Private and Public Digital Domestic Spaces

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SUMMARY

With the introduction of information and communication technologies into our homes and the different physical and communicative expressions this implies for our living spaces the concepts of being *private* and of being *public* becomes crucial. In this paper we introduce the *design pattern language*, developed by Christopher Alexander in the 1970s, in order to handle these problems systematically. The presentation formally follows Alexander's structure in five cases all related to practical experiments on being private and public at home. We start with a number of concrete user situations related to human-computer interaction. Social and communicative phenomena or possibilities end up in novel design patterns at the interface between an architectural and a technological perspective. The novel patterns presented are primarily based on experiences from practical work on the development of a conceptual dwelling of the future, *comHOME*, designed and constructed as a full-scale model of a flat. By creating different zones for video-mediated communication, *comZONES*, the user can control the private and public digital areas varying in time and space. The novel patterns refer to two separate levels. On the first level a specific pattern, called "PRIVATE AND PUBLIC DIGITAL SPACES", is designed as a conceptual floor plan layout. This plan distributes private and public digital spaces for video-mediated communication over the flat. At a second level, four patterns show the integration of the specific comZONES aiming at solving four specific problems with video-mediated communication at home. Our intention is to describe the application of design patterns as a method for analysing and solving novel problems encountered with the introduction of information and communication technologies in our homes. The video-mediated set-ups are not dealt with in depth. They serve mainly as designs that make it possible to apply the design patterns.

1 BACKGROUND

We are now experiencing a transition from the industrial society to the society of information. The information and communication technologies (ICT) are the prerequisites for the current transformation from a society based on the production of goods to a society characterised by information processing and communication (Dahlbom 1997). One emerging consequence regards the way we will use our homes in the future. Increasing interdependence in both time and space between work, shopping and traditional domestic activities is assumed to take place (Junestrand and Tollmar 1998). Further, ICT are assumed to support new processes in the home, thereby overcoming the traditional organisation of domestic activities. Many of these processes have a public or semi-public aspect, especially those possibly supported by video-mediated communication (VMC), but to large an extent the existing building stock seems to lack the qualities needed to support those processes. The earlier "public" character of a traditional farmer's house or bourgeois flat has disappeared with the modern housing planning. Instead, distinguishing the public from the private has become central during the industrial age, with the dwelling as a private place. Now, with the transition to an information society, it seems as if the concept of public space in the private dwelling has to be reconsidered (Junestrand & Tollmar 1998), which means that the borders between the private and the public at home are opened up (Graham & Marvin 1996).

1.1 Video-Mediated Communication in the Domestic Environment

Our core hypothesis is that Video Mediated Communication (VMC) is useful for the mixed demand required at domestic communication. VMC supports primarily social and emotional aspects of communication, which then become the primary requirements for a VMC system (Kraut and Fish 1997 and Whittaker 1995). Thus, VMC can support and complement a wide range of home based activities like, e.g., work, studies, care of elderly and disabled persons, leisure activities and consultations with a bank or a doctor. But, VMC, with its current solutions mainly developed for traditional offices, does not seem to be well suited for homes. Other problems are acoustics and light conditions, floor plans and spatial design in general as well as lack of technical infrastructure in existing dwellings. Though, VMC has the potential to open up our homes with new public areas electronically accessible from anywhere and at any time. The main focus of this paper is how to handle the public and private aspects with the introduction of video communication in the domestic spaces.

1.2 The Home of the Future - a Multidisciplinary Design Problem

The design of the built environment of the future is a multidisciplinary activity and requires a variety of competencies, e.g. architects, mechanical engineers, electrical/lighting engineers, telecommunication designers and construction managers (Hartkopf et al. 1999). Emerging problems in the design process of residential houses are the increased importance of ICT competencies and the speed of the development in the field. Another problem is that the change of home based activities and their organisation in time and space is not fully understood by those involved in the design process. The expertise involved, including the architect, seems to adapt to standard solutions without any concern for the new requirements. Pemberton and Griffiths (1998) write: "Clearly it would make sense if, rather than each profession conceptualising the problem and the solution in its own way, they shared some terms and mental structures for communication and design goals and constrains which apply in each area. Buildings need to be designed by people capable of speaking a common language". Christopher Alexander introduced such a language in the 1970s as *A Pattern Language*.

Pemberton and Griffiths (1998) argue that the various generally available design processes can be effectively applied also to architectural and engineering design from the 1960s and onwards in the US and Europe. In particular, in the complex multidisciplinary domain of building design, they see a place for the Design Pattern Language. Although Alexander's design patterns were originally developed for the domains of architecture, town planning and interior design, they have been applied successfully over the last few years in computer science, e.g. in object-oriented design. Thus, the approach of using Design Patterns as a method for solving multi-disciplinary design problems in a variety of fields has encouraged us to develop new patterns for the design of the future home environment.

2 A PATTERN LANGUAGE AS A DESIGN METHODOLOGY

The work of Alexander during the 70s on the development of a *pattern language*, PL, emerged from a desire to explore the unmeasurable aspects of architecture, which largely had disappeared in modern planning and building during the 1950s and 1960s. This work resulted in two volumes. *The Timeless Way of Building* (Alexander 1979) contains a description of the making of towns and buildings. Here Alexander intends to show that towns and buildings will not come alive unless all members of a society make them come alive by means of a PL. The book can be described as a theory of PL. His work provides a valuable theoretical framework that is necessary for the understanding of the concept of PL. In *A Pattern Language* (Alexander et al. 1977), an applicable PL is presented. The PL has the structure of a network. "The elements of this language are entities called patterns. Each pattern describes a problem which occurs over and over again in our built environment, and then describes a core solution to that problem, in such a way that you can use this solution a million times over, and without ever doing the same way twice." (Alexander et al. 1977). A *core solution*, a notion used by Alexander, is a *generic solution* in terms of systems theory.

"The patterns are ordered, beginning with the very largest, for regions and towns, then working through neighbourhoods, clusters of buildings, buildings, rooms and alcoves, ending finally with details and constructions. This order, which is presented as a straight linear sequence, is essential for the way the language works" (Alexander et al. 1977). Most important is the hierarchical connectivity between the patterns on different levels, which relate them to each other, like a semantic tree representing a total structure.

Alexander (1977) writes that "the patterns are very much alive and envolving. In fact, if you like, each pattern may be looked upon as a hypothesis like one of the hypotheses of science. In this sense, each pattern represents our current best guess as to what arrangement of the physical environment will work to solve the problem presented. The empirical questions centre around the problem - does it occur and is it felt in the way we describe it? - and the solution - does the arrangement we proposed in fact resolve the problem? And the asterisk represents our degree of faith in these hypotheses. But no matter what the asterisks say, the patterns are still hypotheses, and are therefore all tentative, all free to envolve under the impact of new experience and observation." This quote explains our own approach to the use of patterns. The PL has been an object for criticism, e.g. its top-down problem solving principle. Despite this we have found it reasonable to apply PL as a design method with regard to the home environment in connection with new communication media in the homes, since it offers a scheme that demonstrates and communicates the ideas and experiences we have acquired in our own work.

A design pattern has the following structure (Alexander et al. 1977 and Pemberton & Griffiths 1998) (see the Appendix 1 as an example). Later in this paper precisely this structure will be applied to the new patterns introduced for the handling of new VMC technologies in the home setting.

Concept	Form	Description
Title	Pattern no. & Text & 0-2 asterisks.	Indicates the design solution of the pattern. The asterisks indicate the validity of the pattern, two at most.
Picture	Photo or illustration	An archetypal example of the pattern.
Introduction	...Text	The context for the pattern by means of links to larger patterns. Starts with three dots.
Diamonds	◊ ◊ ◊	Three diamonds mark the beginning of the problem
Headline	Text in bold type	The essence of the problem in one or two sentences.
Body of problem	Text and illustrations	The empirical background to the pattern, the evidence for its validity, the range of manifestation in a building and so on.
Solution	Text in bold type	The field of physical and social relationships which are required to solve the stated problem in the stated context. The solution is always stated in the form of an instruction so that you know exactly what you need to do to build the pattern.
Diagram	Drawing and text	The solution, in the form of a diagram, with labels that indicate its main components.
Diamonds	◊ ◊ ◊	Three diamonds to show that the main body of the pattern is finished.
Connections	Text...	Tie the pattern to all the smaller patterns that are needed to complete this pattern. Ends with three dots.

Figure 1. Table of the Design Pattern structure.

3 SOME THEORETICAL ASPECTS

Several fields of knowledge influence our perspective: the architectural, the technological and the social, each with its own framework of concepts and theories. All these fields include an aspect of exploration and design, which we have taken as our common view for the above mentioned scientific fields. A source for this approach is the "Sciences of the Artificial" by Herbert Simon (Simon 1981) and further developed by Bo Dahlbom in the 1990s (Dahlboom 1997). Thus, PL should be seen as a design method rather than as a formal theory.

3.1 Design theory

According to Simon (1981), the design process, contrary to the natural sciences, aims to define how things *ought to be*, rather than how things *are*. This leads to Simon's four criteria for the sciences of the artificial:

- Artificial things are synthesised by man (like our homes, communication systems and devices).
- Artificial things may imitate the appearance of natural things, but lack in one or several respects the reality of the latter (an image of a man on a screen is not the man himself, although we may neglect this fact under some circumstances).
- Artificial things can be characterised in terms of functions, goals and adaptation (e.g. a VMC communication shall convey messages, intentions and emotions more fully than a telephone communication).
- Artificial things are discussed, particularly when they are being designed, in terms of imperatives (shall, ought to) as well as descriptives (is, will become).

Dahlbom criticises Simon, not for the approach, but for not bravely fulfilling the line he initiated. Dahlbom stresses the fact that we live in a world of artefacts that both enable us in different respects and influence our lives. The research on artefacts is oriented towards the future. The research methodology, Dahlboom argues, is *archaeology of the future*. While the archaeologist creates a picture of the past by searching for fragments from earlier cultures and synthesising and interpolating these fragments, the scientist of the artificial makes designs (fragments of the future), to model and simulate possible larger parts of the future. Dahlbom (1997) writes: "When we realise that the world we live in is an artificial world, a world of human creation, made up of artefacts of all kinds, becoming even more complex and intertwined, our attention will shift from studying nature to contributing to the design of artefacts. In this future science we become, as designers, a part of the design". Thus, our intention is to investigate what is possible in design and thereafter to structure, analyse and communicate our findings.

The idea of design as a science of the future complements other approaches to design as a scientific field. Adrian Forty (1986), e.g., is basically descriptive in his work with unveiling the close connection between the design of objects for the home during two centuries and the concurrent development of society. We also believe in such a connection in our time, albeit not in focus for our work described here.

3.2 Social life and everyday technology in the home

In predictions about the future, the domains of work and play, education and entertainment, industry and art, public and private, are no longer strictly separated (Philips 1996). Transactions and communications continue around the world at the same pace, day and night. At home, too, many activities are performed simultaneously; cooking while watching TV, monitoring the children sleeping in the bedroom while entertaining friends in the living room; working while listening to music etc. (Venkatesh 1996).

Hughes et al (1997) describes a more holistic view of the role of technology in the home environment mainly from a sociological point of view. The authors argue that the impact of new technology in the home environment is increasing. They found that the presence of technology in the home is absorbed so completely into the routines of home life that it becomes yet another way in which these routines can be articulated. However, technology is not applied without problems in everyday life. On the contrary, the context of home activities is generally strict. The activities are constrained by explicit or tacit rules. If reconfigurations of rooms occur, they are carried out within given boundaries. The authors also found, in cases where technology was the reason for the rearrangement, that this caused stress. The technology was badly designed and not user-friendly.

3.3 Architectural design

Architectural design issues are related to the explorative and creative development of the early functionalist period of architecture with the development of novel ideas for the dwelling occurring in the beginning of this century. The building was then referred to "as a machine to live in" (Le Corbusier 1923). Here it is more considered as the central place in peoples' emotional and social lives. There is also a reference to the more formal aspects of architectural design as far as cognitive and psychological aspects are concerned (cf. Hall 1966 and Weber 1995).

During the planning and design of a dwelling, different spaces might be considered as being more or less private. For instance the bedroom is considered as private space and the living room might be considered semi-public. But the actual use of these spaces is very different. It unveils e.g. that a bedroom during a party can become a public space with people sitting on the bed or dancing on the floor; or a living room becomes a “bedroom” for an invited guest sleeping in the sofa. Based on the facts that no room has a degree of privacy as a specific property, but is rather decided by how that space is used, we have tried to create designs that can vary in time and space adapting them to the current social context.

Architectural research and development (R & D) related to the use of IT in the home environment, intelligent buildings or smart homes, appear to be focused on the technology rather than on architectural design. An exception is the work by Olindo Caso (Caso & Tacken 1993), which is an analysis and a classification of different IT-supported activities to be carried out in a home environment. The study includes no experimental verifications but gives a comprehensive overview of some of the principal questions discussed here.

3.4 Computer Supported Cooperative Work (CSCW)

Within the research area of CSCW, the importance of a medium that might support informal communication has been discussed for a long (Kraut & Fish 1997). Studies of video-communication have indicated that the predominant contribution of the video-medium is the rich social context (Tang & Isaak 1993) and that video-communication is well suited for informal communication (Bly 1993).

We assume that informal network building and maintenance will become even more crucial for the individual when an increasing part of professional work will be carried out at home. Consequently, our working hypothesis is that VMC has the potential to become a major communication media for work at home. In our work presented in this paper are we still experimenting with the foundations of enabling the VMC in domestic settings.

As VMC moves from the office to the domestic environment, we should be able to learn many important lessons from the CSCW research. In the context of video communication for remote collaboration, the major focus has been on whether or not the video medium actually improves conversation. A great deal of work in this field has moved along the path of defining variables that might be used in order to solve the question of how valuable the video medium really is. In some cases, researchers have been able to separate variables moving along deterministic paths. However, it has been difficult to generalise these findings (Whittaker 1995). In current research on mediaspace, non-quantitative studies have been conducted in an attempt to specify users’ perception and awareness of the presence of others. This provides a new direction to study video-communication, by assess the user experience of the technology rather than by defining some “objective efficiency” factors.

4 COMHOME - A VISION OF A FLAT OF THE FUTURE

Our primary research site is the *comHOME* flat, which simulates a dwelling of the future. The site is used both as a laboratory and as a showroom. The comHOME project covers several aspects of a future dwelling. The main goal in the comHOME project has been to integrate VMC solutions into the home, but we work on smart homes too. *Smart* in this context refers to an object or an environment that contains one or more of the following characteristics:

- *interactive*, i.e. the user can interact with the device and influence the way it works;
- provided with *information and communication technology*, e.g. sensors, processors, and software;
- *communicable*, e.g. that messages between the user and the device/system can be conveyed and exchanged;
- set-up with *novel types of interfaces* such as speech, gestures, positioning and touch that differ from traditional ones (screens, keyboards and mice);
- *adaptive* to individual needs and desires;
- *learning*, i.e. to learn and support the user's habits automatically.

We have had the responsibility for the architectural and technological design of the comHOME dwelling. However, the project was conducted in co-operation with a telecom operator and a company providing and developing Lon-Works automation technology.

The comHOME dwelling consists of three rooms: a living room, a kitchen, a combined home office and bedroom. It was constructed as a full-scale model inside an existing office building. It is not a complete flat, for example, there is no bathroom, and the floor-plan layout is not intended to live in.

In our attempt to explore the usability of the concepts *private and public digital spaces*, we have designed a set of four places, *comZONES*, for which we have created different architectural and technical design set-ups. Each one of these set-ups is independent and aims at supporting fundamental home based activities. This has forced us to work with the core processes of every activity. However, in real life the whole dwelling, should be seen as a potential place for e.g. "telework", rather than having this activity strictly limited to a specific area (Junestrand & Leal 1998).

The comHOME flat was built on the basis of existing "on the shelf" technologies. The presentation of the new design patterns below describes a mix of what has been done and visions of what is going to be done in the near future in the design of the comHOME flat. The solutions of the different comZONES will not be further described here (for more detailed descriptions, see Junestrand et al. 2000 and Junestrand & Tollmar 1999).

5 OUR TASK

The research project aims to *explore* and to *make proposals* for new patterns when using ICT in the home. The general research objective is: “how should VMC solutions be designed and integrated into a future home environment, with regard to the need for both private and public spaces in the home?”

From this starting point, more specific research objectives can be formulated. As mentioned earlier, the questions can be referred to two levels. The first level refers to the whole floor plan layout of the dwelling:

- What should a general floor plan pattern look like in a home of the future, when integrating digital public and private spaces?

The second level addresses the VMC solutions proposed or designed:

- How should the different design patterns be formulated in order to generalise the experiences of the specific comZONES, set-ups, developed for the comHOME?

Some general background questions have guided our work:

- What processes in the home environment of everyday activities of the future can and should be supported by VMC?
- How should the specific VMC set-ups be designed to support the activities they are supposed to support?
- What is the organisation of time and space for everyday activities like in a future home environment?
- How can VMC be integrated with other advanced domestic technologies and a general smart system?
- How can the design pattern methodology contribute to the formulation of requirements for new interfaces, in order to facilitate user interaction with the VMC system?

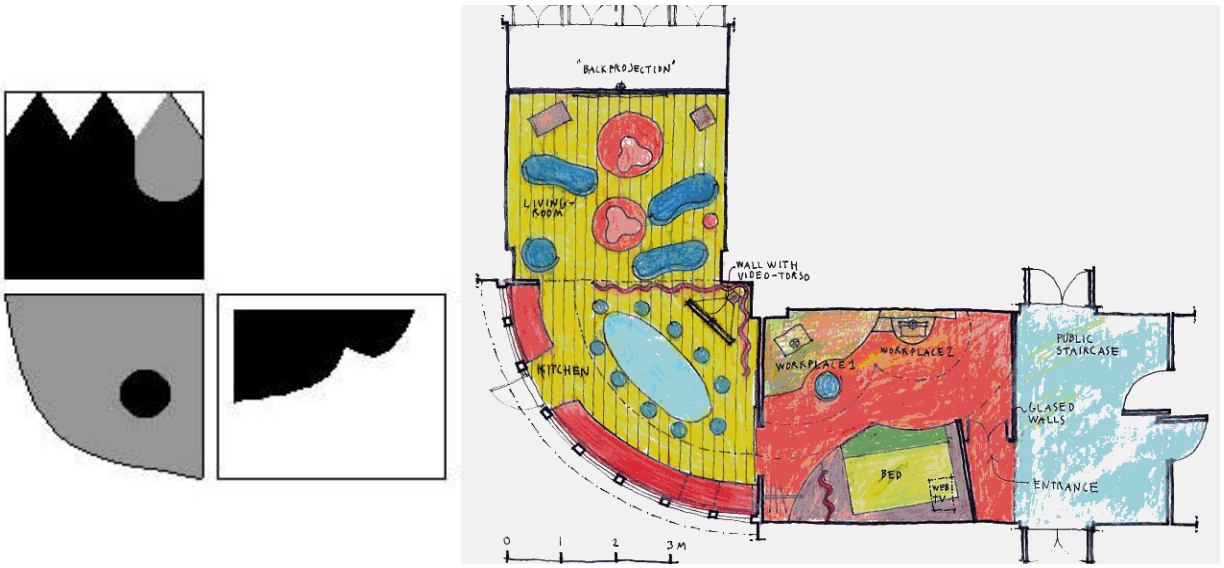
Below, we elaborate some of these questions, by applying the pattern language methodology. In a way, this is an intellectual exercise, aiming at the exploration of PL. Further our aim is to contribute to better insight into the crucial issue of public and private spaces, and into the VMC and its constraints.

As pointed out above, many restrictions have to be considered when the result from the analysis is interpreted. Communication of other sensations than image and sound, such as tactile communication, smell and taste, are not supposed to take place, although such qualities will certainly not be excluded in the long term. We are also limiting ourselves to images on screens and, in one case, a back projection. Furthermore, several activities could certainly have locations better suited for a part of the living process than those arranged for and described here. Reading a book in a sofa, e.g., is more natural than sitting with a book in front of a VDU. Also only fixed set-ups are tested and no mobile unit has been used due to technological limitations. The work described here is primarily a test of the Pattern Language as a method of design and communication, rather than a test of specific set-ups. So, the PL has not been applied to the design of the set-ups, rather it is tried in order to explore if it is a convenient method for the design of other set-ups.

6 DESIGN PATTERNS FOR PRIVATE AND PUBLIC DIGITAL SPACES IN THE HOME ENVIRONMENT

A set of new patterns, developed from the comHOME flat, is presented in this section. The patterns strictly follow the pattern language presented by Alexander (1977), see figure 1 for the applied schema and Appendix 1 as a reference to an original pattern. The number given to each new pattern is chosen so that we can introduce our new patterns in the context of an existing pattern language. From the perspective of the design of a home, the patterns represent two structural levels. On the first level there is a general pattern "PRIVATE AND PUBLIC DIGITAL SPACES" for a flat, which is shaped as a grid over a conceptual flat floor plan and which distributes private and public (fixed and flexible) spaces for Video Mediated Communication (VMC). On the second level, there are a number of patterns that provide solutions for the integration of the specific comZONES (communicative zones for VMC) that support different home activities, and where the resident can be seen and heard in different ways varying in time and space. The comZONES are described principally from an architectural perspective (representing form and function) and a technological perspective (hardware and software). Note however, that the descriptions of the comZONES in the proposed patterns are a combination of existing technologies on one hand, and on the other hand design concepts and goals that are not yet fully in use.

6.1 (127 b) PRIVATE AND PUBLIC DIGITAL SPACES



<u>To the left</u>: Conceptual design of the floor plan indicating the comZONES. In the inner black zone the individual can be both seen and heard by the VMC equipment. In outer grey zone the resident might only be seen but not heard. In the surrounding white zone the person can neither be seen nor heard. The zones do vary in time and space. <u>To the right</u>: Floor plan sketch of the dwelling. The entrance is at the lower right. The middle room at the bottom is a combined telework and sleeping room. To the lower left is a kitchen, and to the upper left is a living room.

The current development of information technologies is rapid and VMC will probably become an important part of the communication to and from our homes in the future. VMC has partly a public character. This pattern helps to distribute the integration of private and public digital spaces in the design of the dwelling. It is also connected to THE FAMILY (75), the HOUSE FOR A SMALL FAMILY (76) and the HOUSE FOR A COUPLE (77). It also refers to the MAIN ENTRANCE (110) and complements (and in some way opposes) the INTIMACY GRADIENT (127).

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New public digital spaces are created when activities supported by video mediated communication are performed throughout the domestic environment. This breaks the established hierarchical separation of private and public spaces in the design of the home. If the different aspects of this problem are not addressed consciously a lot of people will feel uncomfortable and insecure in their own home.

The spatial design of comHOME supports activities with the use of VMC and is based on the idea of creating different comZONES (zones for video mediated communication) in order to support the demands of both private and public digital spaces in the home. In *public zones*, a person can be both seen and heard with the help of an image and a sound recorder (VMC). In *semi-public zones*, the individual can be seen but not heard. In the *private zones*, the resident can neither be seen nor heard. The zones are variable in time and space.

The governing architectural principle in the design of the comHOME flat was to establish the mental and physical boundaries between the public and the private zones. A good balance between the VMC-activities and other everyday activities is important. Both the inside-out

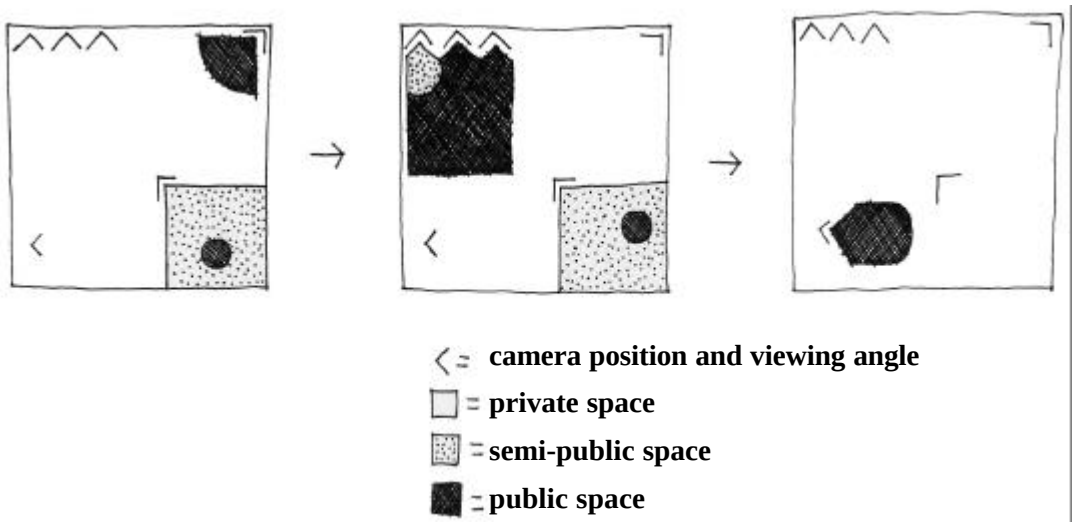
and the outside-in perspectives where acknowledged, i.e. how the outside is perceived through VMC from the inside, and how the inside is perceived from the outside. This was solved by the creation of a number of comZONES intended to support a number of everyday activities. The different comZONES are expressed by technical set-ups - screens and cameras - and by using architectural terms - spatial forms, colours, light, materials. Thus, the architectural space related to ICT solutions forms an interface to the digital world (see the following patterns for descriptions of each of the comZONES).

Developing VMC in the comHOME setting uncovered multiple layers of complexity. First, a home is a radically different place compared to a more controlled office environment, and poor lighting and audio conditions, for instance, should be considered to be the norm rather than the exception. The technical design of the video and audio space in comHOME is based on several short-range cameras and microphones that are mapped and routed through a common media switch. The switch could be seen as the heart of all incoming and outgoing media streams. The control of the media switch is monitored either via a remote control or via a graphics user interface, or, automatically, by the central logic of the smart home. Further, a default set-up could be activated by the central logic of the smart home that governs the data stream through the media switch. Hence, the video and audio space is closely linked to the automation of comHOME as a smart home. An incoming video call, for instance, could automatically be routed to the room where the receiver is and triggers dimming of the lights and muting of the radio in the room.

The different comZONES for the rooms in comHOME can be created in many different ways. Reducing the number of potential solutions is a major undertaking. With the location of the cameras, the control of depth of field, and viewing angles, the video space in the different zones could be adjusted. The control of the audio space is more crucial. Array microphones and spatially directed loudspeakers might be a solution. However, experience of these technologies was lacking. Similarly, real time image manipulation, which extracts irrelevant background activities, can be used in some cases. Early works have proposed the use of physical metaphors for the control of the video and audio space in VMC systems. One approach, suggested by Kawai et al. (1996), was to use a graphics user interface with a floor plan in order to control the viewing range of the cameras. Most of these methods suggest an explicit and direct control of the cameras. For comHOME, the variation of the zones in space will mainly be controlled by a spatial recognition system linking the physical position to the identity of the person(s) in the room.

Therefore:

Design and locate the comZONES in the dwelling in such a way that they support the activities they are designed for in the best way possible. At the same time the design and locations of the comZONES have to be integrated so that they do not interfere with other everyday activities. The comZONES should be expressed both in the architecture and technology and made to fit naturally into the home environment. The public places may vary in time and space but it should always be clearly indicated whether the comZONES are in a communicative mode or not, i.e. if the space is *public* at the moment. This should be done by a clear feedback to the user (similar to WYSIWYG - what you see [and hear] is what you get, but with an extended and entirely new interpretation). This will make people feel comfortable and secure in the home environment.



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Consider the possibility to use INDOOR SUNLIGHT (128) for some comZONES and create comZONES in relation to COMMON AREAS AT THE HEART (129). To complete the pattern, consider A ROOM OF ONE'S OWN (141), a good distribution of SEQUENCE OF SITTING SPACES (142) and that the STRUCTURE FOLLOWS SOCIAL SPACES (205).

6.2 (196b) videoTORSO

A desire for more informal social contacts with friends and members of the family can be fulfilled with the help of a videoTORSO, which is a set-up enabling communication with a person as if he/she stood in the room. This pattern helps to complete the aspect of informal social communication in PRIVATE AND PUBLIC SPACES (127 b), COMMON AREAS AT THE HEART (129) and at the FARMHOUSE KITCHEN (139), and makes the pattern design applicable to the home context.

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Family members and friends seem to have less and less time to spend with each other. The lack of communication tears the family and relations apart.

Informal social communication between family members and friends is crucial to personal relations. But individuals, both within the family and among friends, seem to spend less time in each other's company. This concerns both the number of times people meet and the length of time they spend together. The physical distances between related persons also increase because of the fact that people travel more and longer distances and that the patterns of human habitat are more widely spread around the world, for both social and economic reasons. The need for informal social communication in the domestic environment among family members and friends will probably remain strong. The *videoTORSO*, which is a VMC set-up, is intended to support this type of casual conversation style. The hardware and software of the videoTORSO consist of:

- A large flat screen placed on a wall, which is possible to adjust in height, thereby allowing for both tall and short standing users.
- Loudspeakers just above each side of the screen, making the sound appear from the videoTORSO.
- A camera with automatic tracking placed as close as possible beside the eye level of the person appearing on the screen.

- Microphones placed just beside the screen.
- Software for video communication, voice and gesture commands.

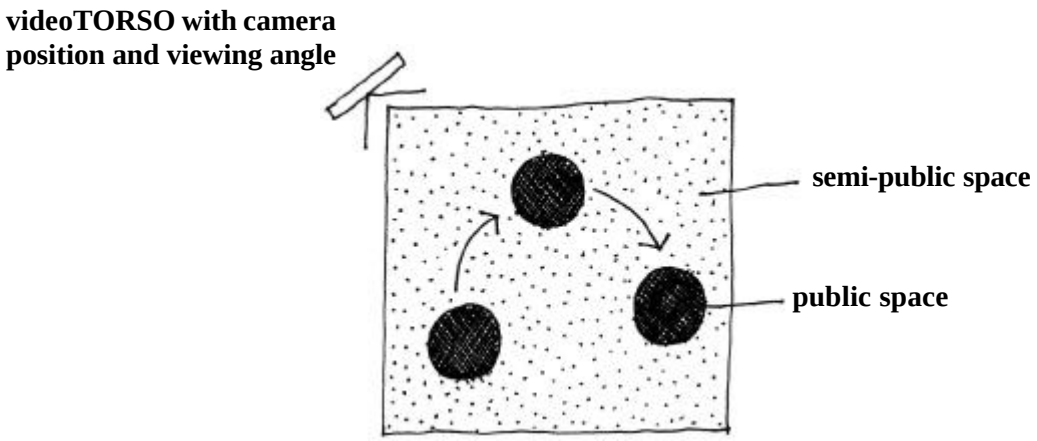
These parts are integrated in one single device, the videoTORSO, which makes it possible to convey social and emotional qualities similar to those that could be attributed to a person. The videoTORSO is connected to the logic of the smart home, and enables routing of calls, positioning of people etc.

The location of the videoTORSO in the room is also essential. If the objective is to simulate a person standing in the room, it is important to locate it at a place that is natural to turn to. It is also important to consider the tracking cameras connected to the videoTORSO. They capture the person and his background. The limits of the camera view (angles of tracking) have to be controlled. This can be done with architectural delimitations or software/hardware solutions and may restrict the location of the videoTORSO to places where the viewing angles and the background are physically obscured by the architectural design, e.g. a wall or a curtain. The sound in the room should be captured mainly from the person having the conversation. If several persons participate, the sound from all of them should be captured. People in the room who are not participating in the conversation should only appear as images producing background sound and images and are thus *semi-public*.

The videoTORSO might substitute a person in the room. The person at the other side of the screen, however, will not experience him/self being in the kitchen. Since the camera automatically tracks the person in the kitchen, the environment is not fully perceived. This makes the dynamic space around the communicating person a *public space* and the rest of the room becomes at least partly *semi-public* or *private.* It is fundamental that the system's feedback is clearly expressed. When testing the systems, we noticed that people felt that they themselves where not seen or heard as soon as the VMC set-up was black and mute. It is recommended to locate the videoTORSO in relatively public space, preferably the kitchen, in the home where informal everyday activities take place. This provides high accessibility and natural user situations.

Therefore:

Create a videoTORSO, equipped with a large flat screen mounted on a wall, loudspeakers and a camera with tracking functions and microphones, constituting one single entity. Place it in a corner of the room, with the viewing space expressed in the spatial design. The public space should follow the user. The rest of the room has to be considered as semi-public. Locate, if possible, the videoTORSO in the kitchen or another room that is often used for informal everyday communication. This system should be connected to the central logic of the smart home and be provided with an overall design that enables seamless communication of a high quality.



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The FLOOR AND CEILING LAYOUT (210) and NATURAL DOORS AND WINDOWS (221) are crucial to the successful use of the videoTORSO. The design of this pattern is completed and might be improved by considering DEEP REVEALS (223) and the LOW SILL (222).

6.3 (157b) digital workPLACE

A workplace for professional work, as a part of OFFICE CONNECTIONS (82), supported by video-mediated communication in domestic environments, must often be perceived from the outside (by the remote person) as a *public* place. Sometimes, the space that this pattern forms is to be considered as A ROOM OF ONE'S OWN (141), although it should rather be considered as a space than as a room. It is also necessary to make the people in and around the digital workPLACE feel comfortable and *private*, so consider INTIMACY GRADIENT (127), PRIVATE AND PUBLIC SPACES (127 b) and THE FLOW THROUGH ROOMS (131). In some respects, this pattern replaces the HOME WORKSHOP (157), but in other respects it is a complement. If this pattern is used correctly it will be found that the integration of a *public* space into a *private* room works well.

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The use of VMC for professional work activities in a home environment might create many problems, both for the person performing professional work supported by the video-conference system and the persons around the workplace, whose integrity can be disturbed and who may feel uncomfortable. Therefore, it is important that one is able to feel private and comfortable when passing behind someone using a VMC set-up for professional work.

Professional work supported by ICT at home tends to increase. The working hours seem to be extended around the clock. The globalisation, increasing flexibility of working hours and the technology development are some reasons for this development. People tend to locate places for telework to very private spaces such as bedrooms, because of a lack of suitable places at home. This might work well until VMC becomes a more common device for the work. Then it will be necessary to control the areas of the private space around the workplace that can be captured by a videocamera at the desktop. But it will be equally important to be able to feel private and secure when being behind someone using a VMC set-up for professional work.

<u>Upper left and right</u>: the user appears as in the real home environment using the videoconference system. <u>Lower image</u>: from the remote place (the perceived image by the partner in the conversation) the user appears to be in an office environment, a process handled by software manipulation of the video image.

In a set-up developed at the comHOME project, the workPLACE is placed in a combined home-office and bedroom, which causes the camera to view not only the person at work, but the bed behind, as well. This pushes the aspects of private and public to its limits and requires a development of measures that facilitate the interpretation of the borders between *private* and *public spaces*, as well as complementary ICT devices and software. A table with two sideboards and a lowered ceiling with integrated light defines the *public zone* spatially, where the user can be seen and heard. The zone outside, with the bed, is *private.* This is achieved with a short-range microphone that captures only the voice from the person seated at the workPLACE, and with a software for the digital camera that cuts out the person sitting at the workPLACE and places her in the background of an office environment.

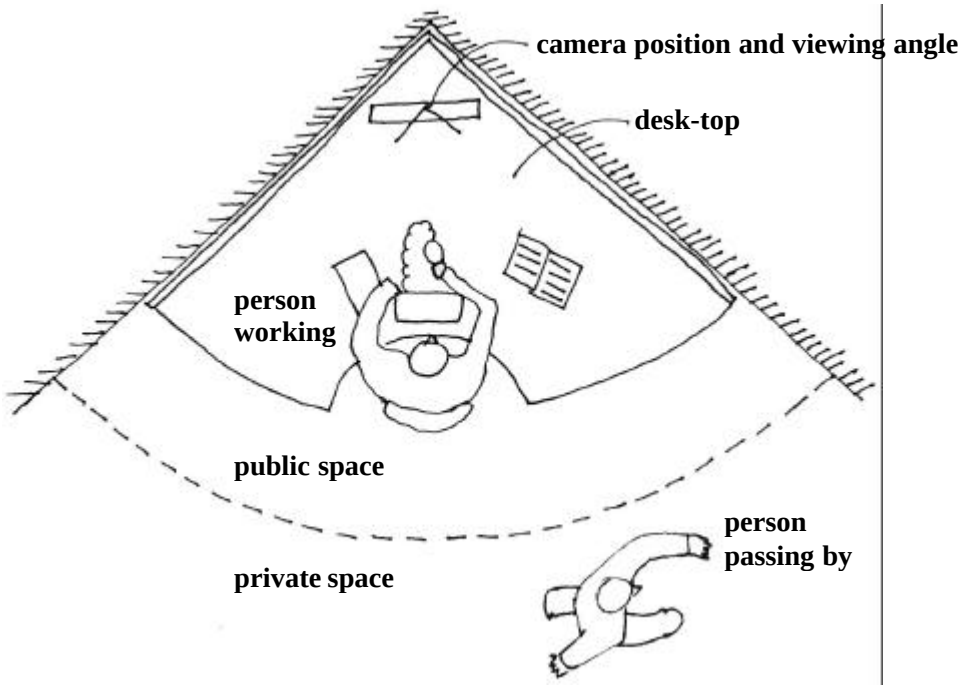
The workPLACE only allows for the core activities supported by the VMC and the additional necessary equipment (other functions can be distributed arbitrarily throughout the dwelling). The space has one or several computer screens, with an additional desktop camera as the visual focus of the VMC. The workplace should include a comfortable table area that provides good ergonomic conditions. Besides, the workplace should be extended so that the desktop worker can sit and move freely at the table. The work area – the public area – should be delimited by an architectural design that is easy to understand. The workplace should allow for work to be carried out without the user unintentionally getting outside of the public zone.

The area outside the public zone allows for a person to pass comfortably behind the digital zone unseen.

Therefore:

Create a workPLACE with a desk with the space necessary for the performance of core activities, and those supported by the VMC with the necessary equipment. The space should have the focus point at a screen for VMC equipped with a desktop camera. Generate a radius from its approximate position, which indicates the outer limit of the table. Generate another and larger radius, which delimits the *public zone* and has the same centre as the first radius. The difference in length between the two radii should allow for work to be carried out without the user getting outside of the public zone unintentionally. It should be possible for a person to comfortably pass behind or stay behind the digital space in the area outside the public zone unseen and unheard. Indicate clearly the border between the public and private zones, using architectural design.

The input to the system of images and voices should be strictly limited to the public zone, while the output might be experienced also from the private zone. This problem can be resolved by using, for instance, a headset and limited projection of images in glasses. The figure of the person at the digital workPLACE should be cut out and the background replaced with an image of an office environment or any other convenient one.



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Use the play with TAPESTRY OF LIGHT AND DARK (135), WORKSPACE ENCLOSURE (183) and CEILING HEIGHT VARIETY (190) to complete this pattern.

6.4 182b comTABLE

This pattern forms a part of a SEQUENCE OF SITTING SPACES (142) among the COMMON AREAS AT THE HEART (129), which is distributed within the grid of PRIVATE AND PUBLIC SPACES (127 b) in the home. It is a fundamental part of the FARMHOUSE KITCHEN (139), COMMUNAL EATING (147) and completes the EATING ATMOSPHERE (182).

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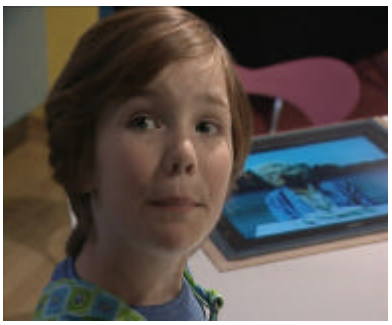
The activity of eating together is important for the unity of the family or a group of closely related individuals, and for the social upbringing of children. Getting together for a meal is often difficult nowadays due to the separation in space of the individuals.

The act of eating together is a cultural activity that is full of rituals and common experiences. Everybody "knows" how to have dinner. So, it is an activity that is best carried out in a shared environment, even if some of the participants are not physically present. An important part of the social upbringing of children takes place at the dinner table. Nowadays, however, it seems to be difficult to get together not only for dinner during the weekdays, but even for the traditional Sunday dinner. Parents may work too much and at irregular hours, the children may study elsewhere, grandparents and other relatives may live in other parts of the country etc. The *comTABLE* offers a complement to the physical participation of a person being at a remote place, who otherwise would not have been able to attend at all. The comTABLE contains a flat screen, a camera, microphones and loudspeakers, which are all integrated into a mobile frame at one end of a dinner table. This arrangement permits everybody around the table to perceive the image and it reproduces the remote person in a fairly natural size and position. The screen can be folded and hidden in the table when not in use. It is just as easy to use the table without the video communication.

If a remote person connects with the table, he/she appears on the screen, but will not hear or see anything. When the frame is lifted and put in a vertical position the system connects the input devices to the guest and the person can hear and see what is going on at the table and participate in the dinner conversation. After dinner, the screen being folded down terminates the communication, and thereby the flow of information is stopped. By integrating the screen, camera, microphone and loudspeakers into the foldable part of the device, the control of the visual view and sound becomes very physical; as a syntax for adjusting the public and private space of the comZONE. A comTABLE is a substitute for the dinner table and should be placed where this is generally placed. The location of the table should allow for the light to be directed towards the persons around the table. The sun or strong light must not be directed

towards the screen. For future designs we can imagine more screens around the table, several cameras and more complex sound-capture - and maybe even the transmission of smells!



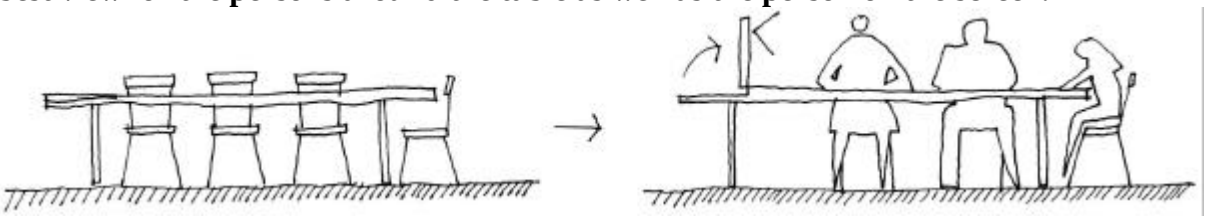
The remote dinner guest appears on the screen, still without seeing or hearing anything, when down...



...and is invited to the dinner by the lifting up of the screen.

Therefore:

A comTABLE should have an integrated screen that permits a person at a remote place to participate in the dinner. The participation of the person on the screen should be easy to control (cf. opening the front door for a guest). Therefore the screen, camera, microphones and loudspeakers should be integrated in foldable frame. When the equipment is directed towards the ceiling, the remote person cannot see or hear anything. The screen should be placed in the rear end of the table, which permits the best view for the persons around the table as well as the person on the screen.



as a normal dinner table

with the screen folded up for a dinner with a digital guest

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Use POOLS OF LIGHT (252) to produce lighting that both supports the activity of eating and improves image quality for the remote dinner guest.

6.5 147 b mediaSPACE

This pattern supports the social interaction between THE FAMILY (75) and family members and friends at remote places. It should be considered as the most public space within the INTIMACY GRADIENTS (127) and should be treated as one of the COMMON AREAS AT THE HEART (129) that are distributed within the grid of PRIVATE AND PUBLIC SPACES (127 b) in the home.

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Social and cultural events such as parties, weddings, anniversaries, celebrations, etc. are examples of a cultural heritage that should be kept alive. Ordinary everyday activities are more stimulating to carry out in the presence of other family members or friends than by oneself. Nowadays, however, family members and friends live further away than before. It is often impossible for many members of a family or a group of friends to attend both everyday activities and special social events. This might create isolation and tear relations apart.

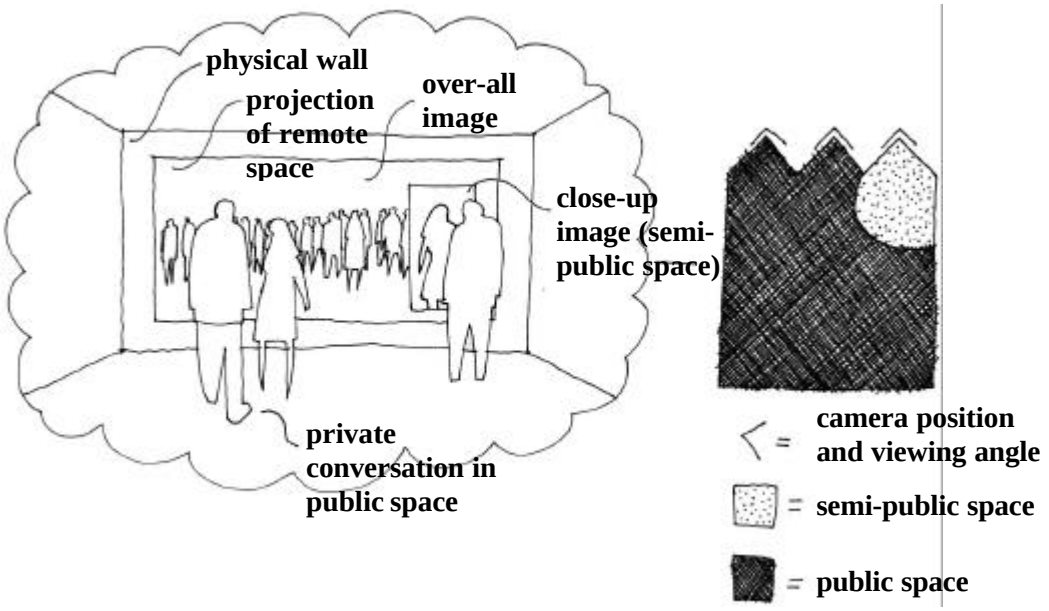
People move around the world for work and for leisure more than before. Friends and families often live far away, in distant regions and other countries. Many social activities have taken place without the possibility for everyone concerned to attend. The mediaSPACE is a digital social space both for formal and informal events.

The participation at a wedding, maybe on the other side of the world, celebrating with the just married…and then having a private talk.

At anniversaries, weddings, christenings and parties etc., it is important to get an overview of the space occupied by the participants. But it is equally important to create the possibility of a focused view of a specific individual or a smaller group of people. Thus, the mediaSPACE contains a large wall with a general overview projection of the whole space, and provides a possibility to get a picture on a part of the screen, similar to a "window" covering a part of the background. The cameras are located at the media wall in order to generate viewing angles that are as natural as possible over the space. The sound system can be connected to the surrounding system of the space. The microphones are placed at the media wall in order to capture the general atmosphere of the sound, and to create possibilities for private discussions on the other hand. The user must, of course, be aware of this arrangement in order to carry out a more *private* conversation within the public space.

Therefore:

Create a system that is able to generate a large digital social space. It consists of a wall exposing wide landscape images, cameras to capture both overall images and close-ups, and microphones to capture both the overall sound and sounds from specific locations in the room. This can be done by placing a pictorial cutout of a person or a smaller group within the framework of the large image, close to the border to the large screen. It should be possible to get closer to the wall and have a more private talk with a remote person or a smaller group of people. This procedure has to be supported by the sound system, which must create a general background sound as well as specific directed sound for personal conversation. The system has to be supported by at least one camera for an overall image. The image projected on the media wall must seem natural. At least one camera is required for the support of the close-ups. The lighting is crucial and must be compatible with the technical design. Good general lighting from above, supported by lateral lighting is preferred. The remote site should have a similar set-up.



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To complete this pattern, consider the INDOOR SUNLIGHT (128), the SITTING CIRCLE (185) and THE SHAPE OF INDOOR SPACE (191), as well as the possibility to use WARM COLORS (250).

7 DISCUSSION

The examples above demonstrate how Alexander's PL might be applied in a specific setting and with a specific technical artefact, i.e. the home setting and VMC. The patterns have been designed on the basis of the experiments conducted and the designs developed for the comHOME project. During the R & D on comHOME and its patterns it has become apparent that a surprisingly large number of the aspects of the various comZONES seem to be possible to generalise in order to support different aspects of video-mediated communication in a home environment.

Although the setting for this exercise is confined to a specific set up, comHOME, it offers a possibility to test the principles of the Pattern Language according to Alexander. The very nature of PL is explorative – it permits the development of new patterns based on hypotheses that have not been absolutely verified.

The following specific issues could also be mentioned:

- We are aware of the fact that our new patterns are not fully compatible with Christopher Alexander's Pattern Language of 1977. By further adapting our patterns to his schema in order to get a description that is as complete as possible, we will get a better insight into the nature of our particular problem. In particular with respect to how the conflicts between new media at home are influenced by traditional floor plans. What architectural and technical measures could be taken in order to reduce these conflicts and how could we benefit from the challenges they offer?
- The work on *a pattern language* has encouraged further development in the area of intelligent buildings and smart homes. It seems, but still remains to be proved, that the pattern language is a point of departure for a more precise definition of a schema that leads to results that are clearer and can be used more directly.
- Several design methods should be considered to the work to develop new patterns. To design by creating *scenarios*, e.g. by making a movie (Junestrand et al. 2000), by performing *user studies* (with intellectually disabled persons) and through *workshops* have all been productive methods. They have also helped us to keep the designs close to systems supporting basic aspects of everyday life which ordinary people can use.

To us it seems that the scientific approach in all essential respects underpins the methodology that we have used in the practical experiments. This is important and should be considered also for future progress of our work.

8 FUTURE WORK

The work on the development of design ideas for the comHOME flat is carried out continuously. A user study with a number of intellectually disabled and non-disabled persons was carried out in comHOME in the summer of 1999. This study is now being structured and analysed. Furthermore, an experimental video with professional actors demonstrating the different VMC set-ups in the social context of everyday life was recently recorded in comHOME (Junestrand et al. 2000) and it is used as a basis for supportive discussions about the work. Improvements and redesigns of the comZONES are under way, as well as a further integration of the VMC with a smart environment system that now functions separately.

The principles of the patterns presented in this paper can be introduced in real flats. A housing company will, in collaboration with us, apply these principles to a multi-storey residential building in southern Sweden, in connection with a housing fair during the year 2001.

9 ACKNOWLEDGEMENTS

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11 APPENDIX 1

Pattern 184, COOKING LAYOUT, in: Alexander et al. (1977) pp. 853-856.