

## COLOPHON

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## 365 days' Ambient Intelligence research in HomeLab

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# AMBIENT INTELLIGENCE IN HOMELAB

# Ambient Intelligence: BUILDING THE VISION



**Emile Aarts , Philips Research**



After 365 days of intensive research in HomeLab it is time to take a break and step back for a moment to have a look at what has happened with the vision of Ambient Intelligence and to see how it has developed over time. Clearly, the concept of Ambient Intelligence did not come into being overnight. It took quite some time to formulate it and shape it into a mature vision that could not only govern research and development processes within Philips, but also have an impact on the company's product portfolio and marketing strategy.

The notion of Ambient Intelligence was proposed in 1998 in a series of workshops that were organized within Philips, and that were commissioned by the Board of the Management [Zelka, 1998]. The workshops

were aimed at developing different scenarios that would lead a high-volume consumer electronics industry from the current world, which was called *fragmented with features*, into a world near 2020 with fully integrated user-friendly devices supporting ubiquitous information, communication and entertainment. Palo Alto Ventures, a US management consultancy company, acted as the facilitator, and they involved several Philips departments including Research, Design and Global Brand Management.

The workshops coincided with a number of worldwide developments from which it can be concluded in hindsight that the time was right for developing a vision like Ambient Intelligence. Let me mention just two of them. Firstly, performance

indicators of semiconductor circuitry, such as computing power, communication bandwidth, storage capacity, power dissipation and integration density, revealed that these quantities had come within ranges that allowed electronics to be integrate into any possible physical object like clothes, furniture, cars and homes, thus making people's environments smart. Secondly, socio-economic investigations revealed that a next wave of business development was emerging, based on mass customization and leading to a new economic order called *The Experience Economy*.

The first official publication that mentions the notion "Ambient Intelligence" appeared in a Dutch IT journal [Aarts & Appelo, 1999] and emphasized the importance of the early work of the late Mark Weiser, who had been working for more than ten years already on a new concept for mobile computing which he called *ubiquitous computing* [Weiser, 1991]. From a technological point of view this concept has been very influential and it can be viewed as the starting point for several new developments, including IBM's pervasive computing and Philips' Ambient Intelligence.

From the point of view of industrial design we need to mention the work of Philips Design, who, through a number of large projects such as *Vision of the Future* and *La*

*Casa Prossima Futura*, had managed to visualize persuasively a world in which the current demanding consumer products would be replaced with new products that support greater ease of use [Philips Design, 1996; Philips Design, 1999].

In the meantime the vision matured. In 2000 the first serious plans were launched to build an advanced laboratory that could be used to conduct feasibility and usability



studies in Ambient Intelligence. After two years of design and construction, HomeLab was opened on April 24, 2002 by Gerard Kleisterlee, the president of Philips Electronics. On the occasion of the opening an international technology seminar was held and a booklet published explaining the purpose and the ambition of HomeLab [Aarts & Eggen, 2002]. The opening event officially marked the start of the Ambient Intelligence research in HomeLab. Since then HomeLab has attracted much attention →

from the press. In less than a year it was featured on television, including *Discovery Channel*, more than 25 times, and more than 100 press articles have been published in a large variety of journals ranging from *Focus* to *The Wall Street Journal*. More than 150 visits to HomeLab were organized and it has become a real challenge to ensure that HomeLab adheres to its original objective of being a research facility, because there is a continuous and natural pressure to turn it into a showcase.

Along with the development of the vision for Philips, a parallel track was followed which was aimed at positioning the vision as an open initiative for the advancement of innovation in information and communication technology in Europe.

During a series of workgroups organized by ISTAG (Information Society and Technology Advisory Group), which serves as an influential advisory board to the European Community, the vision of Ambient Intelligence was adopted as the leading theme for the sixth framework on IST research in Europe [ISTAG, 2001]. This major achievement will result in a subsidiary European research program with a budget of EUR 3.7 billion over the coming four years, focused on research in the domain of Ambient Intelligence.

At the same time the vision was recognized as one of the leading themes in computing

science by the Association for Computing Machinery (ACM), and as a result a chapter on Ambient Intelligence was included in the book *The Invisible Future* [Aarts, Harwig & Schuurmans, 2001]. The book was published on the occasion of the ACM1 conference, which was aimed at providing the electrical engineering and computer science community of the world with new insights into the future of computing. In addition to the chapter on Ambient Intelligence the book contains a wealth of contributions from various renowned scientist expressing their vision on a variety of subjects ranging from computer hardware and programming through to health, education and social issues.

The Ambient Intelligence vision has also been used by Philips Research to establish new and promising collaborations with other strong players in the field. In 1999 Philips Research joined the Oxygen alliance, an international consortium of industrial partners that collaborated within the context of the MIT Oxygen project. The Oxygen project is a joint effort of the MIT Computer Science Laboratory and the Artificial Intelligence Laboratory, and it is aimed at developing the technology for the computer of the 21<sup>st</sup> century [Dertouzos, 1999]. It allows multi-modal controlled handheld communication units to connect through environmental units to a broadband communication network, thus supporting ubiquitous information access and communication. Several technological



results obtained in the Oxygen project have found their way to HomeLab. Examples include the Cricket location detection technology and speech and vision technologies. Another example of an international Ambient Intelligence-based activity is the joint virtual laboratory that was established in 2000. The activity involves Philips Research, INRIA and Thomson Multimedia in a project called Ambient Intelligence Research and Development (AIR&D), and is aimed at developing software platforms for Ambient Intelligence applications in the home. This project has proved quite successful and first results have become available to HomeLab in the form of middleware supporting intelligent broadband services.



In the summer of 2002 Philips Design and Philips Research launched a joint project aimed at producing a book on Ambient Intelligence. The book should consolidate the position of Philips as the intellectual leader in the field of Ambient Intelligence. On March 1<sup>st</sup>, 2003 *The New Everyday* was published [Aarts & Marzano, 2003]. The book contains over 100 contributions on Ambient Intelligence, on a broad range of topics ranging from materials science through to marketing and business models. Most of the contributions are from Philips authors, but about ten are from renowned specialists on various aspects ranging from promising new applications to warnings of the possible social disorientation that might result from Ambient Intelligence. The book

is a unique object because it covers the subject of Ambient Intelligence from a remarkably broad perspective, thus providing a solid basis for future discussions of the subject.

After five years of steady development we can safely state that the Ambient Intelligence vision has reached a well-recognized status of maturity. It has been adopted by Philips as a strategy for the company, and it has been recognized by the European Commission as a research directive for the IST 6<sup>th</sup> Framework. Both inside and outside Philips the development of the vision will continue and HomeLab will play a prominent role in the studies on feasibility and usability aspects of Ambient Intelligence. We need to continue evangelising the vision throughout Philips and Europe in order to make it come true. ←

# 365 days' Ambient Intelligence research IN HOMELAB

Boris de Ruyter, Philips Research

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Studies into the meaning of the home of the future have revealed that people want this home of the future to be like the home of today. Based on in-depth interviews we discovered that people fear scenarios of the future in which technology would interfere with their daily life in the home of the future. In fact, people expect technology to become more supportive in the future. A home is defined in terms of family rituals such as breakfast and bedtime storytelling. The biggest challenge for future technology is thus to be not only physically embedded but also to be interwoven into the social context of the home of the future.

During the first year of Ambient Intelligence research in HomeLab, special attention was

devoted to interactive systems that support three consumer needs:

### **Need to belong and share experiences.**

As broadband Internet connectivity is becoming reality, research in HomeLab has been investigating real user benefits of bringing connectivity into the home environment. This research has been focusing on connectivity as an enabler for

true experiences. Research in HomeLab on enhancing experiences has been focusing on: (a) using light as a technology to enhance movie watching and (b) adding intelligence to a remote control.

### **Need to balance and organize my life**

With the breakthrough of mass storage and broadband connectivity, users will get access to content from different media,



(a) supporting the sharing of content and experiences and (b) creating the feeling of being together.

### **Need for thrills, excitement and relaxation**

When people think about the home of the future, they emphasize that technology should enable them to maximize their leisure time. Whenever possible, the consumption of content should result in

stored at different locations and via different access devices. Research in HomeLab has been focusing on developing intuitive navigation concepts that put users in control. ←

# Need to BELONGING AND SHARE EXPERIENCES

Leonie Jansen, Philips Consumer & Marketing Intelligence



Even though individualization is a fact in today's society, we still want to be part of something. There is a strong need to belong and connect: ME within the collective WE. With everything around us changing so fast, we want to be close to people as a desire for reassurance. With friends and family we share feelings and experiences, then they become really special and valuable. Watching movies or playing games is even more exciting when doing it together.

Especially among youth, the need for belonging and sharing experiences is extremely important. They want to be a respected member of a tribe. However, within the boundaries of what is accepted in the tribe, they want to be recognized as having their own unique personality. ←

# Sharing CONTENT AND EXPERIENCES

Richard van de Sluis and Mark Verberkt, Philips Research

**Hypothesis:** People want to share content in a networked home environment

**Concept:** Virtual places presented on stationary and wireless screens in a networked environment

**Result:** People loved the concept due to its ease-of-use and saw great opportunities for sharing self-created content such as photos



One interaction concept that was developed and tested in HomeLab was the concept of “spaces”. A “space” can be seen as a virtual place that allows a group of people to stay in touch with each other, to share content and to share experiences. The idea is that a group of people should be able to create a space that is accessible for the whole group, independent of each individual’s physical location. For example, a family space would be accessible for all household members from all over the world, stretching the home beyond

the physical boundaries of the house.

A space contains content items of any type, such as a TV program, a movie, a music track, a memo, a video card or a media album.

Besides content sharing, a space can also be used to meet each other. In a Friends space, for instance, a few friends could have a chat with each other using video communication. But they can also go a step further and start a so-called “shared activity”. This means that these friends can also browse through a photo album together or watch a football match →

together while being in different physical places. In a shared activity, all users involved not only have a synchronized view on the content, they can also see and hear each other.

### The user study

The aim of the user test in HomeLab was to verify if people see significant added value in this type of sharing and communication. We invited pairs of family members and pairs of friends to the test, and let them deliver some of their personal photos and music beforehand. The living room and study were used for the test. If, for instance, two friends came to the test their personal photos and music were put in their personal space, and they were asked to share some of these content items with the other participant through the Friends space. In various tasks they were asked to meet each other, to browse through a photo album together, and to watch TV together using the Friends space.



### Results

All participants in the test had a very positive attitude about the possibilities offered by the system. Of the various functions, content sharing is seen as the most important one. People like the idea because it can be done in an easy and efficient manner and physical distance is no longer a factor. All participants mentioned photos as the most important

content type to be shared, followed by music and home videos. In general, personal or self-created content plays an important role in content sharing. The fact that all those functions can be accessed from the couch in the living room is seen as an important advantage. Besides this, the portable display allows people to move freely through the house without being restricted to a certain location. It was mentioned by some participants that the PC-type interaction is often anti-social, with one person sitting in front of the PC often with his back towards others, whereas a portable display or a wall-mounted display is more conducive to the social interaction, allowing people to watch things together.

While participants appreciate the ease of using the system, some people also mention the fact that they miss particular functionality. For instance, the method of exchanging messages is very limited compared to what is possible on a PC. It can be concluded that many people like to have complete PC functionality in their living rooms, but at the same time they want it to be very easy to control while leaning back on the couch. ←

### Insights gained into:

Preferences people have with regard to content sharing  
The role handheld devices can play within the home environment

# The feeling OF BEING TOGETHER

**Boris de Ruyter, Philips Research**

**Hypothesis:** People want to have the feeling of being together when physically separated

**Concept:** Augment TV content with silhouettes representing movements of the people in the remote location

**Results:** Participants enjoyed this new way of watching TV and had a strong sense of being together while preserving their feeling of privacy

The introduction of advanced technologies such as interactive TV has not resulted in the expected behavioral change on the part of consumers. We contend that one of the most important

reasons for this has been the absence of sufficient content to offer attractive user benefits. Consequently our research in the Philips HomeLab explores the potential user benefits offered by interconnected consumer electronics devices.

One such benefit is “social presence”, which is the sensation of “being together” that can be experienced when people interact through a telecommunication medium. As connectivity permeates our daily lives we expect that network infrastructures will become enablers of social interaction. While communication media such as e-mail, telephony, text messaging, are common, there is more to system-mediated communication than exchanging information.

Our research on the feeling of being together has been focusing on the potential to attain social presence by maintaining a →



peripheral awareness of a connected person or group of persons, outside the context of communication/information exchange tasks. This research assesses affective benefits that arise out of this interconnection and illustrate the positive impact of awareness on social interactions.

### The user study

In total 34 subjects, all Dutch males, participated in the experiment. They were recruited as groups of friends who enjoy watching soccer games. The friends were split (2-1) and placed in two different rooms. During the experiment all participants watched the same soccer game.

The amount of visual information the subjects received about their friend(s) was varied over the different conditions and would range from: no visual information, a sketch-like visualization representing physical movements of the people at the remote location, and a full-motion video of the remote location. Social presence and group attraction (i.e. the feeling of being part of a group) were measured after each condition by use of standardized psychometric instruments available in literature.

### Results

The results of this study indicate that a low-bandwidth visualization of the physical activities at remote locations is capable of establishing a sense of social presence. Furthermore, group attraction was

increased. Compared with the full-motion video, the sketch visualization gave participants less of a feeling of being observed by the remote location. This latter aspect of the sketchy visualization could be of great importance in creating social-presence-enabling systems for the home environment: earlier research has shown that privacy considerations are a major obstacle to the acceptance of video communication in the home.

Test participants indicated that they would prefer different levels of social presence for different kinds of programs. People prefer to watch sports and movies in the presence of others, whereas they prefer to watch news and documentaries alone. They do not want to be disturbed while concentrating on the serious programs. For entertaining programs, viewers enjoy having a cozy atmosphere and experiencing other people's reactions. ←



### Insights gained into:

Mechanisms to provide a feeling of being together when separated  
The relations between content types and the need for social presence

# Need for THRILLS, EXCITEMENT AND RELAXATION

Leonie Jansen, Philips Consumer & Marketing Intelligence



There is a strong need to have an intense sense of being alive, to get away from the daily hassle, to relax and lose yourself in the world of entertainment and discovery. The search for thrill is the result of our ever-accelerating way of living. This is not only expressed in the desire for extreme experiences but also appreciation of smaller things. Consumers seek ways to reward themselves and to rediscover the magic in everyday life.

The keys to this consumer need lies into the ability to switch your mood: from a state of boredom to thrill/ excitement and from stress to relaxation. Consumers want to reach their desired state fast, with a minimum of effort. The need for mood change is not limited to the boundaries of the home, also on the go people want to be able to escape the world around them. ←

# Ambient Intelligent Lighting: LIVING LIGHT

Elmo Diederiks and Jettie Hoonhout, Philips Research

**Hypothesis:** Full-colour ambient lighting enhances the experience of watching TV and listening to music

**Concept:** Living Light

**Results:** Participants highly appreciated the concept, especially for film. They also pointed out new application areas and related requirements.



A favorite leisure activity of many is watching movies, either in the cinema, or at home. The way we watch movies at home has changed considerably since the first television was introduced: from black-and-white to full color, from mono to stereo to surround sound. The next step is now being developed and tested in the Philips HomeLab: the Living Light concept. The Philips Living Light system can be considered as the next step in the Home Cinema Experience. It offers light

ambiences and light effects for film and music. The system comprises four LightSpeakers (left, right, front, back), a CenterLight and a SubLight, which is situated underneath the couch. Light scripts for selected pieces of film and music have been developed in conjunction with lighting designers, theatre lighting experts, filmmakers and musicians. This system has been installed in the living room of HomeLab, to provide the right context for experiencing this concept.

## The user study

The concept has been evaluated with specified user groups, primarily to determine its appeal in terms of acceptance, usability and excitement. The secondary purpose was to collect additional information on possible improvements of the concept from the point of view of the user. Also, participants' opinions were collected regarding the appropriateness of the light settings that were presented. The 32 participants were representative of the target group: they had a keen interest in watching movies or listening to music at home. Half of the participants were shown film and the other half were asked to listen to music, in both cases enhanced by light ambience settings and light effects provided by the Living Light system.

## Results

The evaluation of the concept indicates that Living Light is a potential winner as participants greatly appreciated the concept, especially in the case of film. Participants indicated that the system made watching movies or listening to music a very enjoyable and a more immersive experience.

In addition, participants indicated that they would like to use such a system to create the right ambience in the home, e.g. when having friends over for dinner or enjoying an evening at home with the family. Light is seen as a key factor in creating the right setting and ambience at home. Current technologies do not provide sufficient and easy-to-use means to create the desired light settings. The fact that

the Living Light system offers possibilities to manipulate for example color temperature and intensity was therefore highly appreciated. These findings provide additional directions for future research: lighting concepts that offer solutions that take away the hassle of setting up appropriate lighting, and in addition provide extra means to enhance activities and create enjoyable ambiances. ←

## Insights gained into

The appeal of and requirements for the Living Light concept  
User preferences concerning ambience in the home



# Intelligent

# REMOTE CONTROLS

Tatiana Lashina, Philips Research

**Hypothesis:** Interactive devices will bring more value if they take account of the user's context when attracting the user's attention

**Concept:** Make a remote control context aware by adding sensors to perceive and interpret its context to adapt the way it attracts the user's attention

**Results:** Participants valued context aware behavior of the device as it prevented missing reminders and eliminated irrelevant notifications

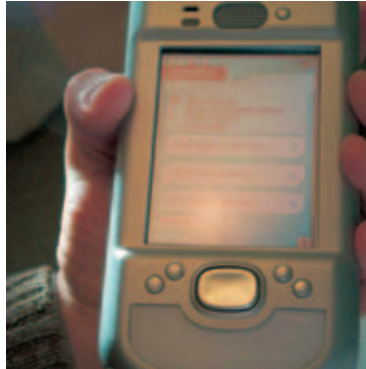
In the drive to improve the experience people get when interacting with a product we explore novel intelligent interaction techniques. One such technique is making a system context-aware so that it can adapt and react to changes in the environment. For this, the concept of a personal remote control (PRC) was developed. This remote control with a color touch screen contains an Electronic Program Guide with a recommender function that filters a complete listing of programs to only those matching a user's personal profile. With this information, the PRC can remind users of upcoming programs of interest.

A common problem with conventional portable devices with an alarm function is that they either irritate us by disturbing at the wrong moment or fail to inform us of events we wanted to be reminded of. We made the PRC context-aware as we wanted to avoid such problems. Equipped with a

number of sensors, the remote control can detect contexts such as being in the user's hand, lying in a drawer, the user being around, and so on. With this information, the remote control changes the way it issues reminders for upcoming programs that are of personal importance as indicated by the user.

### The user study

An explorative user study was conducted with the aim of gaining an understanding of



the user-perceived benefits of context-aware features and the relevancy of context awareness for specific applications. In order to involve subjects who were representative of the potential users, we selected them according to the following criteria: subjects had to watch TV on a regular basis, they had to plan their TV watching at least for the upcoming evening and not just zap through the channels, they had to be in the possession of a mobile phone and have

experience with an electronic agenda and electronic messaging applications. After experiencing context awareness, participants were interviewed. A number of questions in the interview compared context awareness usage scenarios of the PRC to those of mobile phones.

### Results

The context-aware features of the PRC were considered significantly more attractive than similar features in the context of a mobile phone. In the interview that followed the respondents revealed that missing a reminder is seen to be a more serious problem than missing an incoming call since users themselves install the reminder. Each usage scenario was analyzed in terms of the relevancy of the problem addressed and the attractiveness of the context-aware solution. All PRC context-aware features received a relatively high rating.

Participants in the study were enthusiastic about the application demonstrated in the PRC concept and considered it a potential replacement of the TV guide give the additional benefits it offers. ←

### Insights gained into:

The perceived user benefits of context awareness  
 The relevancy of problems addressed by sensor-based context awareness and the attractiveness of the context-aware solutions

# Need to BALANCE AND ORGANIZE MY LIFE

Leonie Jansen, Philips Consumer & Marketing Intelligence



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Our need for organizing comes from the fact that we have too much to do in too fast a pace with too little time. To feel in control we want to bring order into our lives by organizing time, money and space.

Consumers are striving to find a good balance between their work/ school life, friends and family and personal time. This is not only true for families with children, also teenagers, young singles and couples experience time constraints.

They look for solutions that bring more efficiency and simplicity in every day life, keep them informed about what interests them and enable them to take care of their priorities. These solutions should help them navigate through life, but they still want to be in control and they want it to happen at their terms. ←

# Photo browsing in a SMART ENVIRONMENT

Evert van Loenen and Elise van den Hoven, Philips Research



**Hypothesis:** People have a need for Ambient Intelligent products that support digital photo browsing, and the Memory Browser concept is suited to meet that need

**Concept:** A system that helps people to navigate their photo collection at any place in the home in an intuitive manner, by means of physical objects such as souvenirs and “drag-and-view” of images to stationary and portable screens

**Results:** Users were delighted by the meaningful navigation concept and device, and acknowledged the need for it: “Great, when will it be on the market?”

One of the concepts being studied in HomeLab is that of Memory Browsing. The aim is to provide users with natural, intuitive means to recollect and share experiences of past events. The motivation for choosing this concept came from an extensive user-study into what people find important in their homes. One of the major conclusions was that “Photographs are irreplaceable representatives of memories that people have. They are the undisputed number one in the ranks of important objects”. Many people mention the need to share their memories with others, for example, by showing them their photos and telling about the experiences they had at the time.

With the advent of digital photo and video cameras, recording snapshots of important events in one’s life has become much easier. However, retrieving them has not. On the contrary: the amount of personal content increases dramatically, and is typically stored →

on a PC which is not located where the photos are needed. To address these problems, a first version of a Memory Browser was developed, which focuses on intuitive retrieval and sharing of digital photos.

This Photo Browser has the following features:

- It consists of a portable touch-screen device ('Sepia'), which is wirelessly connected to a PC or other storage and processing unit. This PC with stored photos remains where it normally is (the study), while the Sepia can be used anywhere in the home to retrieve the photos.
- The user interface on a Sepia shows all available albums in a continuously moving photo-roll. By touching a particular album, the photos contained in it are shown in the roll. These can now be dragged to the center of the screen to enlarge them. The photo-roll can be grabbed with a finger or pen, and the movement can be reversed, accelerated or stopped at will.
- Other available screens (both fixed and portable) are shown as icons, and photos can simply be dragged to an icon for immediate display on the related screen ('drag-and-View'). Any screen can be used, provided it is connected to a device on the home network that can run a small Java 'servant'. A distributed software platform ('Empire') takes care of discovery and connection of all available servants in the network.
- The system is location-aware: in HomeLab the location of each Sepia can be tracked, and only the screens in the room where the user is

located are shown in the user interface (UI). This helps to keep the UI free of irrelevant information.

- Finally, tagged graspable objects can be used as shortcuts: by placing a souvenir on the table, the photos associated with this souvenir are presented instantly in the photo-roll.

### The user study

Besides a technical evaluation, a sequence of user studies was performed. This started with a focus group on reminiscence, followed by an expert evaluation of the UI during the design process, and an evaluation of the total system in HomeLab.

### Results

After incorporating all lessons learned in the focus group and formative evaluation, the total system was implemented in HomeLab. Specific attention was paid to realising a truly ambient system, i.e. keeping the PC s and wireless access point outside the living room, and integrating the RFID-detection system for the objects in the existing coffee table.

The implemented system works quite well. The implementation of the Empire platform proved a major improvement in system robustness, compared to an earlier demonstrator based on the commercially available Jini platform. A tablet PC was selected initially as an implementation of



Sepia, to enable rapid prototyping. Later, it was demonstrated that the Photo Browser runs equally well on the Philips Detachable Monitor, albeit with less smoothness in rendering the moving photo-roll.

For the user evaluation, the Photo Browser has been demonstrated to many visitors (roughly 2000) since its implementation in HomeLab.

Recurring themes that emerged were:

- Visitors generally recognised the usefulness of the system immediately: many own a digital camera, and have encountered the problems described above themselves: “This is great, when will it be on the market?”
- Stimuli for picking up a photo album are very diverse, ranging from a simple question, a typical smell or sound, or missing a loved one badly. Once people are in such a mood, photo browsing is considered a fulfilling activity.
- Photo browsing is often characterized as a social activity. Photos, and the memories they evoke, are used by people to share perspectives, consolidate and tighten relationships, or simply have fun. The possibility offered by the Photo Browser to use screens present in the environment for displaying photos, as well as the option to instantly access relevant albums by means of objects, is valued as an enhancement of photo browsing in a social context.
- People discriminated between two different contexts of use: an individual setting in which the experience of remembering is linked to mood, and a multi-user setting in

which the activity of recollecting memories is related to telling stories about the past. In both situations people mainly talk about the experiences and less about the actual photos. This seems to indicate that efforts to solve the problem of how to support the recollecting of memories should focus on how the system can optimally *trigger* the experience of remembering. To fully explore this concept we are conducting a large-scale study in HomeLab, evaluating the power of photos, smells, sounds, videos and graspable objects as memory triggers. ←

### Insights gained into:

User needs, wants and wishes related to retrieval and sharing of memories  
System requirements for a product that can fulfill these  
Feasibility, usability and appreciation of a first prototype system, focusing on photo browsing and enabling drag-and-view and use of personal souvenirs.

*The authors gratefully acknowledge the other members of the Phenom team involved in this work: Nick de Jong, Esko Dijk, Yuechen Qian and Dario Teixeira.*

# Meaningful NAVIGATION

Gerard Hollemans, Philips Research

**Hypothesis:** Navigating large databases of digital content will be more enjoyable if the content is consistently organized in a filter structure

**Concept:** The MediaBrowser with consistent navigation for any type of content and any size of collection using filtering

**Results:** Participants expressed that the MediaBrowser navigation concept offers strong user benefits for personal digital content

The concept of the MediaBrowser aims, to provide people with consistent interaction for accessing and navigating photos, music and video content. This

consistency extends not only over types of content, but also over types of interaction devices. In addition to content access and navigation the MediaBrowser offers the user functionality to bring content into the system, to organize content, and to enjoy content.

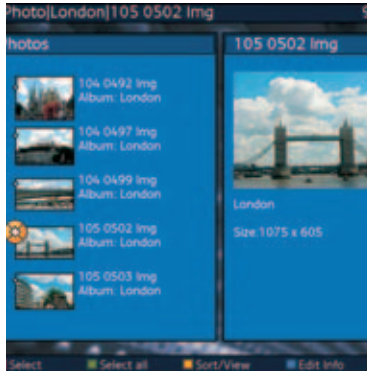
The MediaBrowser enables users to navigate their content collection. After selecting the location and the type of content, e.g., audio, video, or photos, the user can decide to use a full overview of the content or to use filters to reduce the list of content to that content that is related to, e.g., holidays (for photos). Users can set multiple filters at the same time to reduce a (potentially very) long list to a browsable list.

To enable the use of filters in the interaction, metadata needs to be available for the content. Without the metadata the user will only get a list of all albums that are available for the selected content type. The metadata needs to be provided either by the user or by automatic

extraction of metadata from the content through content analysis by the system. To support the former option, functionality to annotate albums and items is included in the MediaBrowser concept.

### The user study

The MediaBrowser was evaluated in a user test to investigate the use of filters. With real users the content retrieving styles of filters and (hierarchical) folders were compared. The aim



was to identify, from a user perspective, the benefits and possible drawbacks of a filtering approach. In addition to this, usability aspects of the MediaBrowser as implemented for a TV set were investigated.

For the user test the participants brought in their own content, (a subset of) their collection of photos with a minimum size of 500 photos. This in contrast to many studies reported in the literature, in which users are presented either with relatively small-sized collections

(around 200 items) and/or with collections that are not their own, which makes it harder to give the users realistic tasks that they would carry out in the context of their own collection. The participants in the evaluation study were users who maintain the collection as well as their partners who also own the collection, but who do not maintain the collection.

### The results

The study led to interesting results. Most participants hardly ever annotate individual pictures, and sets of pictures (analogous to conventional “albums”) usually only have one keyword as a description. So, participants appreciated the extra entries in the filtering approach, allowing them to retrieve pictures and sets of pictures more easily than with the conventional approach. Even though this requires some additional work when bringing new pictures into the collection, participants thought that this effort was minimal, manageable (especially since albums can be annotated, making it unnecessary to annotate each individual picture), and certainly worthwhile the effort, given the benefits of later retrieval options that are now available. ←

### Insights gained into:

Meaningful content classification mechanisms  
Consistent navigation structures for multimedia content

# Looking into THE FUTURE

**Boris de Ruyter, Philips Research**

An infrastructure such as HomeLab allows for early user evaluations of advanced interaction technologies. Given the system approach advocated by Ambient Intelligence these user evaluations require innovative methodologies and measurement instruments. Established organisations such as the Usability Professional's Organisation have recognised the need for new approaches to usability testing [Branaghan, 2001]. Moving towards the conceptualisation, creation and evaluation of user experiences, there is a growing need for adequate methods and tools. Usability criteria such as effectiveness and efficiency are being enriched by criteria such as user satisfaction and experiences.

During the first year of usability research in HomeLab, Philips has gained insight into the operationalisation and measurement of user experiences. Usability research in HomeLab has been confronted with advanced and extensive data logging

mechanisms and, due to the complexity of data gathered, research in HomeLab has brought advanced data analysis tools into the evaluation cycle. With these tools, the behavioural researcher in HomeLab is now equipped with data mining instruments that will reveal hidden behavioural patterns captured inside HomeLab during observational studies.

Some of the recognised experts in the area of usability testing, with whom we have been working, present their vision on future challenges for usability research in HomeLab. From the methodological point of view, **Rex Hartson** (Virginia Tech) expresses some interesting usability research issues. Research challenges with regard to data collection and analysis instruments are discussed by **Lucas Noldus** (Noldus IT). To conclude, **Manfred Tschelig** (Center for Usability Research & Engineering) gives his view on researching user experiences in HomeLab. ←

# HomeLab AS A FORCE FOR ENSURING USABILITY

**Prof. Dr Rex Hartson, Virginia Tech., USA**



Philips has a vision. In an age when so many others are pursuing technology just because it is possible, Philips, through its HomeLab, is instead mastering the use of technology by people. Philips is learning about how people interact with technology, so they can make Philips innovations work for users.

Many organizations work to include new technology in their products. That in itself is easy. However, we are all too familiar with technology that is frustrating and difficult to use or that cannot be used in the ways we want.

How, then, does Philips expect to make technology work for people?  
They know that people use technology to

perform tasks to accomplish various goals in their lives, that the connection between technology and people is use. It has to work for them in the context of real use.

How is Philips working to understand technology in this context of use?  
The answer is fundamental knowledge that comes from a multi-disciplinary approach to the science and engineering of empirical studies used for technology prototype testing with real and potential users. Success hinges on something we call ecological validity, which simply means that the context of the engineering studies must be like the context of real use - exactly what the Philips HomeLab is uniquely qualified to provide!

HomeLab takes user-centered context →

significantly beyond that of the typical usability-testing lab. HomeLab provides context for Ambient Intelligence supporting long-term living in a home - a much richer, broader and more detailed context to represent realistically the complexities and subtleties of daily human living.

The user's context for technology has two parts: the physical, cultural and social aspects of daily living activities on the one hand and the interface to technology on the other. Philips' user-centered engineering is what bridges that gap; translating from the user's cognitive and perceptual language to the physical language of the controls and displays of technology. Without this basic understanding of technology in the context of use, especially for new technology such as Ambient Intelligence, Philips Design cannot know for certain if they are making the best connection between people and technology in their product designs.

The philosophy that underlies the approach is a rock-solid user-centered engineering approach that has already proved itself effective in human-computer interaction. Engineers in other organizations where technology itself is the focus do not see real users; they don't see them experience using technology; they don't see users struggling or failing to make the connection of use with their technology. Thus, HomeLab plays a pivotal role as the proof point for Philips' vision of being a

leader in connecting people with technology. Technology studies in HomeLab allow Philips Design to produce future products with users who are in control, users who are satisfied and not frustrated, users who can focus on normal activities and not on how to work the technology. Most importantly, HomeLab will lead to users who don't even "see" the technology; they simply perform their own daily living activities, unobtrusively aided by ubiquitous, transparent and intelligent functionality. ←

# HomeLab AS A SCIENTIFIC MEASUREMENT AND ANALYSIS INSTRUMENT

**Dr Lucas Noldus, Noldus Information Technology, The Netherlands**



**N**oldus Information Technology congratulates Philips on the anniversary of their HomeLab. Its attractive interior and excellent observational facilities have created a unique “living laboratory” for research on how people interact with the technology that may enter their homes in the future. We see several avenues for exciting new developments concerning data collection and analysis in a setting like HomeLab.

## **Enhanced data collection**

HomeLab allows researchers to capture behavioral events relevant for a particular study at any moment during the 24h cycle. Since people usage patterns may vary significantly at different times of the day, researchers need to cover as much of the active period as possible.

Otherwise, important events may be overlooked. However, in practice the duration of a test session is limited by the length of time people want to live in HomeLab, and by the capabilities of the human observer. With respect to the latter: long-lasting observations, especially when important behavioral events are relatively rare and interspersed with long periods of little relevant activity, are very demanding for the observer. This holds for live observation as well as for post-hoc scoring from a video recording. Besides the high cost involved in the many hours of watching and scoring, observer fatigue will negatively influence the reliability of the data collected, not to mention the satisfaction of the observer him/herself! Therefore, in order to get the most out of a test session and to facilitate longer-lasting experiments, data collection should be →

automated as much as possible.

An obvious way to reduce the data collection effort is by capturing user-system interaction automatically using embedded event loggers. Such programs are already in place for computer desktop and web applications. The same approach can be used with mobile devices (PDAs, mobile phones and communicators, remote controls), consumer electronics (e.g. TVs, video and audio equipment), domestic appliances or any other device with a user interface that we may find in the home of the future. The challenge is not so much the data acquisition, which can be built into any system, but the intelligent filtering of the stream of events generated this way, in the context of the system's user interface and the user's intention.

For studies concerning the behavior of people, and their use of technology, over extended periods of time and in different parts of the home, it may be worthwhile to record their movements between rooms and inside the room automatically. When automatically logging how somebody uses an LCD tablet as an electronic book, it is relevant to know if s/he is standing, sitting on a couch or lying on a bed. Thanks to the miniaturization of transponders and other positioning devices, automatic tracking of individuals entering or leaving rooms becomes a really non-invasive measurement that does not affect normal behavior. Movements within a room can be tracked quite easily with computer vision, while body postures (e.g. standing, walking,

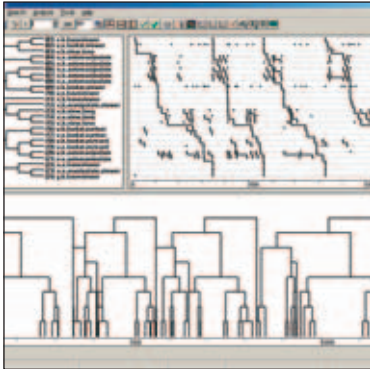
sitting) can be distinguished using either shape recognition in digital video images or wearable sensors. This is not science fiction; these techniques have been used for many years in studies of animal behavior, using tools like EthoVision<sup>®</sup>, and have matured to such an extent that the move into the human domain has become possible. Experimental psychologists are now exploiting the possibilities of computer vision, and there is no reason why these techniques should not be used in usability research. Automatic monitoring of people's movements and gross body postures also allows the automated pre-processing of large quantities of video footage to extract those episodes where relevant behavioral events are likely to occur. This way the human observers can limit their visual inspection and manual data collection to a fraction of the video material.

One of the cornerstones of Ambient Intelligence is the adaptive behavior of systems in response to the user's mental or emotional state. In order to test the performance of such a system we obviously need to measure the physiological state of the user before and during the interaction with the system, especially if we also want to know if the user's state changes in the process. At the risk of making HomeLab too much like a "real lab", one could ask participants to wear a tiny telemetry device with surface electrodes that continuously transmits relevant biosignals such as heart rate, as an indicator of stress or arousal, to the data collection system. These techniques

are commonly used in tests of applications where the attention of the user is critical (e.g. control rooms in process industries or air traffic control, drivers in cars, pilots in aircraft). Once the sensors and transmitters become small enough to make them wearable and non-invasive, these methods may be ready to make their entry into the usability lab.

### Data mining and pattern detection

Enhanced and automated data collection methods will lead to large data sets, containing valuable information awaiting discovery. When we know what we are looking for, e.g. if we want to know how the number of errors or the time needed to complete a certain task varies between several design prototypes of an appliance, classical frequency and duration-based statistics will suffice. However, if we are exploring sequential aspects of



user-system interaction, different methods are needed, such as lag sequential analysis, Markov chain analysis and T-pattern analysis. These techniques are not new, but they have not been extensively applied to usability research. They need to be validated and software tools need to be developed to make them accessible to usability testers.

A good example is Theme™, a tool capable of detecting repeated patterns that are hidden to observers and very hard or impossible to detect

with other available methods. It is particularly suitable for analyzing behavioral data. Theme is able to detect patterns that are obscured by other events, and finds patterns that no form of frequency count, lag sequential or time series analysis can identify. As such, it is an effective way to detect patterns in user-system interaction and to identify the precursors or consequences of specific behavioral events.

Theme has been used extensively in studies of human communication, spoken dialogue, gestures, protocol analysis, etc. The Philips HomeLab is the first corporate user in the domain of user-system interaction.

To wrap up the tour of new and future tools for usability testers, a few words about data visualization. With all the new data collection and analysis methods coming along, we will be seeing new graphical methods to visualize user interaction with systems as well as usability bottlenecks, with integrated coupling to video and audio clips and raw data. Such tools will enable us to take maximum advantage of the rich information gathered in a laboratory such as HomeLab.

HomeLab is already an exciting place to work. I am sure it will be even more so in the future! ←

# HomeLab as a tool

## FOR STUDYING USER EXPERIENCES

**Manfred Tschelig, Center for Usability Research & Engineering, Germany**

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Intelligence, ubiquity and transparency are the building blocks of Ambient Intelligence. Every single element of the Ambient Intelligence vision of supporting people's lives in different contexts has to do with people. People with different backgrounds, with different needs and specific communication behavior. It is claimed that technology and intelligence will guide and accompany people during different phases and situations in their day. Will this be true? Users and their acceptance of Ambient Intelligence technology (and their willingness to invest money, time and patience) will be the success criteria in the end.

Ambient Intelligence technology delivers a new level of complexity. Over the years usability experts have developed knowledge,

guidelines, methodology and tools to optimize the usability of "traditional" software and hardware. Neglected or not, consolidated qualitative and methodological knowledge is available. This is different for upcoming Ambient Intelligence systems. There are no guidelines out there, nor will there be in the near future. For example, most usability research environments are not geared to studying users on the move (even to studying a user not sitting at an office workplace or wandering around with his mobile device within some office space is a different situation), changing between contexts, using multiple devices, being supported by "hidden" intelligence or solving tasks at different times of the day. What are the differences in having intelligence around me immediately after a

wake-up call in the morning or in more relaxed situations in the evening? What degrees of difference in intelligence would user groups like to have and what are the control mechanisms they will request? These are only some of the questions to be tackled. There are many more!

Studying the needs of users, anticipating the interaction requirements based on solid data and studying the experience in the interaction with artifacts, the synergy of artifacts and intelligent environments can only be accomplished by setting up and utilizing flexible user-experience study environments. Environments like HomeLab are a prerequisite for facing the challenges of developing user experience knowledge, which will guide people-oriented product design. Multidimensional and open study environments allow research on different levels: basic interaction research towards basic understanding of interaction parameters, and applied interaction research towards specific artifacts and environments in different stages of design and development. Multidimensional means the possibility to study a multidimensional combination of user experience factors. Open means covering all situations, both those that can be foreseen and those that cannot. There is an incredible power in utilizing this type of environment to gain insights into the behavior of people and feed these insights into innovation cycles. Studying the user experience within the

Ambient Intelligence society means coming up with new methods to obtain these insights in a variety of situations, to efficiently integrate these insights, in the development of new potentials and creation cycles, and to develop a well-coordinated knowledge mosaic related to user experience factors. Knowledge to help us address the challenge of the upcoming ambient society is available but fragmented. Strategies are needed to connect the pieces and develop well-formulated roadmaps for usage-oriented interaction. Enriched user experience environments have to be set up to support the vast amount of data collection and analysis and the study of the user experience in context.

If that is done, Ambient Intelligence will deliver real benefits! If not, will fail! ←

# Experimenting THE FUTURE

Josephine Green, Trends and Strategy, Philips Design

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What might we want, what might we find useful and enjoyable, in ten, five or even two years time? What technologies will we adopt, and, perhaps more importantly, what technologies will we not adopt, in order to live well with one another, ourselves and our surroundings?

For Philips, finding possible answers to these questions, lie both in its vision of the future and in experimenting that vision and future. The Philips vision is of a sensitive and responsive environment where technology is seamlessly embedded into our everyday surroundings and is personalized to our specific needs and wants. We have called it Ambient Intelligence. Experimenting the future means exploring with people, in their daily

living and activities, ways in which Ambient Intelligence can facilitate, improve and enhance their quality of life. For one thing is certain, before looking for any answers to these questions, technology only makes sense if it contributes to improving our quality of life. For this to happen it has to be relevant to our ways of living and fit our personal needs.

In journeying to the future, Philips Research, Philips Design and the users themselves, work together to experiment new solutions and new value. A multidisciplinary team of sociologists, anthropologists, psychologists, designers and researchers study and research people as they go about their daily business. To do this they draw on established observational, ethnographic and user research techniques and methods as well as developing new user research approaches that actively involve researchers, designers and users in the process. This “observational” research is embedded in an integrated approach that offers a richer understanding of the complexities of today

### **People and Trends**

The integrated approach draws on the ongoing research programme into Society, Cultures and People in Philips Design. This offers the background to thinking up new qualities for future living and sets the context in which the research takes place. Let's take health for example, the ongoing trends research looks at how society and individuals

are re-defining the concept of healthcare. Is it more than not being ill? Is it about well-being? Do different cultures, generations or gender define it differently? What does this signify for healthcare in the home and can our technologies add any value?

To make the content and insights from the trends research more “manageable”, we cluster the values and needs that emerge from our research into different themes, which in turn act as narratives or “scripts” to help us think about human focused futures. In essence these themes represent relatively clear “clusters” of values, attitudes and concerns that we believe will be guiding many people's lives during the coming decade. These insights help us think about technology and Ambient Intelligence and to go beyond the work paradigm of efficiency, productivity and performance, so often associated with technology, towards more “soft” values concerning the building of relationships and communities and the enhancement of the emotions and senses. A couple of brief examples can hopefully serve to explain this

### **Mosaic Living**

From linear living we are moving towards mosaic living, where we de-structure our lives, exploring different ways of doing things and indeed different things to do. This gives the feeling that there are many opportunities to take advantage of, on the one hand, but also feelings of stress and

information and/or technology “overload” on the other. People are caught between the enthusiasm of the new opportunities and the desire to effectively juggle their work, their family and their leisure.

In this context, Ambient Intelligence needs to help simplify our lives as we look for ways to cope with complex situations and juggle our multiple options and commitments? How can it help us be empowered and not *overpowered* –by the vast array of choices and possibilities we have available. How can it allow us to access information, communication and entertainment in a non-intrusive and natural way, through intuitive interfaces that are customized to our lives, tastes and preferences. How can it ensure through seamless integration and connectivity that we can get this where and when we want? And how can we stay in control?

### Emotional Feeling

Now that many of our physical needs have been satisfied, we are turning our attention to satisfying emotional, aesthetic, sensory and even spiritual needs, with moments of entertainment and experience no longer seen as extraordinary events but very much a part of everyday life. Entertainment itself is changing. From theatre and concerts to cinema and TV, it has tended in the past to involve one-way communication only, requiring a relatively passive attitude on the part of the audience. Now, however, the interactivity made possible by the Internet and by the digitalisa-

tion of broadcasting is encouraging us to take a more active part, engaging in “experiences” rather than simply consuming “products” or services. As we move beyond consuming to experiencing we are also looking to co-create or “customize” the experience according to our own mood and moment.

How can our vision of Ambient Intelligence provide us with an environment that helps us experience more through our senses and allows us to “create” our own experiences that we could change over time? Perhaps even introduce moments of magic and surprise, helping us to enhance mundane events with “experiential” moments, stimulating our imagination and feeding our soul.



## Caring

Increased mobility, the fragmentation of family life, and the breakdown of national, local and community safety nets will increasingly mean that we will feel a need to take responsibility for our own welfare. Popular confidence in the ability or will of governments or other institutions to care for them and protect them is waning. Greater availability of information allows people to scrutinize the basis of “expert opinions” and reach their own conclusions. It is also bringing to light abuses of power that would have remained hidden in the past. We trust less and we fear more. We will therefore be searching for reassurance and guarantees.

Given this we will search for anything that helps us, nurtures us and keeps us safe. In other words we shall search for peace of mind. We will welcome tools that allow us to monitor the health of ourselves or our loved ones, that allow quick links with emergency services, or “tag” our children so that we know where they are. In short how can our technologies look after us and our environments rather than us looking after out technology

In essence our research into society and culture at a more abstract level and our research with people at a more concrete level have one purpose. To ensure that our vision of Ambient Intelligence and our solutions for the future are not only socially relevant and culturally specific but also individually



meaningful. That is the challenge but it is in the challenge that we also see the way forward. In the final analysis relevancy and meaningfulness can only be achieved by involving users at all stages of the innovation process: in the research, in the concept creation and in the development of the actual solutions. Users and researchers need to create Ambient Intelligence together through hands on experimentation and through trial and error. This is what we mean by experimenting the future. Home Lab is one avenue to this end. ←

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