommuting the peripheral boroughs are divided into two categories, based on the distance from the city centre, one under 30 kilometers (local area) and one over 30 kilometers (remote area), see Table 2.

In the Oslo area the peripheral boroughs represent a much greater percentage of the population than in the Bergen area, where the Bergen borough itself is dominant, as is seen in Table 2. The number of employed is also greater in the Oslo area with a total of 390,000, while for the Bergen area it is about 106,000.

Short description of model

The basic presuppositions for analyses of the potential for teleworking are first built on the fact that the future spread of teleworking in an area will be dependent on the population's *professional structure*.[5)] The basis for this estimate is that teleworking will be most suitable for certain professions rather than others. This will however vary within the two scenarios described. Secondly, there is a basic presumption that *travelling time between home and job* will affect the motives for teleworking. It is anticipated that the interest for homeworking will increase with the length of the journey. This will however also vary with the scenarios.

This enables us to develop indices for potential teleworking in different city areas, based on the two scenarios. The presuppositions for the individual professional categories are however estimated such that the total scope of teleworking will be 10 % in the supplement scenario and 20 % in the substitute scenario.

Indices in Table 3 show to what degree *professional structure* will steer the teleworking percentage higher or lower than the calculated mean for the scenarios. It is possible to see from the table that the teleworking share is highest within the technical professions, knowledge and culture areas.

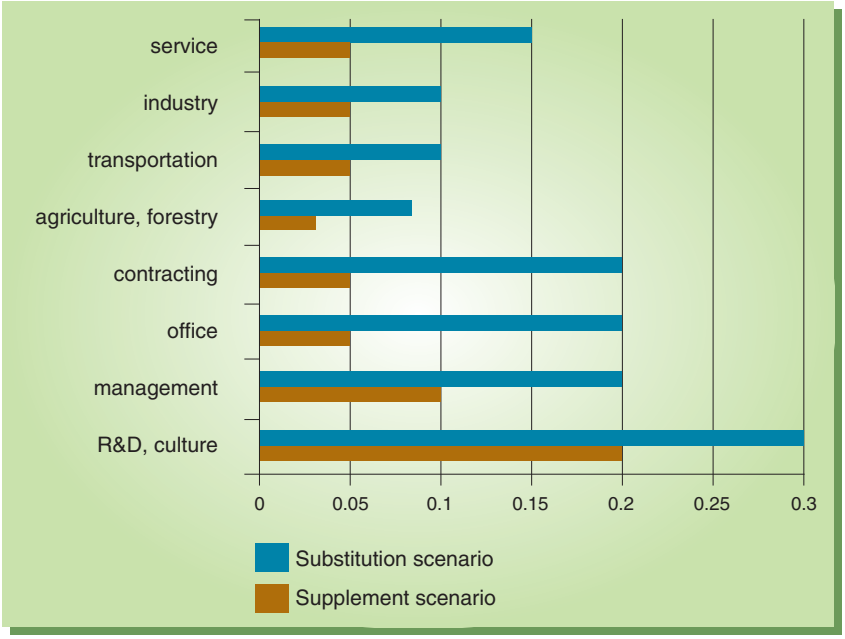
For the employed within trade and commerce the estimated number of teleworkers is higher in the substitute scenario than in the supplement scenario. As far as travelling times are concerned, it is assumed in the substitute scenario that the percentage of teleworkers rises steeply with increasing travelling time, see Table 4. The reason is that this alternative assumes the use of transport policies that mean that travelling is more costly or takes a longer time. The presuppositions for the individual categories are also here estimated such that the total scope of teleworking will be 10 % for the supplement scenario and 20 % in the substitute scenario respectively.

Based on the profession index and travel calculations a final estimate for the teleworking share in the individual boroughs can be made. This is shown in Table 5.

The calculations show that there will be little difference in teleworking between the zones. There will also be little difference between scenarios related to distance profile. The relatively small differences are due to the fact that the professional and travelling time calculations pull in different directions. For both scenarios the calculations give little variation between boroughs with regard to the percentage of distance workers in the population.

If we start from *professional structure* and combine this with the presuppositions in Table 3, it is reasonable to assume that teleworking will be most widespread in the more central boroughs. This is related to the fact that the highest education level amongst the employed is found here. If we begin from the *travel distance* (measured in time) it will be

Table 3 Presuppositions for percentage of teleworkers by profession and scenario



[5)] *The professional structure for the Oslo and Bergen regions are found in "The population and housing census" (SSB 1992).*

Table 4 Presuppositions for teleworking percentages for two scenarios, by travel time

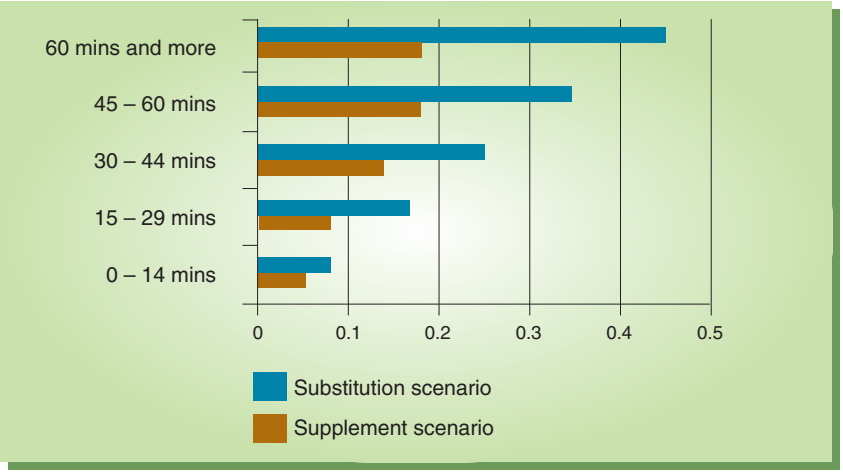
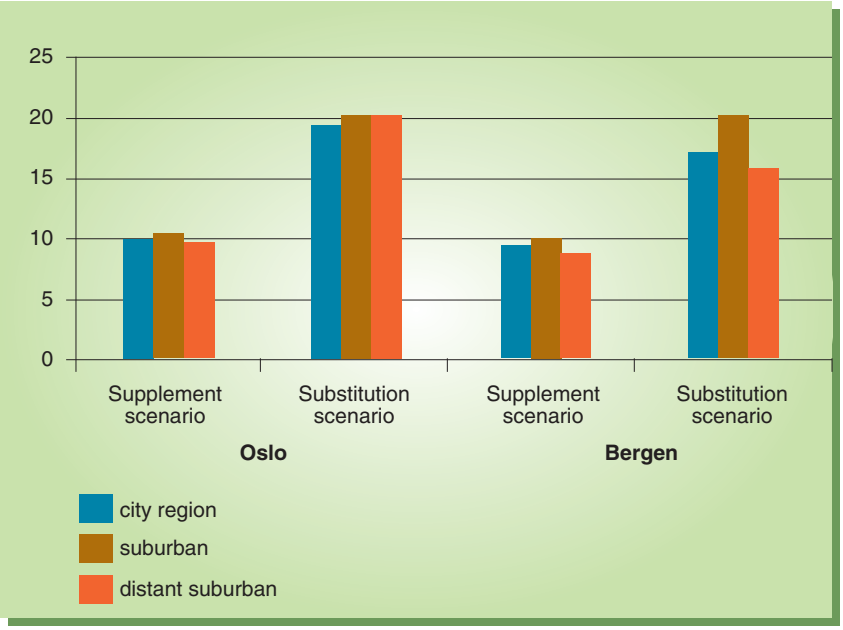


Table 5 Distribution of teleworkers in the zones, by scenario. Percentage of workforce



reasonable from the presuppositions to expect that teleworking will be most widespread in the peripheral zones, which is the opposite effect to what the calculations show. A slight calculated tendency can indeed be traced in the Oslo area that teleworking increases with distance in the substitute scenario, but the main impression even so is that there is very little difference between boroughs in the calculated teleworking percentage.

Since the majority of employees live in the central borough or in the local zone, and there is very little variation between zones with regard to the teleworking percentage, this means that the majority of distance workers live relatively central in the regions. This is especially the case for Bergen, where the central borough contains a large percentage of employees. The Oslo area moreover has a potential for teleworking which is four times greater.

Opportunities for transport reductions

There is a total of some 200,000 drivers in the study area, of which about 45,000 are in the Bergen region. According to the calculations, a considerable part of these will start teleworking. In the substitute scenario there will be a reduction of around 30,000 drivers, against 13,000 in the supplement scenario. The calculated reduction in car use however will be no greater than 15 % in the substitute scenario, which has 20 % telecommuting. This is due to the car use percentage being lowest in the travelling time categories which have the highest percentage of telecommuting, ie. among those with long journeys to work.

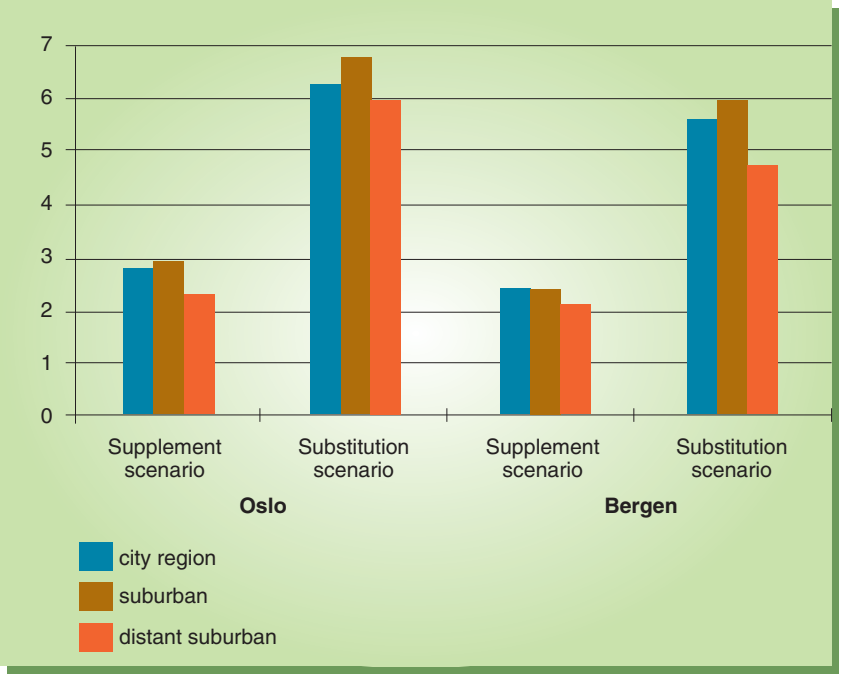
As displayed in Table 6 the calculations show a reduction in travel to work of 3 to 6 %, measured in number of car journeys. Out of this, the saving connected with full-time teleworking is almost half (30 % of car drivers, 47 % of saved car journeys). The decrease may perhaps seem small, but in peak rush hour a 3 to 6 % reduction plus greater flexibility regarding the timing of journeys, can mean much both for travelling comfort, exhaust fumes and noise.

There is a reservation in that the calculations are based on the pattern of journeys around 1990. In the years up to 1990 there was a clear trend, at any rate in Oslo, that jobs were moved out of the centre. The percentage who work in the centre and inner city has been reduced from 72 to 62 in the course of the 13 year period from 1977 to 1990. This points to the possibility that even more people will use a car to and from work.

4 Teleworking as a tool for environmental politics

The results in this article have shown that under certain conditions there is a potential for teleworking or telecommuting in the two Norwegian conurbations of Oslo and Bergen. The calculations which have been made are relatively simple, based on the situation at the beginning of the 1990s regarding structure of journeys to work and professions in the population. In the most optimistic scenario, based on organizational and political efforts to reduce commuting trips with ICT, the reductions reach 6 %.

Table 6 Reduction in total car journeys in the regions, by scenario and zone (percent)



Will this work in practice?

The fact that telecommuting can have an effect on rush hour car traffic is in agreement with a series of research projects carried out in the USA and the Netherlands in the course of the last 15 years. A pilot project with telecommuting, carried out in South California in the late 1980s, has indicated reductions in the number of journeys to work of between 10 and 40 % (Kitamura et al., 1990; Pendyala et al., 1991; Mokhtarian et al., 1995). Two Dutch pilot projects reported reductions in commuting journeys of 15 %. These results were based on the employees being able to work at home 1–3 days per week (Hamer et al., 1991; 1992). In relation to these studies reductions of 3 and 6 % are modest figures.

However, this must be seen in relation to the fact that our data is concerned with two larger regions, not selected organisations or divisions. Many of the quoted studies have been criticised just because they are based on findings from individual innovative organisations, which are not very representative for other commercial companies and organisations (Mokhtarian et al., 1995). Even so, it must be stressed that the material in this article is based on a purely theoretical probability analysis, not a real empirical trial.

The focus for our analysis has been *reductions* in travel to work. It ought to be mentioned however that an increase in flexible workstyles in itself could have a positive effect on traffic in the sense that it contributes to spreading the travel pattern throughout the day, and thereby reduces queuing. This effect will come in addition to the mentioned reductions.

Conditions which reduce the potential

Reductions of 3–6 % of car journeys can be felt as considerable. At the same time there are signs in our material that the success in terms of transport reduction to a degree is "eaten up" by opportunities and motives pulling in different directions. Many of those who had professions which were suitable, lived in the central zones and could not therefore be expected to be motivated by a long journey to work. Many of the commuters who in fact *had* a long journey, did not work within the most relevant trades, or they did not use the car for transport. The need to telecommute and the possibilities to do it, appear therefore to work in *opposite directions*, something which made the revealed transport reductions smaller.

The reductions could also have been considerably *larger* if this effect had not been present. This finding is to a small degree visible in other studies, and can be a trait of the Norwegian regions, which should be made clear. It is however likely that this is an effect which will have less influence as gradually larger numbers of the population work within "information based" professions. The actual professional structure is expected to be more "friendly to teleworking" in 2015 than it was before 1991 (Salomon et al., 1995).

However it must here be stated that the model has obvious weaknesses with regard to calculations of distance workers' expected motives for teleworking or telecommuting. In reality there will be many motives which underlie a wish to work at a distance, not just a long journey or your profession. For example, access to relevant work locally, petrol prices, or nursery school availability will be elements which are involved. This indicates that the material in this study should be regarded as directional. Within individual newer studies, important theoretical preparations are directed to mapping individual motives which control telecommuting. (cf. Mannering et al., 1995). In the long term it is desirable to make more detailed studies of the Norwegian teleworking potential, based on this type of model.

5 Conclusion: Environmental wins with teleworking

Several conditions speak for a realisation of telecommuting, and in this respect especially homeworking. The interest for working at home, or near it, is generally high in Norway, as in most of the other European countries.[6)] The spread of technologies such as PC, mobile telephony and ISDN are also high in Norwegian homes[7)] and many companies and public institutions have signalled an interest in offering a home office to their employees on a larger scale. Unfortunately, it is also a fact that the disadvantages of an increasing car usage in cities and towns is gradually more obvious. In the Norwegian government's policy plan for an improved environment several actions have been signalled for reducing noise and air pollution in cities and local areas (Ministry of the Environment, 1996). The target results are that both air

quality and noise problems *"shall be markedly better by 2005 in relation to 1994"*. These are factors which argue that telecommuting can and should be more widespread than it is today.

Viewed in total, however, it cannot be expected that telecommuting in the future will have anything but a damping effect on car traffic around the larger cities. The total number of car journeys is still increasing, and this will certainly continue in the next years. In addition comes the fact that telecommuting, as we have seen, is dependent on the individual motivation coinciding with the actual possibilities. This can hamper the growth. The win with telecommuting lies therefore truly in that it can help to *damp down the growth in car use*, as well as solve queueing in the course of rush hour.

In order to succeed in taking up telecommuting to reduce traffic, this ought really to be considered in conjunction with other types of traffic damping actions, as for example the use of toll barriers, general charges, and parking regulations. In relation to such actions telecommuting could represent a positive alternative, which is also relatively simple to set up. How *great* the reductions can be will in turn to a large degree depend on the initiatives directed from organisations and legislative authorities. Here it is still possible to control development in the direction of "substitution before supplement".

6 References

Bakke, J W et al. 1998. *Håndbok i fjernarbeid*. Oslo, Arbeidsmiljøforlaget.

Di Martino, V, Wirth, L. 1990. Telework: A new way of working and living. *International Labour review,* 5 (129).

Hagen, K-E. 1996. *Nytteberegninger av tiltak i miljøforbedret trafikkplan for Oslo.* Oslo, Transportøkonomisk institutt. (TØI-notat nr. 1039/96.)

Hamer, R, Kroes, E, van Oostroom, H. 1991. Teleworking in Netherlands: an evaluation of changes in travel behaviour. *Transportation*, 18, 365–382.

Hamer, R, Kroes, E, van Oostroom, H V. 1992. *Teleworking in Netherlands: An evaluation of changes in travel behavior – further results.* (Transportation Research Record 1357.)

Huws, U, Korte, W B, Robinson, S. 1990. *Telework. Towards the elusive office.* West Sussex, John Wiley.

Høyer, K G. 1996. Bærekraftig mobilitet. *Prosus*, 4, 5–13.

Jacobsen Steen, J K, Julsrud, T E, Lian J I. 1996. *Fjernarbeid og potensial for reduksjon i arbeidsreiser. Scenarioer for fjernarbeid i storbyene Oslo og Bergen.* Transportøkonomisk institutt & Telenor FoU. (TØI notat 1024/1996).

Kitamura, R et al. 1990. *Telecommuting as a transportation planning measure: Initial results of California Pilot Project.* Washington DC, Transportation Research Board, National Research Council. (Transportation research record 1285.)

Korte, W B, Wynne, R. 1996. *Telework. Penetration, potential and practice in Europe.* Amsterdam, IOS Press/Ohmsha.

Lagg, A. 1994. *Med distans till jobbet – distansarbete i USA. (*Utlandrapport från sveriges tekniska attacheer. USA9404.)

Lødemel, T. 1996. *Arbeidstidsundersøkelse FAFO/Opinion – en kortversjon.* Oslo, Næringslivets Hovedorganisasjon. (Arbeidsnotat nr. 2/96.)

Mannering, J S, Mokhtarian, P. 1995. Modelling the choice of telecommuting frequency in California: An exploratory analysis. *Technological Forecasting and Social Change,* 49, 49–73.

Ministry of Communication and Transportation. 1998. *Miljøhandlingsplan for samferdselssektoren.* Oslo.

Ministry of Environment. 1997. *Miljøvernpolitikk for en bærekraftig utvikling – Dugnad for framtida.* Oslo. (St.meld.; 58 (1996–97).)

Ministry of Trade and Industry. 1998. *Norge – en utkant i forkant: Næringsrettet IT-plan 1998–2001.* Oslo, Nærings- og handelsdepartementet.

Mokhtarian, P. 1991. Telecommuting and travel: state of the practice, state of the art. *Transportation*, 18, 319–342.

Mokhtarian, P, Handy, S, Salomon, I. 1995. Methodological issues in the estimation of the travel, energy, and air quality impacts of telecommuting. *Transportation Research,* 29A, (4), 282–302.

Nilles, J et al. 1976. *The telecommunications-transportation tradeoff.* New York, Wiley.

Nilles, J. 1991. Telecommuting and urban sprawl: mitigator or inciter? *Transportation*, 18, 411–432.

Pendyala, R M, Konstandinos, G G, Kitamura, R. 1991. Impact of telecommuting on spatial and temporal patterns of household travel. *Transportation*, 18, 383–409.

Salomon, R. 1995. *Arbeidsliv mot år 2010.* Paper til den 18. nordiske sosiologkongress, Helsinki, AFI 1995.

Statistisk Sentralbyrå. 1992. *Folke- og boligtellingen 1990.*

Sveriges Offentliga Utredninger. 1998. *Distansarbete*. Stockholm. (SOU1998: 115.)

6) *Studies indicate that roughly a third of Norwegian employees would like to work at home some days each week (Lødemel, 1996).*

7) *Today about 58 % of the Norwegian population have access to a PC at home (Data from Gallups Intertrack, 1998–99).*

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Epilogue – “Confessions of a would-be homeworker”

LARS HELLJESEN

Introduction

Being an avid gadget freak, but also a rather conservative sceptic concerning changes to my work-life, I was asked by the editor to write an epilog to the more scientific contributions to this issue of *Telektronikk*.

Instinctly assuming that the bias of this issue would be a collection of overtly optimistic theory based tributes to the gospel of the so-called flexible work-organisation, I said yes, thinking that a couple of more concrete examples describing the challenges of putting theories into practice, would not go amiss.

As it turns out I was wrong about the bias of the issue; it seems to me that all the contributors have delivered well-balanced articles concerning the different aspects of teleworking. So, dear readers, please view my contribution as a well-meant and somewhat humorous observation from a man willing to try, but as yet unable to succeed, in the wonderful world of homework.

Background

I am a geographer who has been working at Telenor Research and Development since 1991. The department to which I belong is called “Future Users”, a research unit consisting mainly of social scientists such as sociologists and psychologists, in addition to a couple of engineers and a domesticated physicist. One of our research areas is to look into social implications of new technology, and one of the areas is therefore implications of teleworking. We find that it is important to try out new ideas on ourselves, before putting new solutions on to the market. So, in 1998, when we were offered the possibility of trying out the latest fad in workplace organisation, open solutions instead of cell-like offices, we said yes. We accepted the challenge on one condition: that the company installed ample equipment for doing concentration work at home, thus the “Future Users” staff became a pilot in the area of homeworking, and we started researching our own experiences.

Figure 1 A typical situation for a homeworker?

ISDN and a Pentium PC along with the appropriate equipment for connecting to the workplace servers have now been installed in the homes of one group.

And it works! The technology works fine (well, most of the time), and the installed software seems to give us the adequate backbone for doing most of our work from home. So, as they say in the world of IT-based learning, two out of three prerequisites for successful implementation are met: the “technological” part and the “pedagogical” part. The third prerequisite is of course the “organisational” part, and in this area I have a confession to make: I have failed. I have failed because I have a small child with limited time in the nursery, and a well-developed sense of making a mess out of most things while he is generally having a good time.

The following describes a “normal” day for at least this homeworking parent.

A true scenario

So here I am, eager to try out the flexible, pro-active, modern family-man wonder of being a homeworker. ISDN-lines are installed and tested, my IBM ThinkPad is filled with the appropriate software, the line-up of today’s work is structured and well defined, and I am ready to go.

After a few false starts I manage to get in contact with the correct server located at my workplace. I find my personal folder, and double-click on the document I started yesterday, but never finished. After a couple of words “trouble” sets in; my three year old son comes running yelling: “Daddy, Daddy! Are you using the computer? Me too, me too! Where is my letter? Are there any pictures of Postman Pat?” In other words, time for the first pause of the day.

Having shown the boy “his” letter, assuring him that there are no Postman Pat pictures on the computer, and explaining that Daddy would like to be alone at the computer while the hopeful one views a couple of Postman Pat videos in the living room, I resume working on the document. Of course I have by now completely forgotten all the fantastically intelligent formulations I made up in my head just a couple of minutes ago.

When this repeats itself for the third time, one begins to wonder if the notion

of homework may not be such a good idea after all.

But of course it is. It is perfect not having to drive the 15 miles to my workplace after having spent most of the day in meetings in Oslo. Instead I go home, check my mail, make phone calls, and do most of the ordinary work from home. The problem is the more "serious" concentration work, for which working at home is no option for me. It just seems to be too much of a challenge to be a research scientist and an active, positive and forgiving father at the same time.

So for this reason, I have occupied a "cave" at work (ie. a standard office with a door). I work days, my wife work evenings and we take turns looking after the boy. Of course not an ideal situation, but at least some of the work gets done!

Conclusions

The pros and cons of teleworking and homeworking have been discussed in detail in this issue. In my small contribution I have tried to raise some awareness of the challenges of putting theories to practice. The conflicts that may emerge in shifting work from the workplace to the home should not be underestimated, and it is important that these issues are taken into account before just deciding to be a homeworker.

For me personally, the different roles concerning private and professional life have set distinct limitations to my experiences as a homeworker. You see, I really love my family, and I really love my work. It just seems to be a little too much love at the same time!

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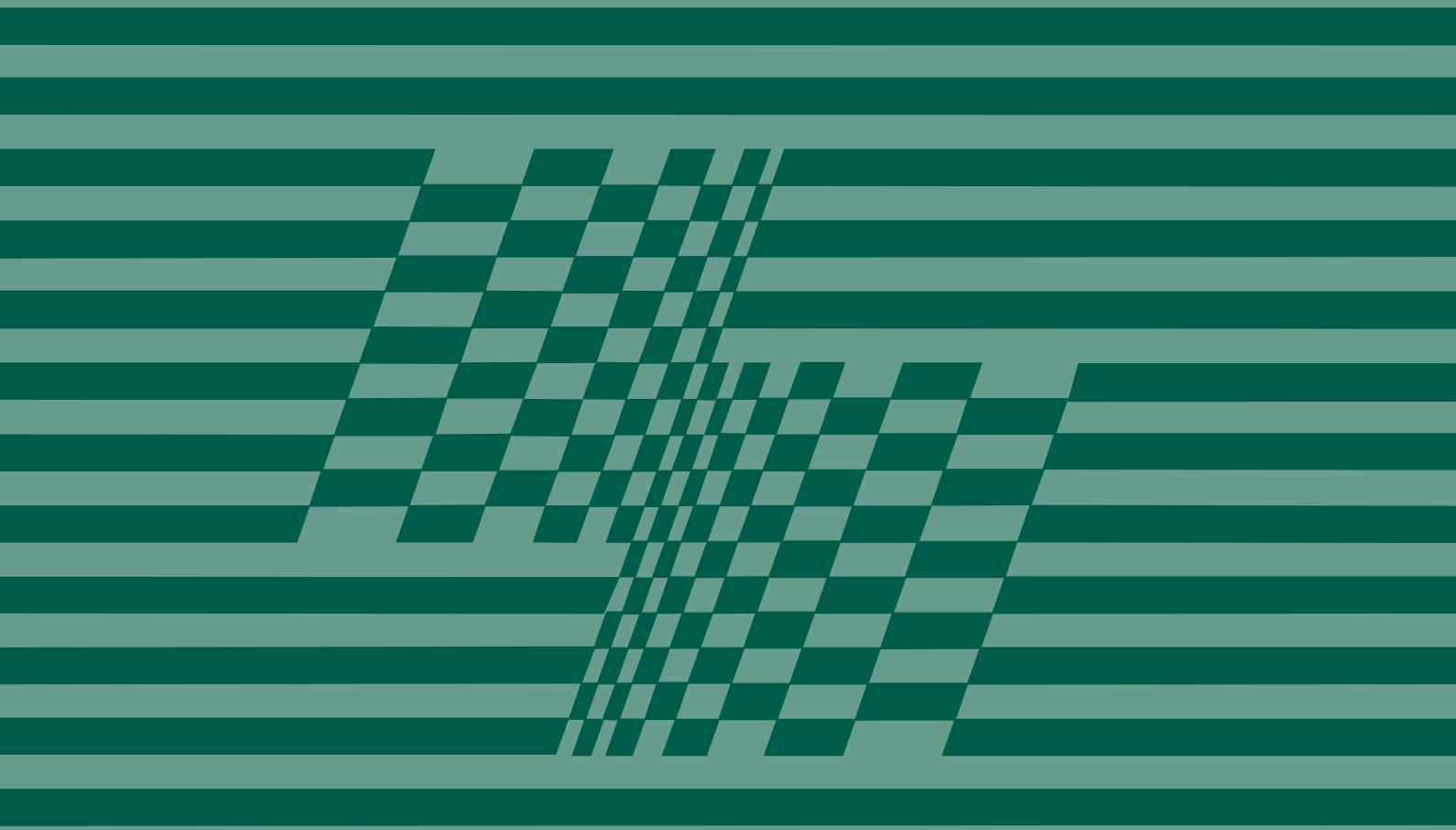
Special



IN and IP telephony interworking

BONING FENG

This paper is a summary of the studies of IN/IP telephony interworking, which is a part of the DISIPLIN (Distributed Service Platform for IN) project running at Telenor R&D in 1998. It gives a short introduction of IP telephony, followed by an overview of ongoing activities on IN/IP telephony interworking. It also gives some suggestions to future work.

1 Introduction

IP telephony (or VoIP, Voice-over-IP) is an emerging new service. From being seen as a hobbyist activity for Internet enthusiasts talking to their friends via the computer, IP telephony has become a competing method of voice transmission for all telephony users. It is now one of the fastest-growing areas in the telecom industry. Many analysts regard IP telephony as set to transform the way in which operators conduct their business. However, IP telephony is still at an early stage in its development and it is not yet clear how much of an impact it will ultimately have.

"Start shipping voice traffic over the data network – and stop paying phone bills." That is the message of IP telephony. Currently, the main market drive is not technological innovation; it is cost. For customers IP telephony can gain big savings, especially on long-distance and international calls. Those who stand to suffer are providers of circuit-switched voice. Consultancy Phillips Tarifica Ltd. (London) estimates that AT&T will lose $620 million to $950 million in international calls by 2001 because of IP telephony [1]. We believe that other providers (such as Telenor) also will face a similar challenge.

One of the advantages of IP telephony is that it makes more efficient use of backbone, by applying packet header compression, silence suppression, and advanced compression. It is claimed that IP telephony needs only 10 % of the capacity compared to PSTN telephony.

The longer-term strategic value of IP telephony is that it opens the door for integration of voice, video, and data on a single IP-based network, and it can potentially reduce the cost of network equipment, operations, and management. It may even lay the foundation for new types of communication services.

In Norway Telenor Nextel offers IP telephony services in co-operation with Delta Three. Customers send calls direct to a gateway operated by Telenor Nextel, before Telenor Nextel and Delta Three route the calls to the destinations.

In our study, we focus on the role of IN services in an IP-telephony environment. We want to investigate how Internet and the rich edge-based capabilities that it offers can be used in a symbiotic manner with network-hosted IN capabilities to provide new and innovative services to both Internet users and telephony users.

This document is a summary of the studies so far. It starts with a short description of IP telephony (Chapter 2), followed by a summary of ongoing activities on IN/IP telephony interworking (Chapter 3). Finally we give a brief summary.

2 IP telephony overview

2.1 What is IP telephony?

The first use of IP telephony consisted of sending voice calls from one PC to another via the public Internet, but a number of commercial operators are now introducing other services, including PC-to-phone, phone-to-PC, phone-to-phone, and Internet fax services.

There are several ways to send voice across the IP net, as shown in Figure 1. One is to run voice over a data VPN via IP telephony gateways or ISP switches to the branch office or off net (top). Another is to sign on with an ITSP (bottom). Companies send calls through the corporate gateway and on to the ITSP gateway, or they send all calls directly to the ITSP gateway via toll-free dial-up.

PC-to-PC services

In order to transmit voice calls over the public Internet, calls from a PC are routed via the local ISP, as with any other type of transmission. The person being called must be similarly equipped and online. The caller and the called party must agree to use the same software to code their voice signals for the Internet.

PC-to-phone services

PC-to-phone services are becoming more widely available. To make a PC-to-phone call, the user must connect to his local ISP, and then dial the number of the user he is trying to reach (who is connected to the PSTN) via the ITSP's gateway. The caller pays whatever his local TO charges for connection to the local ISP, plus an additional charge to the ITSP. The ITSP then pays the call charges from its nearest gateway to the destination.

In Norway, Telenor Nextel currently offers a service called 'Interfon PC' which handles both PC-to-PC and PC-to-phone services.

Phone-to-PC services

Where voice is being used from a PC on a corporate network, phone calls can reach the user from the PSTN via a private gateway located alongside the PABX. Outside corporate networks, it is not yet possible to place a normal phone call directly to a PC.

Phone-to-phone services

There is a wide range of ITSPs that now offer phone-to-phone services over the Internet. Customers send calls direct to a gateway that is operated by an ITSP by dialling a special assigned number, before the ITSP routes the calls to the destinations. From the user's point of view, these services appear similar to other call-back and resale services, in that the user typically dials a special prefix, enters his authorization code and dials the number he is trying to reach. He needs never to be aware that the calls are routed over the Internet. Telenor Nextel in Norway also offers this type of service.

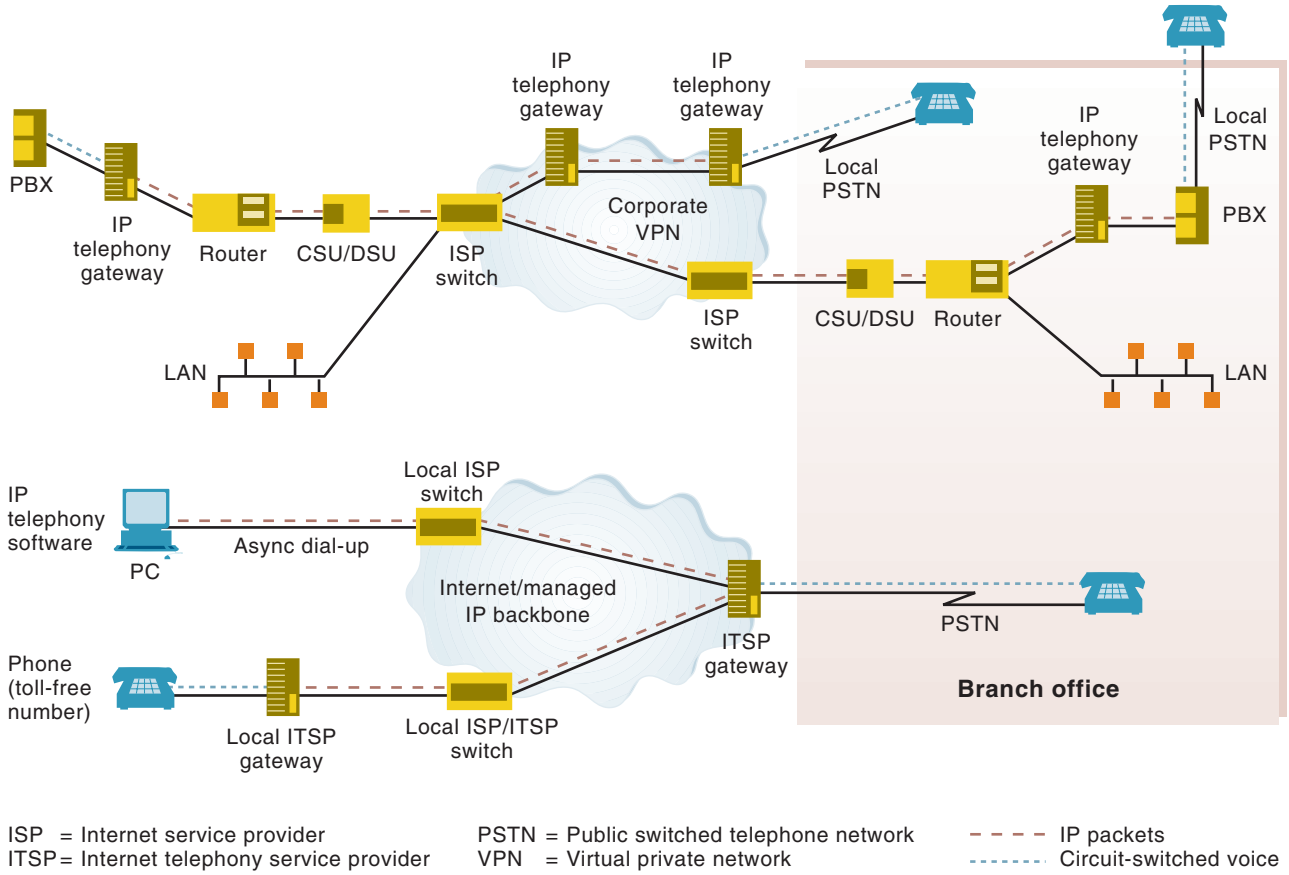


Figure 1 Calling Collection (Source: [1])

2.2 Challenges faced by IP telephony

The quality issue

In spite of the efficiency and cost advantages offered by IP, the fact that it was not originally designed to carry voice has its principle adverse effect on quality of service. On an IP network, there is a number of fundamental problems connected with the fact that the voice signal is split into separate packets which may take different routes, encounter different network delays, arrive in the wrong order, or even get lost altogether. IP telephony is only possible because the software designers go to great lengths to compensate for such problems.

Within the IP telephony industry, it is now generally asserted that quality of service is no longer an issue. However, while a typical domestic call in USA suffers just 50 to 70 ms of delay (and a transoceanic call from 150 ms to 500 ms), Internet delays can range from 400 ms to 2 seconds, well above the 250 ms level considered noticeable. Besides, the gateways themselves also contribute to delay, adding up to 200 ms of delay each, according to the Internet Products Operation of Motorola Inc., which provides systems integration for IP telephony networks [1]. Where private IP circuits are used, rather than the public Internet, it is possible to configure the network to minimize the number of route hops and to use protocols such as Open Shortest Path First (OSPF), which became a standard in 1990 and is supported by many router vendors.

Variation in the delay encountered by packets, known as jitter, causes more problems than the delay itself. Jitter results in packets arriving in the wrong order. Terminal software incorporates buffers that store the packets, so that they can be put into the correct order before playing back the sound to the user. These buffers are the major source of delay in the communication. The more sophisticated software available dynamically changes the length of the buffer according to the quality of the connection.

Customer acceptance

Quality is one of a number of factors that may have an adverse effect on customer acceptance of IP telephony. *Ease of use* is also an important issue in determining customer acceptance of IP telephony in the residential marked. Outside an office environment, it is likely that IP telephony users will need to dial an access number (and pay for the local call involved), and probably enter a personal identification number (PIN), before dialling the destination number. Currently the IP telephony service is mainly offered to the residential market (ie. phone-to-phone ser-

vice). In Norway, Telenor Nextel offers phone-to-phone service based on prepaid calling cards (the 'Interfon telefonkort'), thus eliminating the use of PINs.

Security

Security has long been criticized as a problem to be solved. Much work has been done in recent years to address the issue. Security in the Internet can be handled at different levels. Depending on security features available in the network technology employed is not a satisfactory solution as the Internet is composed of many different types of network technologies such as ATM, FDDI, Frame Relay, etc. Next up on the stack is the IP layer. Firewalls on the edge of a corporate network can be used to prevent unauthorized access from unknown IP hosts. RFC 1825 "Security Architecture for the Internet Protocol" describes how security can be implemented in the Internet. IPSec is a collection of security protocols from the IETF that adds authentication and encryption to all IP communications over any network technology. Security can also be built into the application layer. This would be required on a service by service basis and would obviously be an extra overhead in the development process.

Despite the fact that the tools are available, security can still be compromised in other ways. The causes can be

- Incompetence;
- Social engineering (eg. posing as somebody from the IT department and obtaining a valid ID and password from a user over the phone); and
- Political reasons (such as international laws for exporting encrypted data).

In summary, security on the Internet is a weakness if it is not applied properly.

Undermining the PSTN

For established telecom operating companies, which own and operate circuit-switched networks, a major barrier is that IP telephony will cannibalize their revenue from existing services. Such companies will often have heavy investments in the PSTN, which have not yet been written down. Some of these companies will be reluctant to enter the IP telephony market, while some other telecom companies do not see this as a significant problem, as the price of IP telephony and PSTN-based services is expected to converge over the next few years. While IP telephony may have an effect on PSTN revenue streams in the short term, in the longer term it is expected to drive up overall telecom traffic because of the additional value-added features it will provide.

2.3 Standards

In order to build IP telephony networks that can work together, and to prevent network operators being locked into single-vendor systems, standards are needed to ensure that user terminals and gateways from different vendors can talk to each other. The breakthrough for IP telephony has been the development by the ITU of the H.323 standard for real-time conferencing over packet networks. The H.323 standard was originally intended to make videoconferencing and collaborative work possible for LANs, but is now being finalized with IP telephony in mind. The standard is supported by all the major vendors. It was approved at the end of 1996, when interoperability testing started under the auspices of a vendor body known as the International Multimedia Teleconferencing Consortium (IMTC), and is continuing. The standard allows a number of options and is not yet possible for clients and gateways to interwork, which is resulting in the development of a number of separate, parallel, and global networks.

The biggest problem associated with the development of global networks is the need to connect different types of networks together and make sure that all the control information about the calls is transferred seamlessly from one network to another. Although H.323 has addressed the basic problems of terminating phone calls from an IP network, there is still a number of issues to be resolved relating to network management and signalling. ETSI has set up a working group, TIPHON [2], specifically to develop standards for interoperability between IP telephony and the PSTN/ISDN and GSM networks. In the next chapter we will give a short description of TIPHON and other related projects.

3 Ongoing activities on IN/IP telephony interworking

IP telephony can be seen as an extension of telephony and related services to the Internet and to IP-based networks. As a consequence of this development the interworking with the existing telephony networks becomes an important issue.

The ETSI project TIPHON addresses the interworking issue between IP networks and traditional telecommunication networks (which they call Switched Circuit Network, SCN). TIPHON has the following objective:

To combine telecommunications and Internet technologies to enable Voice over IP networks to interwork with Switched Circuit Networks (SCNs).

The TIPHON architecture is presented in Chapter 3.1. Interworking between IP- and IN-based networks is however not covered by the TIPHON project.

While the ETSI TIPHON project addresses the interconnection issues from the IP-network side, ITU-T views it from the IN-network perspective. ITU-T Study Group 11 addresses the issue of IN/IP telephony interworking. The initial IN/IP-network architecture output was from the SG11 meeting in May 1998. Currently two drafting groups are working on the subjects of IN/IP-network interworking; INAP transported over IP, and features in IN CS-3 [3]. In Chapter 3.2 the most recent ITU-proposal is presented briefly.

Under IETF (Internet Engineering Task Force) there is a working group called PINT (PSTN and Internet Interworking). They define a protocol, the PINT Profile [4], for *invoking* telephone services from an IP network. These services include placing basic calls, sending and receiving faxes, and receiving content over the telephone. The generic scenario is shown in Figure 2.

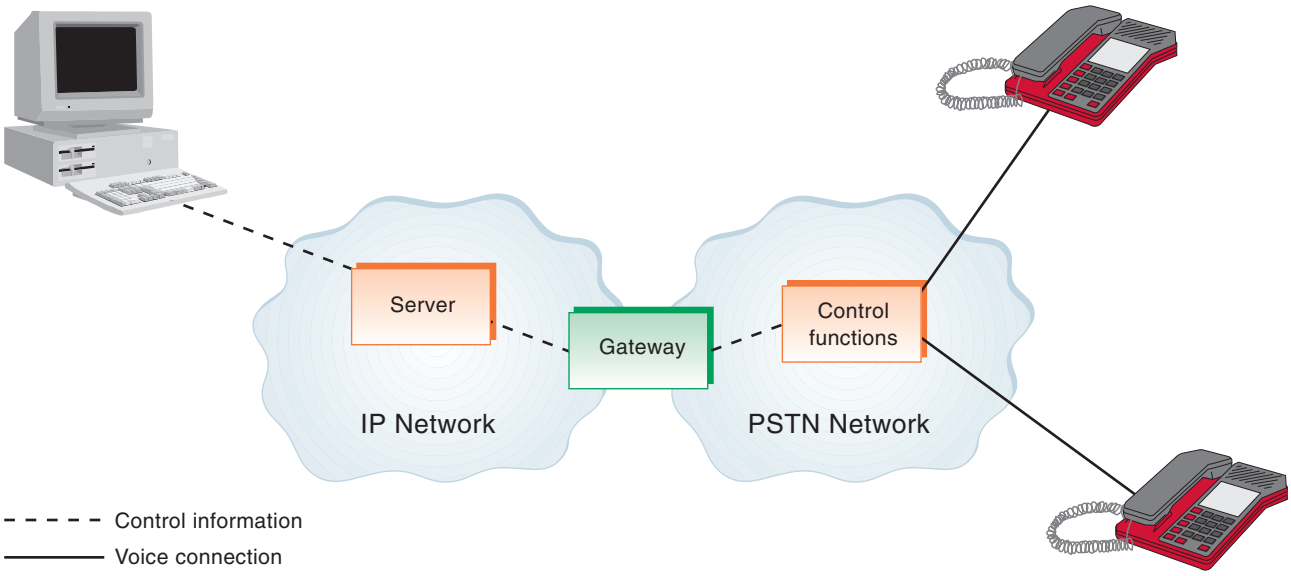


Figure 2 The general scenario of the PINT profile

The characteristics of PINT services are

- IP access to PSTN telephony;
- IP enhancement of PSTN telephony;
- IP control of PSTN telephony;
- Internet is used for non-voice interactions, while the voice (and fax) are carried entirely over the PSTN.

As the work in PINT does not address voice-transport across the IN/IP boundary, their work is beyond the scope of this paper.

IN-Forum is another group working on this topic. A short presentation is given in Chapter 3.3.

Telecordia (formerly Bellcore) is also doing active research on PSTN/IN and Internet Interworking [5]. They are focused on

- The interaction of the Internet and AIN (Advanced IN, the IN concept of Telecordia) in the delivery and control of voice and messaging services; and
- How to assure the security and network integrity of the PSTN/IN as interface points are opened up for access from an open network like Internet for which the security and network integrity is traditionally a less concern.

Further description of this topic is presented in Chapter 3.4.

3.1 TIPHON Architecture

The main objective of TIPHON is to combine telecommunications and Internet technologies to enable Voice over IP networks to interwork with Switched Circuit Networks (SCNs). Its philosophy is to work in an open, international environment, meet frequently, and focus on services and specifications.

The main motivation for TIPHON is that the following facts have been recognized:

- No one was working on the basic services;
- Interoperability between IP and SCN is not sufficiently defined; and
- Operators want a service-oriented solution.

TIPHON is supported by many companies, such as 3COM, Alcatel, AT&T, Cisco, Deutsche Telekom, Dialogic, Ericsson, France Telecom, KPN, Lucent, Intel, Microsoft, Motorola, Nokia, Nortel, Siemens, Philips, Telecordia, and Telia.

TIPHON aims to define:

- A set of requirements for service interoperability;
- A global architecture: interfaces and functions;
- Call control procedures, information flows and protocols;
- End-to-end Quality of Service parameters;
- Address translation between E.164 and IP;
- Technical aspects of billing, accounting, and reconciliation;
- Security profiles and procedures.

Figure 3 shows the TIPHON architecture reference configuration.

The TIPHON project is organized in six working groups:

- WG1: Requirements
- WG2: Architecture
- WG3: Protocols

- WG4: Naming, Numbering and addressing
- WG5: End-to-End Quality of Service
- WG6: Verification & Demonstration.

TIPHON does not re-invent existing standards – they use ITU (H.323v2, SS7, etc.) and IETF protocols wherever possible.

In the TIPHON proposal the support for the gatekeeper-routed-call model has been made mandatory (it was optional in H.323). They are currently working on:

- IP/SS7 interworking
- Security profiles
- Gateway functional decomposition
- Inter-gatekeeper and inter-domain communications
- QoS signalling
- Terminal/user roaming and mobility
- Service mobility.

3.2 ITU-T SG11 and IETF PINT

ITU Study Group 11 is working on IN CS-3 and CS-4. Figure 4 shows an enhanced functional architecture for IN support of IP networks (source: [3]). The functional model proposed is an extension of the IN CS-3 functional model. It is intended to support IN CS-3/4 benchmark services. Internet based service customization and termination of VoIP are to reach users in the telephone domain as well as general management capabilities.

3.2.1 Functional entities

The architecture incorporates the following main components:

PINT server

The current proposal assumes the use of a PINT server as defined by the Internet Engineering Task Force (IETF), working group for PSTN-Internet Interworking (PINT).

A PINT server accepts PINT requests from PINT clients, processes the requests, and returns responses to the clients. Addi-

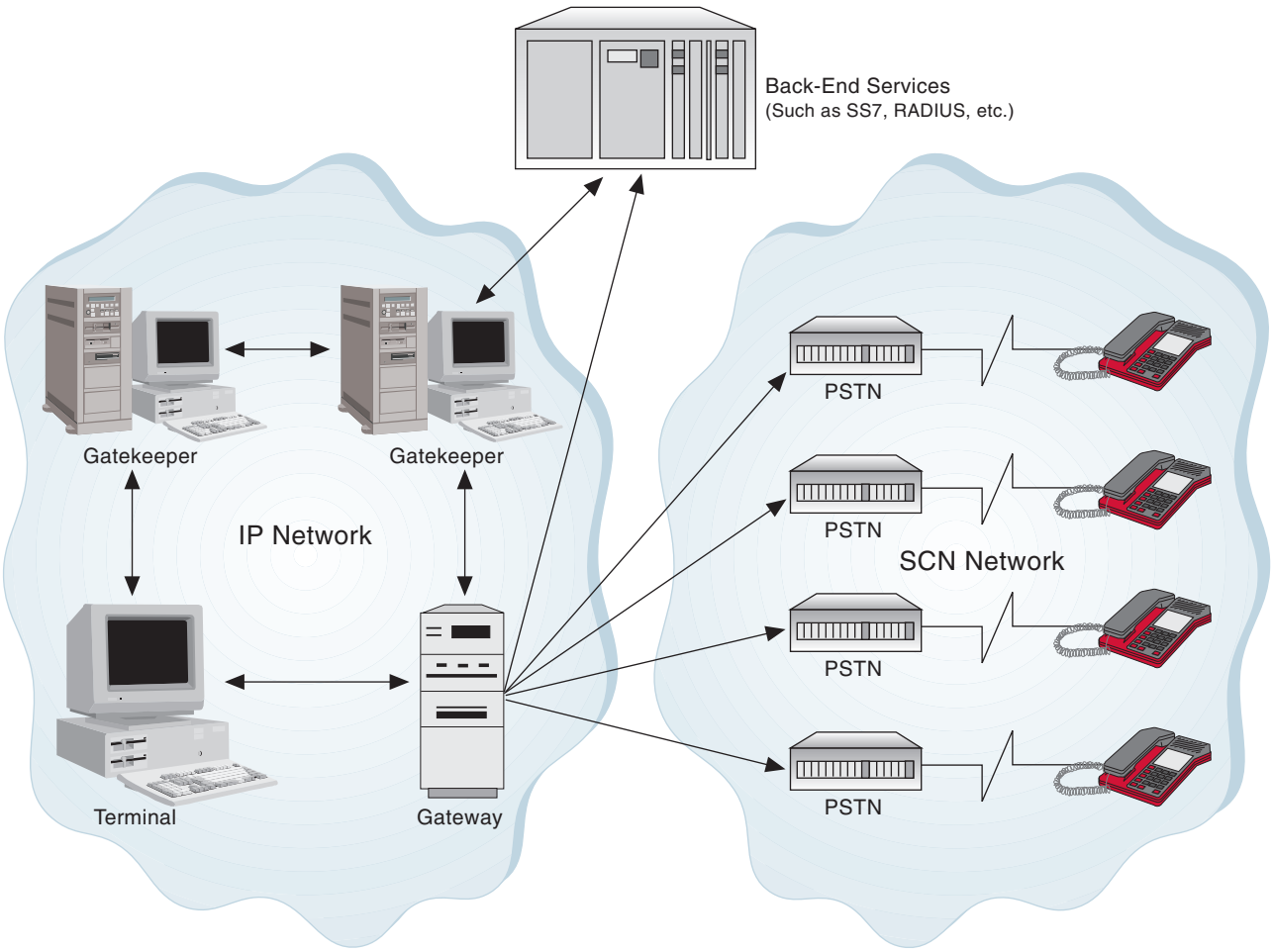


Figure 3 TIPHON architecture reference configuration

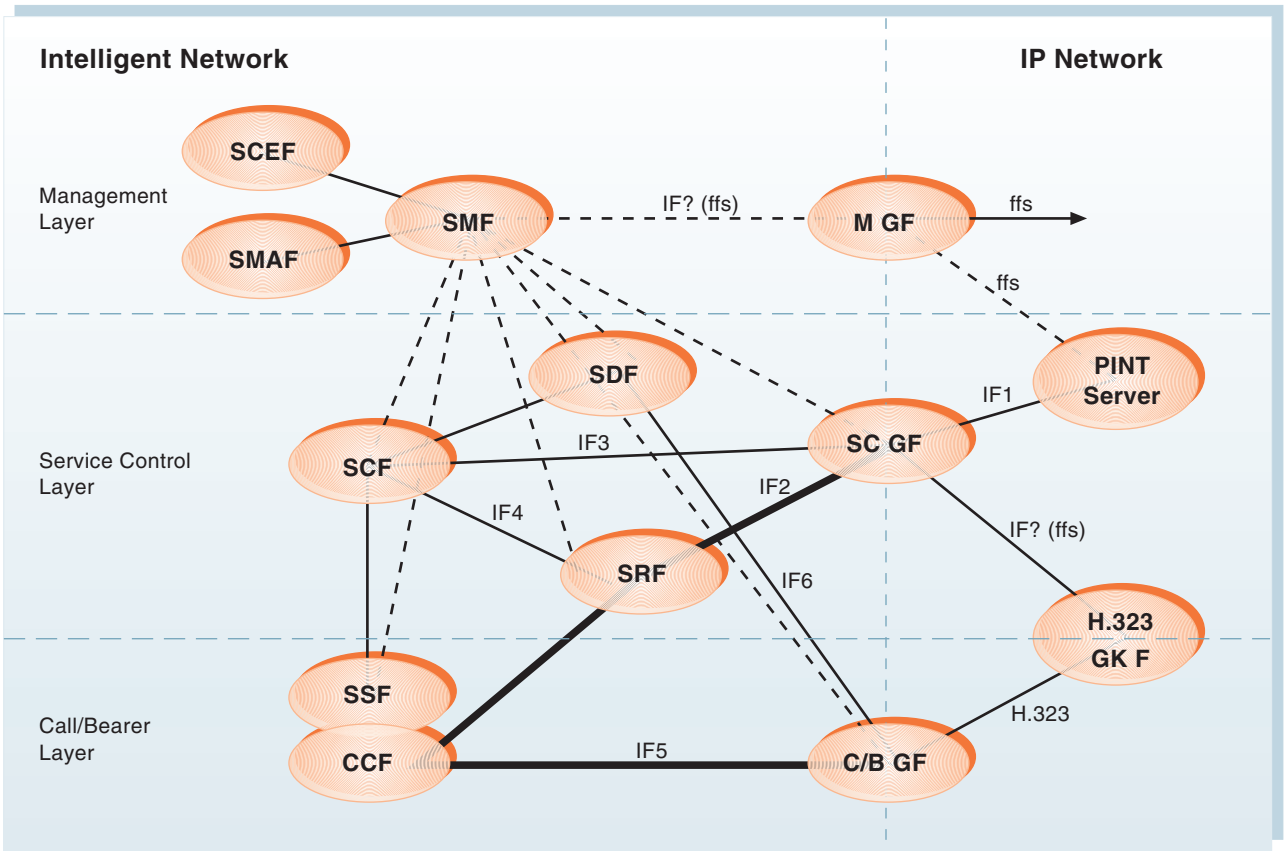


Figure 4 En enhanced functional architecture for IN support of IP networks

tionally, this function transfers data (eg. fax data) between IP-networks and the IN, and associates IP-network entities with the related entities in gateway function.

The IETF PINT working group is developing a protocol set based on a modification of the Session Initiation and Session Description Protocols (SIP and SDP). The architecture configuration envisaged is that end users will make service requests. These requests will be marshalled and converted into SIP/SDP messages by a dedicated PINT client that will be sent to a PINT Server. The PINT Server will further relay the service requests to the Service Control Gateway Function (SC GF). From the perspective of the IP-network requesting user, this SC GF is responsible for processing and executing their service feature request; any entities (such as IN entities) are 'hidden' behind this SC GF, and their operation is transparent to the IP-network users.

H.323 GateKeeper Function

An H.323 Gatekeeper function could be seen as a logical switch (CCF). Call control signalling (H.225, Q.931-like) and connection control signalling (H.245) for VoIP is transferred via the Gatekeeper, who makes network routing decisions.

A Gatekeeper can require SCF assistance for these routing decisions, eg. for toll-free numbers, number portability, user profile consultation, and VPN support.

Service Control Gateway Function (SC GF)

The Service Control Gateway Function allows the interworking between the service control layer in Intelligent Networks and IP-networks. For IN CS-4 on the service control level the relations between the IN and the following entities in the IP-network are supported:

- Functions related to **PINT Server**

  The gateway function receives service requests from the PINT Server in the IP-network domain and delivers them to the SCF. It provides the SCF with the necessary information to control service requests, identify users and authenticate data, and protect the IN from misuse or attacks from the IP-network. Furthermore, it hides the SCF/SRF from entities in the IP-network domain and acts as a mediation device between the IP-network and the IN.

  It also relays requests from an SCF to the IP-network domain to perform services (eg. user notification).

- Functions related to **H.323 GateKeeper Function**

  Interworking for:

  - Number Portability
  - Freephone Translations
  - VPN support
  - O.A.&M.
  - etc.
- General Functions

  The following functions need to be supported by this gateway function:

  - Data filtering/parsing/mapping
  - Security/Authentication
  - Real Time data collection (billing/parsing)
  - Triggering of services (in the IN domain or in the IP-network domain)
  - Configuration/dimensioning
  - Flow control
  - Feature Interaction Management.

Call/Bearer Control Gateway Function (C/B GF)

This gateway supports the following functions:

- Access to a packet network through the PSTN, eg. Internet dial-up access via a modem connection;
- Interworking of VoIP calls with PSTN calls.

Connection of this gateway function to other entities in the IP-network and its internal tasks is not yet defined .

Management Gateway Function (M GF)

The gateway function is required for management purposes. Connection of this gateway function to entities in the IP-network and its internal tasks is not yet defined .

3.2.2 Necessary extensions to existing functional entities

Specialized Resource Function (SRF)

This function has to be extended by capabilities to exchange data with gateway functions to IP-networks. Additionally, for some of the services it needs to support specialized resources with media transformation functions such as

- Text to fax;
- Text to speech (already covered in Q.1224, 3.3.6.2 as TTS function).

Service Data Function (SDF)

For some services there may be a need for the SCF to access a database type of entity with service related information to be shared between the IN- and the IP-network. (As for Internet dial-up access, Internet calls waiting, the association between a PSTN number and an IP-address, or the state of C/B GF resource, etc. ...).

Therefore the following functionality needs to be added to the SDF description:

"SDF contains data pertaining to modem usage/available factor for Internet dial-up access."

SCF, SSF, CCF, and Management Functions (SMF, SMAF, SCEF)

Extensions or impacts are *for further study*.

3.3 The IN Forum (INF)

In late 1995 several companies interested in furthering the use of Intelligent Networking world-wide came together to organize an open industry forum that would address interoperability and implementation issues relative to Intelligent Networks. The result was the creation of the Intelligent Network Forum (INF).

The INF is an open, non-profit organization comprising service providers, equipment vendors, software developers, systems integrators, research and engineering organizations, users and other interested parties promoting an implementation of Intelligent Networking (IN) technology and applications, based on national and international standards.

The Forum started with twenty-one Founding Members and has grown to over sixty members including service providers, equipment vendors, software developers, industry analysts, and more (Telenor is currently not a member of the INF).

The mission of the Intelligent Network Forum (INF) is to promote the continued growth and acceptance of Intelligent Networks by providing an international forum to address issues related to the implementation of Intelligent Network technology and applications.

The INF will achieve its mission through pursuit of key activities undertaken to further the acceptance and use of Intelligent Networking technology and applications to address key industry issues. These activities include:

(1) Promote and influence standards, both national and international;

(2) Develop and publish Intelligent Networking implementation agreements;

(3) Encourage interoperability;

(4) Facilitate application development;

(5) Identify requirements common to the advancement of IN technology;

(6) Provide information and education on IN, the benefits of IN, and the activities of the INF.

In addition to advisory committees, the Forum has established working committees to execute the technical and business objectives of the Forum. The Technical Committee and the Marketing Awareness and Education (MA&E) Committee are

the two standing working committees. Others will be formed as appropriate and disbanded when assigned tasks are completed.

The INF has contracted with outside companies to provide executive management and operations management services for the Forum.

IN/IP Integration Group

The mission of the IN/SS7-Internet Protocol Working Group is to facilitate the broader application of Intelligent Network (IN) capabilities in the Public Switched Telephone Network (PSTN) to access Internet functionality and vice-versa for providing synergistic arrangements for existing and new services. The Working Group will define interoperability requirements, identify any protocol shortfalls, strive to resolve any such shortfalls through influencing appropriate standards, and develop implementation agreements that meet industry opportunities for internetworking IN/SS7 and Internet capabilities.

The group's first meeting was 21 July 1998 in Seattle. The group held a brainstorming session as to possible workgroup output and relationship to other industry organizations, and is beginning the work to define functional elements involved in IN/IP integration.

Currently they are working on IN/IP integration from a service point of view. They are doing sample evaluation of various architectures using the service approach. This means they develop a very detailed description of a service, including functional requirements. They will then use this description and the functional requirements to evaluate interoperability and service delivery with various proposed IN/IP architectures.

If they feel the sample analysis is useful, they will continue with other services and forward results to other industry groups such as ETSI and IETF.

3.4 Telecordia (Bellcore) HORIZONS

The particular business issue to be addressed in the Telecordia HORIZONS initiative "PSTN/AIN and Internet Interworking" is the interaction of the Internet and IN in the delivery and control of voice and messaging services.

Telecordia addresses vertical services in a cross VoIP and PSTN/ IN environment. Four strategically important services are selected to drive the high-level analysis of how vertical services can be made available in this cross network environment through signalling interworking between H.323 and ISDN/SS7. These four services are:

- Call forwarding
- Call waiting
- Calling name delivery, and
- Automatic call-back.

Among the four services analyzed a high-level description of how the services should work in a cross PSTN/AIN and Internet environment is given, including pure Internet, Internet-to-PSTN, and PSTN-to-Internet scenarios. The analysis also gives details on where the service intelligence may reside in the mixed PSTN/AIN Internet domain, either on the CPE or in the network. The topics covered are:

1. Different ways of supporting Call Forwarding in a PSTN/ Internet environment, with different complications;
2. Call waiting;
3. Calling Name Delivery;
4. Automatic call-back.

Telecordia also addresses new services enabled by data sharing between SCP and Web server. It focuses on new services that are enabled by close interworking between an AIN component such as the SCP and an Internet server such as the Web. Major categories of services identified are:

1. PSTN Call Handling Using Web-based data;
2. Automatic Delivery of Web-based Information via PSTN;
3. Delivery of Web Information via Telephony;
4. Unified Messaging;
5. Reuse of SCP Advanced Service Logic for IP Telephony.

Because SCP already has service logic for advanced service on the PSTN (such as call screening, call forwarding, routing services, etc.), it is possible that the same service logic can be reused to provide advanced services for IP telephony. However, the HORIZONS delivery did not discuss this topic further, except recognizing that the feasibility of this reuse depends on a number of factors, including

- Similarity of IP telephony call model to PSTN call model;
- Need for the same advanced services in IP telephony;
- Performance issues related to access of SCP from Internet.

3.5 Telecom and IT vendors

3.5.1 HP/Cisco

The Hewlett-Packard Company is very active in the development of IN/IP integration. The HP OpenCall IN platform provides a service-layer architecture that will enable services to run transparently across the PSTN, wireless networks, and IP-based networks. In a future release of the HP OpenCall IN platform, service providers will be able to use the platform to create and run new IN-type services or to port existing IN and enhanced telephony services – including prepaid and VPN – over the IP domain [6].

In November 1998, HP and Lucent Technologies announced plans to integrate elemediar (a wholly owned venture of Lucent) H.323 gatekeeper software into the HP OpenCall IN platform [7]. HP will not only integrate elemediar's gatekeeper software, but also optimize it into the OpenCall IN platform, enabling service providers and equipment vendors to rapidly deploy advanced IN services over data networks.

HP and Cisco Systems Inc. have teamed together to develop a new solution – known as the OpenCall MultiService Controller – that will span the PSTN and IP networks (which is called Voice over Packet Network – VoPN – by the partners) [7]. The new solution will enable service providers to accelerate the convergence of existing PSTN and VoPN by providing value-added

voice and data services that will seamlessly work across both network infrastructures. The HP/Cisco solution also paves the way for the development of advanced applications – such as desktop videoconferencing and "click-to-talk" – that require voice and data integration. A flexible service creation environment and a joint HP/Cisco developers' program will enable independent software vendors (ISVs) to easily create value-added voice, data, and video services.

Initially available in the first quarter of 1999, the new product will be based on HP's HP-UX UNIX, and will provide value-added VoPN service to Cisco elements.

In the second half of 1999, support for end-to-end voice calls between the PSTN and VoPN will be added. This will allow PSTN and VoPN infrastructures to merge so that a user on a traditional wireline or wireless phone can seamlessly and transparently connect with a user on a VoPN phone.

The new HP/Cisco solution will be sold as a HP-UX-based software package through HP and Cisco, as well as their systems integrator and service provider channel partners.

3.5.2 SUN Microsystems

JAIN – JAVA Advanced Intelligent Network – of SUN focuses on a plug-and-play set of services utilizing wireless, wireline, and Internet capability. SUN starts by defining JAIN SS7 API in JAVA classes to interface TCAP, ISUP, MAP, and Switch interfaces into an SS7 Protocol stack. It allows a JAVA programmer to issue Intelligent Network messaging and process the results without concern of a specific SS7 stack implementation.

The whole idea is to allow rapid development and deployment of Intelligent Network services that run anywhere – any time – on any network by capitalizing on language features of JAVA.

3.5.3 Services enabled by data sharing between SCP and Web server

In the literature [4] we find some other services proposed that are enabled by data sharing between SCP and Web server.

HP Labs WebIN

HP Lab's WebIN applies a hybrid architecture: The subscriber-specific service logic & data are held on the Web server, which is interfaced with the SCP for bearer and resource control. Between the SCP and the Web server a WebSCP gateway is used. When an IN trigger is detected on the SSP, the SSP sends a query message to the SCP. The SCP identifies the server location and sends the HTTP query to the Web server to retrieve service data. The SCP uses the service data from the Web server to instruct the SSP for call processing, or takes default action if time-out.

IETF PINT WG

Other services that are enabled by data sharing between SCP and Web server are discussed in IETF PINT WG [4]. As we mentioned earlier, the characteristics of PINT services are:

- IP access to PSTN telephony;
- IP enhancement of PSTN telephony;
- IP control of PSTN telephony;
- Internet is used for non-voice interactions, while the voice (and fax) is carried entirely over the PSTN.

Other examples of services enabled by data sharing between SCP and Web server are proposed by

- eFusion [8]
- Hotvoice [9]
- WebTelecom [10]
- IDT [11]
- Genesys [12]
- SUN [13]
- Parlay Group (BT, DGM&S, Microsoft, Nortel, Siemens) [14].

4 Summary

The fast developing IP telephony can pose serious threats to traditional telephony services, which are the major sources of revenues to telcos like Telenor.

Because the technical and economic advantages of the IP network push the development of the IP telephony, while the existing IN/PSTN still has a much larger user base (which we expect to continue in the foreseeable future), we believe that the interworking between IN/PSTN and IP telephony will become an important issue. The expertise in this field can be very useful for Telenor.

Further research on IN/IP telephony interworking should be focused on the following topics:

- Since the Internet is open and usually operated by an ITSP, while the PSTN/IN network is a closed system operated by TOs, the security issue must be focused. Particularly, we should focus on the gateway function. The gateway must be able to support security/authentication.
- Experimenting interworking of IN/IP-telephony interworking in co-operation between Telecom operators (such as Telenor) and industrial partners. Telenor Nextel currently uses the Ericsson H.323 GateKeeper System in their IP-telephony networks, so for Telenor a possible starting point could be to test the interworking between the Telenor IN platform and the Ericsson GateKeeper and gateways.

Many projects are currently running by standardization organizations like ITU-T, ETSI, and IETF ... They are working on the interworking/integrating of IN/PSTN and IP telephony. We hope that Telenor can be more active in these international activities.

The major telecom and IT vendors are also working on interworking of IN and IP telephony. More work on prototyping and demonstration is important for Telenor.

References

1 Voice over IP Services: The Sound Decision. *Data Communications International,* March 1997; http://www.data.com/roundups/decision.html

2 http://www.etsi.fr/tiphon/

3 ITU-T, SWP 4-4/11, Reporter's Meeting Report, Sophia-Antipolis, 7–16 October 1998.

4 IETF PINT WG, work in progress.

5 Bellcore HORIZONS, PSTN/IN and Internet Interworking, 1998.

6 HP Telecommunications News, issue 16, September 1998.

7 http://www.hp.com/telecom/

8 http://www.eFusion.com/applications/apps_info.html

9 http://www.Hotvoice.com

10 http://www.webtele.com/welcome.html

11 http://mailcall.idt.net/

12 http://www.genesyslab.com/Genesys2/products/options/options.htm

13 http://www.sun.som/smi/Press/sunflash/9806/sunflash.980609.9.html

14 http://www.parlay.org/

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Status

Standards are still important!

PER HJALMAR LEHNE

It is a cliché, but standing on the threshold of a new millennium may be a good opportunity to take a look at the importance of international standardisation efforts and methods in telecommunications. Telecommunications has moved from being a public utility to a global, market driven industry during the last couple of decades. Will the ever increasing market driven approach together with increasing individuality lead to a smaller need for standardisation efforts? Obviously not. The amount of resources put down in different standards organisations seems to be higher than ever, but a lot of the work is done on new arenas, with many more new players than before.

The start

On 24 May 1844 Samuel Morse sent the first public message over a telegraph line from Washington to Baltimore. This event marks the start of the telecommunications era. The electric telegraph was invented only six years earlier, in 1837.

In the following years, each country built up their own national telegraph networks, with their own telegraph codes and systems. When messages were to be sent across borders, transcription, translation and retransmission were necessary. The need for agreements was obvious, and several bilateral and regional agreements were concluded. However, the number of agreements was high. For example, *15* agreements were needed for one telegraph link between the Prussian capital and the frontier localities bordering the other German states.[1)]

The expansion of the telegraph network and the large number of agreements needed led to 20 European states deciding to meet in order to work out a framework agreement and to decide on common rules to standardize equipment for guaranteeing generalized interconnection. This effort also included uniform operating instructions and common international tariff and accounting rules.

After two months of hard work, the first *International Telegraph Convention* was signed by the 20 participating countries on 17 May 1865. This event marks the foundation of the first international standardisation body in telecommunications, namely the *International Telegraph Union*. Today, this is known as the global organisation *International Telecommunications Union – ITU*, a UN body from 1947.

Later, Alexander Graham Bell patented the telephone in 1876, and ITU defined the first provision of an international telephone system in 1885. Radio communications started in 1895, and in 1906, the first Radiotelegraph Convention was held. The well known SOS signal was adopted as a standard. After trials of broadcasting voice and music using radiotelephony, real sound-broadcasting was 'born' in 1920.

There is a red line through all this; first the technological inventions, followed by agreements and standards to ensure the dissemination of the technology.

From national to global standards

As we have seen from history, the need for efficient communications made co-operation on standards feasible. First, it has started out on a local level and as the technology has spread, on a national level. Different countries have their own national standards bodies, dealing with national standards. International trade and commerce is probably one of the major driving forces for international standards in telecommunications. Much earlier examples of communication standards, however, are spoken and written languages. Thus, *the global communications society is not possible without standards*.

Standards come from different sources

Up till now most standards in telecommunications have come from the work of national and supranational bodies forming groups of experts with the task of producing harmonised specifications in order for networks to interwork smoothly. Examples of such organisations are the ITU, as mentioned earlier, and ISO (International Organisation for Standardisation); both global bodies; ETSI (European Telecommunications Standards Institute) in Europe; ANSI (American National Standards Institute) and Committee T1, in the USA.

But, not only the conventional organisations like ITU, ETSI, ARIB, ANSI, CEN, etc. are one the scene today. There are new kids on the block, meaning: a whole new family of initiatives are here. An example among the different interest groups is the *3G.IP* formed by AT&T, BT, Rogers Cantel, Ericsson, Lucent, Nokia, Nortel, Telenor and Telecom Italia Mobile. The mission of this focus group is to promote an Internet Protocol (IP) based wireless system for third generation (3G) mobile communications technology. The 3G.IP is only one example of the new constellations and fora being more and more important and influential. A recent survey shows more than 140 different organisations involved in standards for what we now call information and communications technology (ICT). Table 1 shows a list that is probably *not* complete. No effort has been made to understand what they all do.

There is also the fact that standards do not always come from standardisation groups. In many areas industry has led the way and developed practical, feasible solutions, which later have been adopted as standards. Often after a short period of heavy competition between several initiatives. This happens more in other areas than telecom, like e.g. computers and home entertainment. Thus, standards are not 'standards' approved by an organisation or body, but have become the preferred method, so-called *de facto*[2)] standards. The software on my computer, ie. Microsoft Windows and Office, are examples of *de facto* standards. Another example is the audio CD format, developed by Philips, and adopted by ISO.

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1) At this time in history, The Kingdom of Prussia (Preußen) stretched from Lithuania to the Rhineland. Berlin was the capital. Germany as a state did not exist, however, some German kingdoms bordered Prussia.

2) "de facto" is used to say that something is true or exists, even though it was not planned or intended.

Everything was easier before ...

Now it is a jungle out there. Previously, national bodies and operators dominated and had control of the work. They had similar interests because they were not competitors but could control their home "markets". Now, several organisations often with conflicting interests, participate. Additionally, we see the different associations and interest groups becoming more and more powerful.

Standardisation work has generally become more complex because of changes in society. Telecommunications has transformed from being a public utility to a global, market driven industry.

- The technological development is so fast that techniques are liable to be outstripped by new technological developments before they have reached the market.
- The requirements of service providers and users are increasing all the time and are becoming more and more sophisticated.
- Legal, economic and technical structures are undergoing fundamental changes which differ from one country to another.
- Telecommunications have become an international market with hard competition. The time when a few major manufacturers dominated geographically limited markets, often protected at national level, is gone.
- New trends are emerging: Globalization, deregulation, restructuring, value added network services, convergence.

The "old" standards organisations try to adapt to the changing conditions caused by increased liberalisation. It is not longer possible for national regulatory bodies and the large operators to sit for years in meetings and draw up the map, because in the meantime, new operators and industry have changed the terrain so to speak. First of all, industry and user organisations have become members of the standards organisations. Secondly, the work is organised differently, as projects with tight time schedules. In Europe, the EU has been a driving force for this development: "Produce a standard within a certain time limit, or else we ask a company to deliver what we want!"

In Europe, ETSI is the main arena for telecommunications standardisation. However, in the case of UMTS, the responsibility is now handed over to a global initiative, the *3rd Generation Partnership Project – 3GPP*, where ETSI is one of the members together with regional organisations from all over the world and individual members like Telenor.

We need standards more than ever

If someone has been misled to believe that the free telecommunications market would lead to a smaller need for standardisation work, please reconsider! Let us take the case of mobile telephones. The huge popularity and growth of cellular telephone usage, especially in Europe, had not been possible without an international standard as well as roaming traffic agreements. The standard is called GSM, and it has clearly demonstrated the power of international co-operation in this field.

If the "Global Communications Society" is to evolve, standards are essential!

Bibliography

ITU History. [online]. 2.11.1999. URL: http://www.itu.int/.

CEN/ISSS – Survey of Standards-related Fora and Consortia [online]. 8.11.1999. URL: http://www.cenorm.be/isss/Finalsurvey3.1.htm.

3GPP homepage. [online]. URL: http://www.3gpp.org/.

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Table 1 List of standardisation and standards related fora (source: CEN/ISSS)

1394 TA	The 1394 High Performance Serial Bus Trade Association
3G.IP	
3GPP	3rd Generation Partnership Project
ACM	Association of Computing Machinery
ADSLF	Asymmetric Digital Subscriber Line Forum
AES	Audio Engineering Society
AIIM	Association for Information and Image Management
AMF	Asian Multimedia Forum
ANA	Article Numbering Association
ANSI	American National Standards Institute
AOEMA	Asia Oceania Electronic Messaging Association
AOW	Asia Oceania Workshop
ARIB	Association of Radio Industries and Businesses (Japan)
ARTS	Association for Retail Technology Standards
ATMF	Asynchronous Transfer Mode Forum
Bluetooth SIG	Bluetooth Special Interest Group
CDG	CDMA (Code Division Multiple Access) Development Group
CEN	European Committee for Standardisation
CENELEC	European Committee for Electrotechnical Standardisation
CEPT	Comité Européen de Post et Telecommunication
CommerceNet	
Committee T1	
ControlNet International	
CSA	Canadian Standards Association
CTFJ	Computer Telephony Forum of Japan
DAVIC	Digital Audio Visual Council
DECT Forum	Digital Enhanced Cordless Telecommunications Forum
DIG	Digital Imaging Group
DISA	Data Interchange Standards Association
DMTF	Desktop Management Task Force
Dublin Core	Dublin Core Metadata Initiative
DVB	Digital Video Broadcasting Project
EACEM	European Association of Consumer Electronics Manufacturers
EAN	International Article Numbering Association International
EBU	European Broadcasting Union
ECBS	European Committee for Banking Standards
ECE	Electronic Commerce Europe
ECMA	European Association for Standardizing Information and Communication Systems
ECOM	Electronic Commerce Promotion Council of Japan
ECTF	Enterprise Computer Telephony Forum
EEMA	European Electronic Messaging Association
EEP	European Education Partnership
EIA	Easy Internet Association
EIA	Electronic Industries Alliances
EIBA	European Installation Bus Association
EIDQ	European International Directory InQuiry Group
EIUF	European ISDN User Forum
EMA	Electronic Messaging Association
ERO	European Radiocommunications Office
ERTICO – ITS Europe	European Road Transport Telematics Implementation Coordination Organisation
ETIC	European Telecommunications Industry Consortium
ETIS	European Telecommunications Informatics Services
ETNO	European Public Telecommunications Network Operators' Association
ETSI	European Telecommunications Standards Institute
EUROGI	European Umbrella Organisation for Geographic Information
FCA	Fibre Channel Association
FCLC	Fibre Channel Loop Community
FIPA	Foundation for Intelligent Physical Agents
FMMC	The Foundation MultiMedia Communications
FRF	Frame Relay Forum
FSAN	Full Service Access Networks
G5 Messaging Forum	
GCA	Graphic Communications Association
Gigabit Ethernet Alliance	
GMCF	Global Mobile Commerce Forum
GO – MVIP	Global Organization for Multi-Vendor Integration Protocol
GSM MoU	Global System for Mobile Communication – Memorandum of Understanding
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IETF	Internet Engineering Task Force
IFIP	International Federation for Information Processing
IFSF	International Forecourt Standards Forum

IIA	Internet Industry Association
IMC	Internet Mail Consortium
IMS	Instructional Management Systems
IMTC	The International Multimedia Teleconferencing Consortium
INF	Intelligent Network Forum
IrDA	The Infrared Data Association
ISCGM	International Steering Committee for Global Mapping
ISO	International Organisation for Standardisation
ITS America	Intelligent Transportation Systems
ITU	International Telecommunications Union
Java Conference	
JEMA	Japan Electronic Messaging Association
KRA	Key Recovery Alliance
MCNS	Multimedia Cable Network System Partners Limited
MCPC	Mobile Computing Promotion Consortium
MMCF	MultiMedia Communications Forum
MMTA	Multimedia Telecommunications Association
MOMA	The Message Oriented Middleware Association
MOPA	Mobile Office Promotion Association
MSAF	Multimedia Service Affiliate Forum
MSF	Multiservice Switching Forum
NAFEMS	National Association of Finite Element Methods & Standards
NCITS	National Committee of Information Technology Standards
NISO	National Information Standards Organisation
NIST	National Institute of Standards and Technology
NIUF	North American ISDN User's Forum
OASIS	Organisation for the Advancement of Structured Information Standards
OBI	Open Buying on the Internet
ODMG	Object Data Management Group
ODVA	Open DeviceNet Vendor Association, Inc.
OGC	Open GIS Consortium
OIF	Optical Internetworking Forum
OMG	Object Management Group
Ontology.org	
Open 56K Forum	
OPIMA	Open Platform Initiative for Multimedia Access
OTP	Open Trading Protocol
PCCA	Portable Computer and Communications Association
PCI SIG	Peripheral Component Interconnect Special Working Group
PCMCIA	Personal Computer Memory Card International Association
PHS MoU Group	Personal Handyphone System Memorandum of Understanding Group
PIAF	PHS Internet Access Forum
PICMG	PCI Industrial Computer Manufacturers Group
PTF	Powerline Telecommunications Forum
RosettaNet	
SFF Committee	Small Form Factor Committee
SIF	SONET Interoperability Forum
Smart Card Forum	
SNIA	Storage Networking Industry Association
Softswitch	
TETRA MoU Association	Terrestrial Trunked Radio Memorandum of Understanding Association
The Open Group	
The Salutation Consortium	
TIA	Telecommunications Industry Association
TINA-C	Telecommunications Information Networking Architecture Consortium
TMF	TeleManagement Forum
TPC	Transaction Processing Performance Council
UCC	Uniform Code Council
UMTS Forum	Universal Mobile Telecommunications System Forum
Unicode	The Unicode Consortium
UniForum	The International Association of Open Systems Professionals
USBIF	Universal Serial Bus Implementers' Forum
UWCC	Universal Wireless Communication Consortium
VESA	Video Electronics Standards Association
VIA	Vendors' ISDN Association
VoiceTimes	Voice Technology Initiative for Mobile Enterprise Solutions
VON	Voice on the Net Coalition
VPIM	Voice Profile for Internet Mail
VRML C	Virtual Reality Modelling Language Consortium
VXML Forum	Voice eXtensible Markup Language Forum
W3C	World Wide Web Consortium
WAP Forum	Wireless Access Protocol Forum
WDF	Wireless Data Forum
WfMC	Workflow Management Coalition
WLIF	Wireless LAN Interoperability Forum
XIWT	Cross Industry Working Team
XTP	Xpress Transfer Protocol Forum

Kaleidoscope

The physics papers of Tore Engset

IVER BREVIK AND IVAR SVARE

It is surprising and remarkable that Tore Engset published a series of short papers on atomic quantum physics in 1926–27 in *Annalen der Physik* under the common title "Die Bahnen und die Lichtstrahlung der Wasserstoffelektronen" ("The orbits and the radiation of light from the electron of hydrogen"). This was a central field of physics where there was especially great activity and revolutionary progress just in those years, and it is astonishing that the self-educated and 60 year old Engset could contribute to scientific journals in this new field far outside the normal interests of a telecommunications man. The fact that Engset could send to *Annalen der Physik* his first note with discussions based upon Schrödinger's new wave equation (S.E.) as early as June 1926, only two or three months after it had been published, shows that he was very much aware of the great developments in physics, and he could apply some of the new ideas immediately. The advanced mathematics of the papers is impressive and shows his great knowledge also in this field, and we have translated his first paper from the original German to show his abilities and style (following paper).

However, in retrospect, now that Schrödinger's differential equation and its solutions and consequences are well established, we can see that Engset used confusing models with errors that made his work uninteresting for physics, and it has long been forgotten. To his excuse it must be said that he was not alone in that period to suggest quantum ideas that turned out to be wrong physics, and the editors and referees must have had great problems in following the rapid developments and evaluating the influx of papers.

To give a perspective on Engset's work, we will very briefly review the development of modern atomic physics, and especially in the years 1900 – 1930, when the foundations for quantum physics and the understanding of atoms were laid. Later, there has been great advances in the applications of these theories to various forms of matter and their physical chemistry, but no basic revisions of the physics and the S.E. have been necessary.

As early as ancient Greece some philosophers talked about 'atoms' as the smallest parts of matter, but they had no scientific basis for their opinions. With the beginning of modern chemistry around 1800 it was found that quantities of matter combined in simple ratios, and the atomic weights of the elements were gradually established. The characteristic line spectra of light from hot gases were found around the mid-century, and it was clear that the spectra pointed to some basic properties of the atoms, but the explanation had to wait for a long time. The new discoveries of X-rays (Röntgen, 1895), radioactivity (Bequerel, 1896) and electrons (Thomson, 1897) gave new information, but deepened the mysteries of the atomic structure.

Our century of physics started in 1900 with Planck's quantization of light energy in units, $E = hf$, to explain the radiation from hot solids, where f is the frequency and h is Planck's constant. However, Planck did not pursue the quantum idea, and it was Einstein who in 1905 showed that it could be used to explain both the energy of photoemitted electrons, and the small low temperature specific heat of solids. By sending alfa radiation through gold foils Rutherford showed in 1912 that an atom has almost all its mass in a very small nucleus, and physicists began to think of atoms as miniature planetary systems of negative electrons circling around the positive nucleus. However, according to classical electromagnetics an atom would be very unstable because it would lose energy by radiation of light and collapse rapidly. This dilemma was 'solved' when Bohr in 1913 postulated that only certain electron orbits were stable because their angular momenta had to be quantized in units of $h/2\pi$, and that emission and absorption of light meant transitions between the stable energy states. These postulates allowed him to calculate the spectrum of hydrogen with such good accuracy that it was clear that his findings reflected some basic truth despite their conflict with the standard physics of the time.

However, the quantization rules in the Bohr model could not explain the spectra of more complicated atoms with several electrons despite many attempts with elliptical orbits and other modifications, and it took more than 10 years before a satisfactory solution was found. Meanwhile, the experimental knowledge of atomic systems grew greatly and increased the need for good quantum theories. A breakthrough was the hypothesis of de Broglie in 1924 that since light could appear as both waves and quantized particles, the same should be the case for electrons, and standing electron waves as a basis for the Bohr quantization rule required that a particle momentum $p = mv$ must correspond to the wavelength $\lambda = h/p$. Schrödinger used this to derive his famous wave equation for electrons, and the stable states introduced by Bohr became standing electron waves in the spherical Coulomb potential around the hydrogen nucleus, in analogy to acoustic resonances in a cavity. The well-defined classical electron orbits of earlier theories were replaced by spread-out matter waves on the atomic scale. The behaviour of many-electron systems could also be calculated from the S.E., and this equation has remained the basis for non-relativistic atomic physics and chemistry.

Engset started from the brand new Schrödinger equation in his first paper, and he followed the mathematical steps in the first Schrödinger paper very closely. However, he seems to have still been thinking in terms of electron orbits, and he talks about projecting the orbit into a plane, which would be of doubtful value because this would change distances and thus the particle wavelength and the strength of the Coulomb interaction. From his arguments he tried to solve the S.E. for the projected electron in cylindrical coordinates r, φ, z. This is a very awkward approach to spherical problems. However, Engset went on by disregarding the z-dependence of the wavefunction $f_0(z)$ by assuming that $d^2f_0 / dz^2 = 0$, which is wrong for a three-dimensional atom. His radial Eq. (3) therefore differs from Schrödinger's, and that gave him great difficulties in explaining the physics of the resulting mathematical solutions. Only by throwing away some solutions and redefining the quantum numbers did he get something that looked like the established results for the hydrogen energies.

In his second paper submitted in August 1926 he discussed radiation of light from his atomic model, but with little reference to the stable states from Schrödinger. He now assumed that the electron states were surface charges on spheres that could vibrate and thus radiate as an antenna. This old model with currents and resistances should have been replaced by a model that more explicitly included the new electron waves, or by Heisenberg's quantum theory from 1925. In the following papers written in 1926 and 1927 Engset continued to work on radiation and damping, Compton effect and the possibility of combination frequencies, hoping to bridge the gap between classical physics and the new quantum theory, but with little lasting success. The time-dependent Schrödinger equation which gave transition probabilities between the states, came at the same time.

Engset was not afraid of long algebraic calculations, and he used many decimals in numerical calculations where he tried to find integral numbers for quantum effects. However, his ideas and assumptions should have been better in line with the more or less established physics at the time, and the many strange consequences of his models could have been discussed better.

His sudden influx of papers in quantum physics lasted for only a year, but it must have been preceded by many years of serious studies. His new responsibilities as head of the telecommunications authority and the illness of his wife that required attention, must have severely limited the time he could spend on physics. Anyway, the rapid theoretical developments in the late twenties would have been hard to follow. Only in retirement after 1935 could he return to physics, but by that time it was too late. The world of physics had changed, he was too old and his long manuscript dated 1943, shortly before he died, seems to contain little of scientific interest.

Engset writes in 1917 in the student reunion book "Studenterne fra 1892" that he had studied electrical engineering and mathematical physics in his spare time, and that he had followed lectures by professors Bjerknes and Størmer with interest. However, he apparently took no university exams in physics or mathematics, and there is no evidence in these papers that he discussed the quantum problems in 1926 with professor Vegard or younger physicists like Hylleraas at the University of Oslo. E. Hylleraas (1898 – 1965) soon afterwards calculated the energies of the two-electron helium atom with very good accuracy from the S.E. It was unfortunate that Engset worked alone, because the papers would have gained by outside comments that would have forced him to give better explanations of the backgrounds for the problems and of his assumptions and approximations, and maybe even some errors could have been corrected. The papers have no drawings of his models and no references except to Schrödinger's first paper, which makes it very difficult to follow Engset's lines of thought. In fact, after the first paper he did not really follow Schrödinger's methods and the new developments, and one gets the impression that he was partly stuck in some older theories. Maybe one can find in these papers remains of early ideas on atomic resonances that he has picked up from lectures by V. Bjerknes (1862 – 1951) who was professor of mechanics and mathematical physics in Kristiania (Oslo) from 1907 to 1912 or from C. Størmer (1874 – 1957) who was professor of mathematics from 1903. Bjerknes had done early important work on electrical oscillations with Heinrich Hertz and on hydrodynamical vortices as professor in Stockholm, and he later greatly improved weather forecasting in Leipzig and Bergen. Størmer worked on the northern light and the electron paths from the sun.

Literature

Engset, T. *Annalen der Physik,*
80, 823–828, 1926.
81, 572–576, 1926.
82, 143–154, 1927.
82, 184–190, 1927.
82, 1017–1024, with corrections in 83, 903–904, 1927.
84, 880–890, 1927.

Schrödinger, E. *Annalen der Physik,*
79, 361–376, 1926.
79, 489–527, 1926.
79, 734–756, 1926.
80, 437–490, 1926.
81, 109–139, 1926.
82, 257–264, 1927.
82, 265–272, 1927.

A discussion of the Schrödinger equation can be found in all books on quantum theory, for instance Schiff, L I, *Quantum Mechanics.* New York, McGraw-Hill, 1955, 1968.

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