

The Dwelling as a Place for Work

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Abstract. This paper will discuss the future use of the dwelling as a place for cooperative work. It is our opinion that the development of the communication technologies and the architectural design has to be treated in parallel when we discuss new forms of living and work habits. Our analysis is built on a theoretical framework that is reflected through earlier experiences in IT technology in domestic environments as well as field studies of computer-mediated communication. By taking into consideration both architectural and communication technology issues we have developed a framework of how these two areas could fruitfully meet in new design concepts. Some of these concepts are now being used in on-going projects where new forms of communication in domestic environments are studied.

Keywords. architecture, computer supported cooperative work (CSCW), video-communication, telework, dwelling, ambient media.

1 Introduction

The purpose of this paper is to describe some aspects on how a future dwelling architecture could be developed and how the communication technologies could be integrated to support cooperative work activities in a domestic environment. The analysis is built on a theoretical backbone reflected through experiences in CSCW (Tollmar et. al. 1996, 1997), as well as field studies of IT in domestic environments (Hunhammar et. al. 1996). A wider context will be presented by analysing the historical development as well as some trends and scenarios for the future.

The dwelling is meant primarily to support the activity "to live". So, when the way of living is changing the design of the dwelling also changes. Compare, for example, the radical difference between a dwelling of the agricultural society of the 17th century and an industrial worker's home in 1960's. We are now experiencing a major change in our way of living in the transition from an industrial society to an information society. Our hypothesis is, therefore, that the dwelling of the information society has to be designed in a radically new way, than the dwelling of the industrial society.

Our key argument is that we will spend more and more time in our homes, where we will also accomplish a wider range of activities, including professional work. The reasons for increased work, and cooperative work as well, in our homes are - despite the prerequisites of available IT tools - among others (Forsebäck 1995, Graham and Marvin 1996):

- New social trends and values in a diversified individual perspective where the limits between the private, e.g. the family life, and the public, e.g. work, are loosening up.
- Changing organisational and economical structure within companies and organisations.
- New attitudes from a political view, both national and international.

The widened range of activities in the domestic life and the technology push will lead to an extended need for communication facilities. These will diversify into a set of communication units for different kinds of use. The motivation for acquiring some technologies in domestic environments might even be derived from the dual purpose of fulfilling both social and professional needs.

One way of understanding different kinds of communication systems is to utilize architectural metaphors in our interpretation of a system. To date, it seems that the imitation of architectural or urban spaces has been the dominant strategy for most of the multi-media telepresence systems (Mitchell 1995). All of these electronic systems are based on a rationale of projecting architectural props into an electronic space, i.e. a room or a table. We would like to argue that such metaphors should be pushed even further.

The major goal with this paper is to work out a framework where we can play around with concepts in modern architecture and communication technologies. This paper focuses on architectural and IT-communicative perspectives of dwellings in Sweden and primarily for a growing group of people working in the information sector. Of the different components that computer supported cooperative work consists of we will focus on the live video and audio communication. The paper, in current scope, will not include any deeper discussion about e.g. social, economical or political aspects. However, all are additional important facts of the implications of the new IT technologies for the society of the future.

2 Scenarios of the dwelling, future life and work style

Two scenarios are developed showing different situations where live video communication forms a part of work and spare time activities. It is our hope that the scenarios might work as an introduction to the complex situation of new needs and possibilities involved in the field of new communication technologies and the architectural design of the dwelling.

The scenarios take place in a eleven stories residential building in a Stockholm suburb. People living in the house well represent the new dominating group working in the service and information sector. The year is 2010...

“When the kids comes home”

It's 4.15 p.m. a Thursday in May and David, a married father of two twin daughters is at home working, just as most days of the week. Now he sits in a semi-transparent glass-cube, which is a sort of transit from the staircase to the apartment. He's having a business videoconference.

- Okay David, your comments on the design were great, says Roberto on the big screen. I will do the changes and call you back when it's done. Anyway how are you wife and kids?

- Great, thank you Roberto! Wait, I can see Maria and Sara coming here in the staircase. They are in the hallway now; maybe you can see them coming. They have been to school this afternoon.

- Hi Maria and Sara, welcome home, says David to his daughters. - Say hello to Roberto, a friend of dad who lives in Brasilia. Maria take a step forward and waves her hand to the video screen. And says: - Hello Roberto, I'm Maria. - Hi Maria, answers Roberto, I like your backpack! - Oh really, says Maria, It's my portable computer, I need it for school.

- Alright Roberto, see you soon and send my regards to your family, finishes David.

The screen automatically shuts down and David pushes the movable wall and places it in front of the glass panel leading to the staircase. By doing so he converts the hall into a more private space than the public working space he needed during the day. At the same time he takes the chair he was sitting in and moves it close to the panorama window. Then he turns the chair upside down and suddenly it becomes a comfortable rocking chair for reading a book later at night...

“Talking to grand-ma“

It is evening, 6.30 p.m. The father and the youngest son are watching the children TV together. A “virtual agent” asks if they are willing to take an incoming call from the grand-ma. Steve, the father, replies:

- Yes, of course, you don't have to ask for that, put her through ... Hi mom, how are you doing?
 - I'm fine, how are you John? I'm sorry to interrupt you in the middle of your TV show.
 - That's ok, what's on your mind?
 - Well its John's birthday next week so I thought that I should ask if he has any special wish.
- John replies immediately: - Yes I would like some new pieces to my Lego robot.
- Grand-Ma ; That sounds expensive! But we will see. Could I talk just to you Steve, and Maria (the mother) so John can continue to watch his show?
 - Yes of course, says Steve, I think Maria is still in the car, so let us meet in the kitchen in a minute.
 - Okay, I wait for you there, replies Grand-Ma.
- Steve re-routes the call to the kitchen with the help from his “virtual agent“, and ask it to locate Maria...

3 Architectural Concepts

The most important concepts in the development of the architecture of the dwelling are primarily: time and space and the concept to live. The concept of time and space are important depending on where, when and how one actually does things - in this case to 'live in your home'. The concept live in an architectural perspective is a condition for the being and the space that can not be separated (Norberg-Schultz 1971).

3.1 The dwelling

Historically the activities in the agricultural society where often integrated both in time and in space. Work and idle time where not separate concepts and the whole household participated in the daily work. The majority of activities took place inside or around the buildings. The dwelling was the physical form of the way to survive, and the form was decided by practical and ecological conditions.

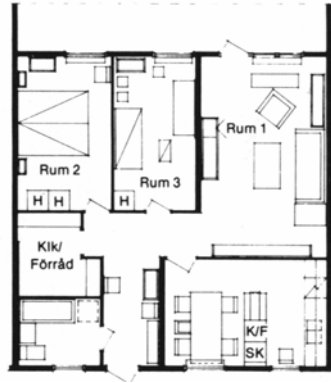


Figure 1. Plan of a Swedish farm with spaces for the majority of the household's activities spread out in different buildings united in one physical form.

Figure 2. Plan of a typical apartment of the 70s, showing an obvious division of some of our different functional activities into spaces.

The industrial revolution led to the division of 'work' and 'live' for the majority of the population and the dwelling turned into a "machine to live in". The dwelling was now designed for: home-work, personal needs, spare time activities and studies for the young generation. The professional work was no longer a part of the dwelling and should be done in the fabrics or at the offices. The activities were separated in time and space with the dwelling at one place, the workplace at a second and the central functions at a third, all tied together through private or public transportation.

The dwelling of the information society will again, probably, represent a wider spectrum of activities integrated in time and space. What will happen is that we, to a much greater extent than today, will work from home, shop from home and take care of the elder population in their homes with support from different IT solutions.

3.2 The concept of time

"Einstein's theory of relativity introduces into physics a notion of time that is intrinsically flexible. Although it did not quite restore the ancient mystical ideas of time as essentially personal and subjective, it did tie the experience of time firmly to the individual observer. No longer could one talk of the time - only my time and your time, depending on how we are moving. To use the catch phrase: time is relative."
(Davies 1995)

Time might apparently be a very simple concept, but it is actually extremely complex and has many ways of interpretation. Here we will, in the first place, focus on how we relate to time. We will also discuss how time is perceived. Worthwhile to notice is that the way we in general relate to time is well behind the more scientific or intellectual understanding of the concept.

In the old agricultural society the relationship to time can be described as circular. The reason for this comes from two directions. One comes from the very nature itself and one origin from the philosophical ideas of Plato. With "from the nature itself" is understood the cyclical character of the nature - the repeating character of the day, the week and the year (Davies 1995). Practically, this relation to time resulted in an adaptation to the nature's outer factors. Philosophically, the circular understanding of time was the way Plato described the time from a more scientific point of view. This model has left deep marks in the western culture.

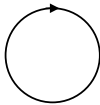

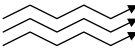
RELATIONS TO TIME			
	"CIRCULAR"	"LINEAR"	"PLURALISTIC-SUBJECTIVE"
GRAFICAL ILLUSTRATION OF THE RELATION TO TIME			
SCIENTIFIC REPRESENTATION	PLATO	NEWTON	BOLTZMAN
HISTORICAL ERA	"AGRICULTURAL SOCIETY"	"INDUSTRIAL SOCIETY"	"INFORMATION SOCIETY"

Figure 3. Graphical illustration of different relations to time in different historical epochs with an indication to identify who originally represented this point of view - in a scientific way

The industrial society's demand of an exact and chronological order in production and distribution changed the concept of time from circular to linear (Davies 1995). There had been an acceptance of an order of time in earlier cultures. But that time could be something precise and objective became possible with the modern science (Davies 1995). Most things such as production of goods and services were measured in time and time studies were done even of activities in the dwelling, e.g., house-wives work in the kitchen.

Time in the information society will rather be perceived as *pluralistic* and *subjective*. Time will be treated as related to: rhythm, length, speed and quality (Mead & Pacione 1996, Philips 1996). More

concrete this could mean that we might feel that the "time is running by" or that something "goes on for ever". In a more global world of information, this new conception of time, means that it's more important what we produce and not when and where we do it. This results in more flexible and individual forms of work and everyday life.

We will be connected and prepared to communicate any second of the day. This will obviously cause problem in domestic environments, in particularly how to handle quality in time - both focus as individuals and as family members. Should, e.g., *all* phones-calls be re-directed towards the answering machine during the family dinner?

3.3 The concept of space

"Architecture is the thoughtful making of spaces. The continual renewal of architecture comes from changing concepts of space."

Louis I. Kahn

The concept of space refers to what Norberg-Schultz (1971) describe as: "architectural space may be understood as a concretization of environmental schemata or images, which form a necessary part of man's general orientation or 'being in the world' ". Man has not always only existed and acted in space, but also created spaces as an expression of their understanding of the world. The architectural space and man's way to relate to and act in it have changed over time.

In the industrial society the concept of space became scientifically rational and in general a spatial result of the analysed function which would take place within it. The dwellings got sleeping rooms, bathrooms and living rooms. The need, will and belief in structuring and classifying even the spaces became important. The American architect Louis Sullivan founded the expression "form follows function", during the late 19th century.

The concept of space in the information society is becoming more complex and can be understood as two parallel spaces: *the electronic* and *the physical*. The electronic space consists of one *representative* space such as virtual reality and another *abstract* space which refers to a non-hierarchical one with free associations and parallel places (Mead & Pacione 1996). The physical space, on the other hand, is the single world where we actually are with our bodies. Hence, the electronic space is global while the physical space becomes more and more local when we spend more of our lives in and around our dwellings.

3.4 Private and public

In the agricultural society where the limits between what we today define as private and public spaces not yet defined. People lived and worked inside the farms main building, outside close to the buildings, or on the fields as a group, i.e., many people slept in the same rooms and beds and the "toilets" consisted of many holes in a row (Rybczynski 1988).

The concept of public and private has during the industrial age developed and become something really important. The private became absolutely private and public became totally public. The earlier public characters in, e.g., traditional farmers house disappeared in the modern planning. The

limits between public and private became sharp; compare for example the public character of a staircase and the very privacy of the apartments hall in a typical residential building of the later decades. Norberg-Schultz (1971) describe this phenomenon as “We have already mentioned variation in the public and the private aspects of the dwelling, and hinted at the fact that modern man to a large extent has lost the level of nature”.

The way to live in our homes in the information society is becoming more complex and with an increasing integration between work, shopping and domestic activities, the limits of private and public will open up (Graham and Marvin 1996). We will also experience new ways of communicating. The technology will, e.g., permit us to break limitations in physical proximity by real-time video communications. Radically different means of connecting places is that everyone can “be their own television broadcaster” and make, i.e., a family home page that opens up the physical family household environment to become more public.

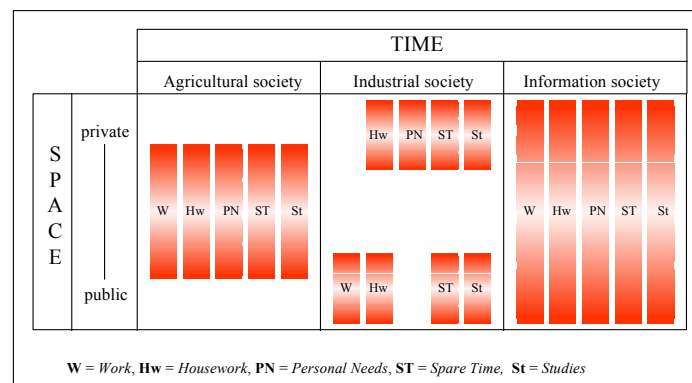


Figure 4. A schematic image over how activities in our everyday-life are located in a private-public aspect over the epochs.

4 Basic Communication

“Many of the significant issues in differentiation arise from the physical environments from which we enter “virtual” spaces; the existencies of particular, local situations lead to variations in virtual behaviour. The homogeneity of distributed communities is often illusory.”
(Dourish 1997)

As the time spent in domestic environment will increase and the activities will undergo changes, the need for new communication facilities will grow. These will diversify into a set of communication units for different kinds of use. We will now discuss some of the implications new communication technique might incur for the domestic environment.

Given the variety of communication in domestic environments one must emphasize on the needed flexibility. Another key factor is to stress the importance of social interaction among members

facilitated by work or by common ties. We may take this a step further and note that in designing domestic communication facilities, the following core attributes might be crucial in creating a sense of accessibility and proximity:

- Finding people and information.
- Creating and sharing social space and workspace.
- Keeping track of events and participating in the governance.
- Use and control of communication media.

Our starting point is the number of prototypes, usability studies and fieldstudies, that have been undertaken on mainly video-communication facilities, e.g. mediaspaces (a virtual space mediated a communication act over distance), within the CSCW (Computer supported cooperative work) community. Previous research on video-communication has revealed many contradictions in our understanding of this communication media. Issues like non-verbal communication and media quality has been heavily debated in the literature (Whittaker 1995). In the context of this work have privacy concerns turned out to be of special interest. In particular, as some places of the future dwelling will become semi-public places, like the family hallway, a dilemma exists where the private, individual, and public space meets. Paul Dourish has reported (1997) about the continuous efforts to experiment with different solutions to privacy issues in mediaspaces. Dourish pointed out the contradiction of the nature of mediaspaces as hybrid physical / virtual environments.

4.1 Architectural Interpretation of Communication Media

One way of understanding different kinds of communication systems is to use physical metaphors in our interpretation of the system. To this day, it seems as if the imitation of architectural and urban spaces has been the dominant strategy for most computer mediated communication systems.

In, e.g., the University of Toronto's video-conference system (Mantei et. al. 1991) a part of the interface consists of small thumb-tack windows, with names underneath of people, who are potentially available for a video-conference. If a person is in her office, a small picture her is displayed, if they would rather not be disturbed, a "half-closed door" reveals only part of the face, and if they really do not want to be interrupted, there is a "DO NOT DISTURB" sign. The design principle was to transpose everyday interaction rituals to an electronic world, based on the social meaning of physical artefacts (i.e. half-closed doors). Architectural props, were used as symbols of an individual's desire for engaging in certain kinds of social (electronically mediated) interaction ("I am busy but if it's really important you can interrupt me with a video-conference").

The intended purpose of such features is to allow the transposition of everyday conversational mechanisms into mediated communication. The essence of this point is an emphasis of the emergence of designing the physical space so it has the affordance of being both virtually and physically shared. The work by William Mitchell (1995) gives us some further references. Mitchell makes a parallel between successful new electronic places and how the urban space was designed in the ancient Greek *agora*, "It was the possession of an agora that made a collection of buildings a city". Mitchell lists four major characteristics that make a space *agora* like:

- Accessibility, open.
- Friendliness, non-hostile.
- Freedom of assembly and action, providing high level of freedom in action.
- Public control of use and transformation over time.

Another worthy source is Ray Oldenburg's (1989) analysis of the concept "third places" in his book "The Great Good Place: Cafes, Coffee Shops, Community Centres, Beauty Parlours, General Stores, Bars, Hangouts, and How They Get You Through the Day". Third places are, according to Oldenburg, neither home nor work, but are places where informal public life can take place. Third places around the world share common and essential features, they are levellers - inclusive rather than exclusive and expand social possibilities.

However it's our standpoint that most imitations of architectural and urban space and places that are used in today's development of communication systems are too crude and superficial. We all know that clever architectural design is like a clever interface - intuitive, attractive and transparent in a subtle combination. In a physical space it is all these subtleties that shape or do not shape the communication within a building, office, public bar etc. Designer of today's electronic communication media unfortunately do not push and advocate the architectural metaphors far enough.

4.2 Create and share social and work space

In our latest research project in video-communication, the VideoCafe project (Tollmar et. al. 1997), we started from an idea of virtually connected public places in two research labs that were about to initiate an collaborative research program. The idea of providing a public mediaspace was built on the assumption that such a space could act as a facilitator for informal community building. By empowering the individuals to be able to take an active part in the discussion and change future plans and activities.

One of the core activities in the VideoCafe project was to experiment with a couple of different room designs. For that purpose we created both new social places in workplaces as well as new styles of interior design that could foster a community.¹

- In connection to shared communication devices (see fig. 5),
- For lobbies (see fig. 6),
- For shared laboratories (see fig. 7),
- For public lunchrooms (see fig. 8,9).

4.2.1 The Corridor

¹ All the places that we here discuss are located within or close to what now is CID (Center for User oriented IT Design) at the Royal Institute of Technology, Stockholm, Sweden. The different interior design solutions for the other research lab at Ericsson MediaLab are discussed elsewhere (Tollmar et. al. 1997).



Figure 5. The VideoCafe concept placed in a corridor.

A corridor was the first place of installation (see fig. 5). The place was close other communication infrastructure, such as faxes, Xerox machines and mailboxes. It also was close to some of the staff member's offices. In general, it could be described as the place through which everybody had a reason to pass, several times per day. Our basic idea was to enrich this place of encounters with the remote lab's presence, but since it literally affected everyone in the lab in a very direct way, several privacy considerations were undertaken to give the place the affordance of different communication zones. The place was divided into three different zones:

- an inner zone where the user could be both seen and heard,
- the background zone where the user could be seen but not heard,
- a free zone where you are neither heard nor seen to be used, for example, by people passing through whom would like to be left alone.

In practice it turned out to be hard to strictly, but flexibly, control the technology in such way that the different zones were clearly distinguished. If you were engaged in a conversation it was hard to protect that conversation, and the place could actually also exhibit a hostile character due to the problem of shielding a conversation. In addition, we found a problem in the fact that public places tend to be owned by their neighbours. What the corridor place lacked in agora terminology was, despite its accessibility, obviously some proportion of friendliness.

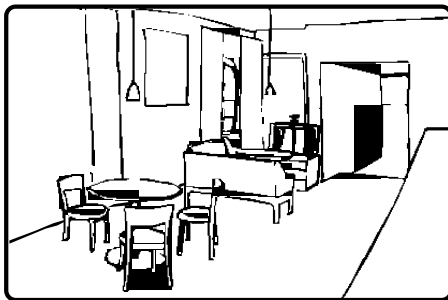


Figure 6. The VideoCafe concept placed in a lobby.

4.2.2 The Lobby

The second place for our prototype was a lobby. The lobby has a more defined role, and is mostly no-mans land. Furthermore, compared to the corridor, it is usually not that heavily trafficked and hence provides a calmer atmosphere for longer conversations (see fig. 6).

However, in our case this place did not work at all. Comments that were made indicated that this is a place of merely pass through,

and very seldom a place where you stop to chat. The frequency of informal encounters dropped noticeably. However, compared to the corridor, this place supported better semi-formal meetings between the labs. Due to its calm nature it became a greater place for extended meetings.

4.2.3 The Lab



Figure 7. The VideoCafe concept placed in the lab.

Our next step was to find a place, which combined the positive aspects from the lobby with the possibilities to, afforded the frequent encounters that the corridor did. The place selected was the common lab. To handle the more tricky privacy issues in the lab, eye-dropping and audio pollution, we removed one of the zones in this prototype. Hence we limited the available zones to two, the inner zone where you can be both seen and heard, and the free zone where you neither are heard nor seen (see fig. 7).

It became apparent that people working in the lab sometimes, naturally, turned the volume down not to be disturbed in their work. Since the audio maybe is the most essential medium for peripheral awareness the need to reduce the volume came into direct conflict with the casual interactions idea, e.g. when people notice the rattle of keys when a person at the other site lock her door at the end of the day. The basic lesson of the lab place experiment was that we needed to add extra interaction devices to our design. Dependent on where you were standing in the room, the communication devices need to adjust to that specific situation. E.g. if people only move around in the free-zone the audio level should be adjusted as well as the camera being positioned into a small, closed field of view.

Another way of solving this is to replace the direct audio with some ambient form of a less intrusive nature. However this form of media-transformation is a complex matter where we have only started to define our needs and have so far only a rudimentary set of conceptual design experiments.

4.2.4 The Kitchen

Taking into consideration the reflections above, particularly that too many of the lab members felt that efficiency was negatively effected by the VideoCafe's presence in the lab, we experienced rather soon a consensus of the necessity of try out a new place. The new place we selected was a half-open self-service kitchen in connection to the main entrance to CID (see fig. 8 and 9).

One of the key problems which we observed during the earlier prototypes was the difference between people sitting down, plausibly engaged in some conversation and people passing through. To be able to work with this, and related issues, we decided to design and build our own tables and

chairs according to our needs. The solution was a raised table in the form of a bar. Our basic idea was two-folded, firstly, we lowered the threshold in the initiation of the conversation and secondly we provided a place for short, spontaneous interactions (see fig. 8).

A problem in the earlier prototypes was that the space did not clearly suggest how many people it was designed for. One of the outcomes of this was that the distance between the participants always varied towards the camera, the microphones and the screen. The shape of the new table also ensured that most participants had a fixed distance between each other. In addition to the tables' two level boards it became possible to separate the hang-around functions with techniques necessary in this settings, remote control, miles of cables, microphones etc.



Figure 8. *The VideoCafé with a specially designed furniture with the two different tables levels for communication devices and the service-area for the user's coffee, papers and pens*

Figure 9. *The VideoCafé concept placed as a café with a piece of specially designed furniture.*

4.3 Use and control of communication media

In our findings three kinds of control veers feedback, system, audio and visual have been identified as critical. Most important is that the user must be able to control the volume of the received audio and turn on and off the audio transmission. An active user must also be able to control his / hers visual field at the opposite site, as well as be given a visual feedback of the video-picture that are sent to the opposite site. We have formulated our experience in two categories of guidelines - how to form the audio-room and how to control the field of vision.

Many earlier studies have shown that the audio quality is an important factor (Tang & Isaacs 1993). In our studies we have been trying to obtain one shared audio-room by using directed audio with CD-quality. Points of interest are in this case to find models for audio visualisation of the shared room to enable equivalent conditions for conversations as in face-to-face conversations in physical room, e.g., back-channels for several simultaneous discussions. This turned out to be a very complicated matter to solve. The basic problem is that every single room audio-acoustic properties differ tremendously from all other rooms, it's like a room's unique fingerprint. No-matter how the audio is processed there will exist a difference in the character of the speech in the physical rooms compared to the transmitted speech from the remote location. Our work-around solution is to filter the audio with extra-ordinary circumspection. But, like in many other design solutions for the

VideoCafe, this will raise a subtle balancing act. The trade-off is to make the speech as good as possible at the expense of reducing the background audio, that is so important for awareness mechanisms.

When people sit in the same room they are able to control their own field of vision by moving their head and body 360 degrees and the participants can immediately see in which direction another person is looking. To be able to achieve some freedom in the field of vision for the remote participants we have experimented with using several video cameras at each site. These cameras can then smoothly provide both overview pictures of the room as well as close-ups. To simplify the interaction with these video cameras a simple IR-control device was developed that controlled both local as well as remote cameras. Nevertheless, in practice we found that contradictory to these features most users instead utilises the space to control distance between participants. For example by placing themselves in the room instead of using the zoom function to zoom in a person they are talking with. This stress even further the question of providing even simpler forms, e.g. a remote control, of interaction devices to control the field of vision. One example in this direction is to use different kinds of motion and presence detectors that could perform camera, as well as audio, adjustments.

4.4 Conclusions from Basic Communication

IT technology is already referred to as a natural component in the way many of us live. Increasing and changing ways of communication will in itself demand new architectural distribution and design of the dwelling. Implementing this for both professional work and social aspects in the context of the dwelling will require more from the technology. With transparent interfaces, intermixed with special devices, it will be possible to focus upon communication instead of technology. Experiences from the use of mediaspaces, that so far primarily have been developed for office buildings, will raise new design-criteria's that seem to be interesting for the dwelling:

- The technology must afford a large degree of flexibility connected to the use of space in the dwelling. It must be possible to transfer a call to another place if the discussion shifts and gets too intrusive for the environment. The space should also afford people to connect to a discussion.
- If a permanent link is connected to places apart there exists big needs of additional levels of communication, sometimes the mediaspace is too noisy and intrusive and in other occasions it is too passive and does not afford that kind of casual communication it is intended for.
- The need for a comfortable and easy interface not distracting the communication act but allowing on-the-fly adjustments of the technology could never be over-exaggerated.
- Problems concerning interior design issues are colour and lightning. Firstly the interior colours need to be colours that can be transmitted with video without distortion. Secondly, does lightning have to be a compromise between the studio lightning and the lightning of a living room.
- Of great importance is also how to create a shared context in the interior that provides an "us" feeling between two rooms.

5 Discussion

The dwelling in the 21st century might not at all mean the same thing as in the 1990's. In the 21st century people will have a greater part of their everyday activities in and around the dwelling. This includes both traditional home-related activities and professional work. The border between homework and professional work will loosen up. Fewer people will have a permanent employment and more will work in temporary projects or run their own business, with the home as their stable and fixed point. A greater number of these activities, i.e. professional work, shopping on Internet, care of elder people and children, and video-telephony, will also be supported by different kinds of communication technologies. The dwelling will in this context function as the physical base of one's existence.

5.1 New use of communication media

From our studies of video-communication we have found two interesting strands of further development that might be of special interest for the appliance of mediaspaces technologies in domestic environments. Firstly, there exist a big need of different levels of communication. Sometimes the mediaspace is too noisy and intrusive and on other occasions the mediaspace is too passive and cannot allow the kind of casual communication that it is intended for. Different forms of media transformations seem here to be a promising direction for further development. Secondly, even a simple function like adjusting the camera with a remote control could easily create breakdowns in the discussion. An alternative kind of interface that utilise the position and the gestures of the body in the room could be a comfortable and easy alternative interface.

It's our standpoint that concerns regarding privacy, a major source to problems in office environments, will only be more important to handle properly if we want to move this kind of communication techniques into domestic environments. Our new direction is to examine some alternative solutions where some media undertake some transformation into new forms, media forms that maybe is not direct and intrusive. It might be wanted to, in some domestic environments, make it possible to hear, rather than see, where other things or people are and what they do. Both due to privacy concerns but also to practical concerns since it is not possible to look around every corner in a domestic environment. Like cord-less phones, we would like to enable users to freely move around and let other more practical factors decide where the communication act takes place.

A mix of the above questions yields a generic issue; *could the room adjust itself to different levels of communication?* Depending on people's position and activity, e.g. use of other services. We are especially interested in investigating different kinds of mechanisms that, in a semiautomatic way, based on preferences and physical controls, help the user to adjust to a suitable level of communication. Today, we are working with motion and image detectors to adjust audio and visual fields in our system. A general guideline is to build the interface as transparently as possible, the ideal is that you will be able to use your body in the room as the main interaction device.

5.2 The architectural and communicative expression

Although the later part of this paper focuses on communicative aspects in the use and design of the dwelling, we will here continue the architectural discussion from the first part of the paper. Lately some architects who have intended to approach IT and communication aspects in the dwelling have done this from a view that the use and meaning of the dwelling is something permanent, and not something that develops with a changing of the way of life. Therefore we discuss some general aspects of a future architecture.

Architecture has always expressed some of the fundamental ideas of the time in which it was created. The information age will be unhierarchical, subjective and flexible among other characteristics and so will it be architecture. Rather than 'tearing down and building new' as in the industrial age, reconstruction, addition and extension will be the dominating way in the construction of the information society. The huge number of existing dwellings will experience a great change to adapt to new and changing needs in the information society. New building elements and techniques will probably be mixed with traditional ways of building. The architectural expression will therefore be a mixture of old and new ideals, forms and materials. Sensors will be built into materials, building components, machines and furniture are meant to collect and transmit information. This will add to traditional ideas about architectural elements and expressions, a new dimension and meaning.

Some architectural design ideas and concepts have been developed from the above discussion. These are here presented in a wider sense:

- There will be an extended number of activities taking place in the homes and these will vary during the day and the week. The average time spent at home will also increase, which means that with maintenance of today's use of space will be a needed to adapt the dwelling according to the activities taking place at the moment. A solution might be *flexible and moveable walls and wall-systems* that could provide spaces adequate for the changing activities.
- Apartments from the industrial ages are generally very closed towards any public space and of a strict private character. There are reasons to expect an increasing need to physically *open up* the apartments towards the public staircase, e.g. with glassed walls or new physical forms.
- Changing and more extended use of the buildings *common spaces* for activities such as meetings, delivery of products and tele-work in favour of e.g. laundry and storage will take place. These semi-public places will in this way temporarily become more private. The borders between the public and private will in this sense be more flexible and diffuse.
- The lack of space and the different characters of the varying activities will also demand a wider use of the furniture in domestic environments. Today a bed, table or chair normally is designed only for one single function. But there will be an increasing demand for multifunctional furniture, adaptable - in colour, size, form and other characteristics - to different activities and situations.

- Another overall aspect is that these technologies, building components and furniture not only have to be able to adapt to different situations but also to personal needs and habits.

5.3 Future Work

An architectural design solution for distribution of video-communication that we are working on is to divide spaces in the dwelling into *different zones* where each zone has an intuitive clear communication mode, as we above argued. The zones may vary over the time and so might the spaces' forms and functions. From this, a more specific architectural and communicative design concept might be developed mutually. A design which is a combination of technology solutions and physically building components.

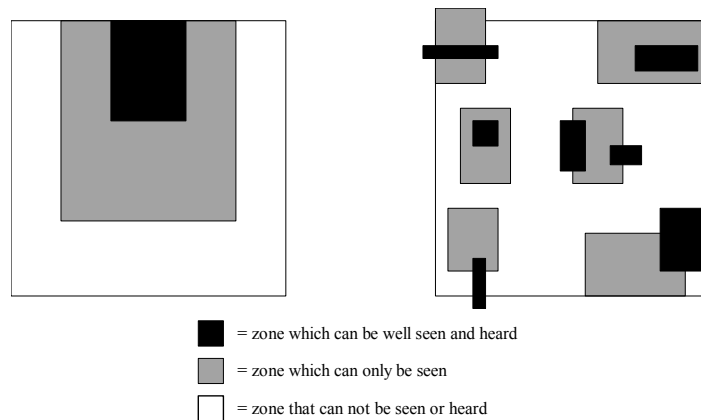


Figure 10. Graphical illustrations of conceptual communication designs.

To the left: Traditional hierarchical design concept for dwellings with one zone placed at a strategic point such as the hallway.

To the right: Alternative "network-floorplan" - developed by the authors - with flexible zones distributed over the apartment.

From our experience it is also clear that this kind of places would strongly benefit from more subtle communication qualities. Qualities, which may not be found in improved video or audio sampling frequency, but qualities that might significantly enrich the experience of remote places through communication technology. We have, thus, in ongoing projects started to explore new spatial and artifactual tools to address other experiences as a complement to the functional media provided by audio and video. The origin of these tools comes from a context of everyday life. The goal is to replace the ambient communication that is obviously lost between remote places but might be replaced by artificial spaces. To illustrate this further we finish this paper here with some brief examples; imagine a connection between a pair of chairs, if one of them is used the other one will also be heated to indicate (tele)presence, a lamp could be connected to a remote piezo sensors or stretch sensors that toggled on/off depending on remote presence, or that

connected places share temperature, air humidity and lightness. Our working hypothesis is that restrictions, for example for privacy concerns - which are of particularly interest for domestic environments, in direct media, could be replaced by incorporating this kind of ambient media.

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