

New Business through User Centric Innovation

A key role for Philips' ExperienceLab

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Colophon

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The key to successful business innovations

Experience research

Interview with Peter Wierenga, Philips Research

Setting is the High Tech Campus, on a sunny afternoon in March. Peter Wierenga is talking about ExperienceLab, the umbrella name for HomeLab, ShopLab and CareLab.

Experience research

Peter Wierenga is sure: experience research is going to be even more important to the future of Philips than it already is. Experience research is at the core of what Philips promotes with Sense & Simplicity: we are developing technology not for technology's sake, but to create products that enhance people's daily life in a meaningful way, taking into account their needs and desires.

What is experience research about, in Peter's view? Basically it is about listening carefully to our customers. It is important that we understand our customers not as consumers, or as buyers, but as human beings. He strongly believes that it is vital that we learn what motivates them,

what they want, what they really need. We need to learn about their emotions, to connect to our customers. Of course, with Philips' campaign Sense & Simplicity, we communicate that we understand what people want, what moves them. But through experience research we have the means to actually comply to this promise.

The AmbiLight TV, and the MRI hospital project in Chicago are examples of projects where this approach has been successfully applied. And it is the firm belief of Peter Wierenga that this approach is going to help us to distinguish ourselves from other companies.

High stakes for ExperienceLab

Developing technology is difficult enough as it is, Peter Wierenga acknowledges, but the key is to develop technology that fits with what people want and need – and that is a much tougher job. A job in which ExperienceLab plays an important part.



Research needs to adopt a user-focused, rather than a technology focused approach. And what is becoming increasingly important is the emotion factor in how people deal with products and services. So, research in the ExperienceLab should also help to determine what the emotional experience should be that Philips can offer through its products.

However, ExperienceLab is not about determining whether one application version is appreciated more than another version – it is about understanding *why* the one version is appreciated over the other – only then it becomes possible to start developing even better applications. If we conduct our research to look for the underlying reasons, and not just for the ratings, then it might turn out that we will come up with yet another version that proves to be even better in truly meeting the needs of our customers.

So according to Peter, the key mission of ExperienceLab is to provide our research community with true consumer insights, which will help Philips to develop not only the best possible products, but also to come with innovative ideas that go beyond incremental improvements of existing products.

From ExperienceLab to Lab Ventures

The past couple of years, HomeLab has already acted as a motor for product innovations, but ExperienceLab can become an even stronger player in the creation of new business. Many application ideas that have been developed and studied in HomeLab, and in ShopLab and CareLab as well, are embraced by our business partners. However, not all ideas are immediately recognized as having business potential, even if studies in HomeLab have resulted in positive feedback from users. In some cases, it might not be clear to the PDs how to fit these applications into their current businesses. Here, Lab Ventures could become an interesting business starting point for projects that originated in ExperienceLab .

The ExperienceLab is an important asset in research, Peter concludes, putting Philips in a leading position in the world, from an industry and an academic viewpoint, to conduct high-standing user-centred research. Once a year ExperienceLab opens its doors to the Philips community, showing a nice set of application demos. However, Peter stresses, we should not forget that the results of the studies conducted in ExperienceLab are the true key assets.

Ambient Intelligence and Open Innovation

Emile Aarts and Fred Boekhorst *Philips Research*



Although originally developed by Philips as a novel paradigm for consumer electronics, the vision of ambient intelligence cannot be regarded as a Philips proprietary concept. Major efforts initiated by the European Commission have led to the vision receiving support from many industrial and academic partners in an open context, thus allowing Europe to regain its strong competitive position in the world.

integrated, user-friendly smart surroundings that promote well-being, self-expression and productivity. In recent years this vision has developed into a solid basis for the three-pillar company-wide Healthcare, Lifestyle and Technology strategy and the *Sense and Simplicity* brand campaign based on the three pillars *designed around you, easy to experience* and *advanced*, which is an excellent way to explain ambient intelligence to people in the street.

The vision and its origin

The vision of ambient intelligence articulates a novel paradigm for consumer electronics for the year 2010 and beyond. It was developed in the late 1990s in a series of internal workshops commissioned by the Philips board of management that led to a vision of a world of fully

Opening up the vision

Following the advice issued by the Information Society and Technology Advisory Group (ISTAG) in 2001, the European Commission used the vision for the launch of its 6th framework program (FP6) on Information, Society and Technology (IST) with a subsidiary budget of 3.7 billion euros. As a result, many new initiatives were launched throughout Europe. Fraunhofer Gesellschaft

embraced the concept and initiated activities in a variety of domains including multimedia, micro-systems design and augmented spaces. Their *InHaus* project is similar to Philips' HomeLab and can be viewed as the Fraunhofer Gesellschaft's approach to user-centred design. Several research programs on ambient intelligence, costing over five million euros each, were set up at national level in a great many countries including, Spain, France, The United Kingdom and The Netherlands.

A novel European subsidiary instrument has been announced called *Experience and Application Research*, which aims to provide financial support for research facilities that conduct research into user behaviour and end-user-driven design.

Over the years, Philips has developed the European Symposium on Ambient Intelligence (EUSAI) and this has now become the leading event for the exchange of novel ideas in ambient intelligence.

Open innovation

During the past years the awareness has grown that the classic type of industrial research facilities can no longer provide the technological innovation required to drive the world's economical development. New models for industrial research have been proposed that build on the

New models for industrial research have been proposed that build on the ideas of the networked knowledge economy using the concept of Open Innovation. This concept is based on the belief that tapping into the abilities of as many clever people as possible will generate more innovative ideas.

ideas of the networked knowledge economy using the concept of Open Innovation. This concept is based on the belief that tapping into the abilities of as many clever people as possible will generate more innovative ideas. At the same time, industrial research needs to widen its scope to become more collaborative and open-minded.

Ambient intelligence has been quite instrumental in the realization of open innovation. There are three major initiatives. *The AMI@Work* group combines parties from both the public and the private domain to provide a forum for discussion about the use of ambient intelligence in daily life. This has given rise to a major research program in the domain of Future and Emerging Technologies called *Ambient Assisted Living*, which has been proposed for FP7.

The *European Technology Platform Artemis* for the development of embedded systems builds on the ambient intelligence visions to define and deploy their strategic research agenda.

In addition to these public-private initiatives, there are also exclusively private initiatives that are aimed at international collaboration. The Ambient Intelligence Research and Development (AIR&D) consortium in which INRIA, Fraunhofer Gesellschaft, Philips and Thompson jointly develop middleware for ambient

intelligence is a very productive example. HomeLab has played a crucial role in many of the initiatives mentioned above because it has enabled Philips Research to partner the best in class, thus enabling us to develop new and promising avenues towards open innovation.

Paving the way from research to business innovation

HomeLab

Joost Horsten *Philips Corporate Technology*



It goes without saying that HomeLab is a wonderful building. It offers fantastic research facilities as well. And yes, it is a very attractive setting in which to organize demos. But it is even more than that: HomeLab is also a powerful enabler for business innovation.

HomeLab has been set up as a lab for studying human-technology interaction and for testing new ambient intelligence concepts. As such, it enables both the development and evaluation of innovative applications and user interaction solutions by means of a user-centric design process. In order to achieve this, there are multidisciplinary project teams consisting of interaction and technology researchers and cognitive psychologists. The laboratory offers an advanced observation and data analysis system for conducting studies with users. Advanced methodologies are used and new research tools are developed to analyze the participants' reactions.

The above factors create a firm foundation for scientific research into consumer preferences. Does a new concept appeal to a user? Does it create a desirable user experience? What user benefits does it offer? Is there anything we have overlooked? What could be improved?

By providing this information about consumers, HomeLab lays a firm foundation for product innovation. However, this on its own is not enough. A new product concept often requires – or enables – new business models. True breakthrough, end-user-driven technology innovation requires a business innovation as well. To achieve this, other players in a business value chain have to be called in. Discussions about new concepts and newly acquired end-user insights can give rise to new opportunities throughout the entire business arena. Together with business partners we can use HomeLab as a valuable asset for business innovation.

One example is the Interactive Display Mirror / Mirror TV. It started out as a concept user interface for a Personal



Health Care application. When it was implemented in the bathroom of HomeLab it became clear that both the technology and the context of use enabled many other applications, such as personal infotainment and beauty care. These applications were very much appreciated by different consumers. It also set new challenges for user interaction technologies. Several of these technologies were developed, implemented and evaluated. As a next step, discussions with several major bathroom companies were held, together with Consumer Electronics, all starting with a demonstration and discussion of the HomeLab bathroom concept. The response was overwhelmingly positive: “great product concept”, “it’s definitely going to happen”, although some also said “it’s too soon for us”. From this process we learned that at that particular point in time the differences in market dynamics and innovation approach were too great to be overcome. This helped us to gain a better understanding of the process.

All of the innovative applications were appreciated, but the one that really got through was simply watching TV: turning the complex interactive display monitor into a design item, a Mirror TV. The product was launched under the name MiraVision. It has generated much market awareness, won many design awards and, being a high-end niche product, is now a profitable business.

Another example is the combination of AmbiLight TV and amBX. These two concepts started out as a cross-fertilization of several research groups and are now finding their way to the market. Both concepts add additional sensorial experiences to AV content and bring entertainment from the screen into the room. AmbiLight TV does so by adding light effects based on an automatic analysis of the screen content. amBX goes further by adding multi-sensorial effects (lights, rumbles, fans, etc.). These concepts are in fact quite complementary, each with their own strengths. Extensive end-user studies have confirmed their appeal. Subsequent discussions with representatives from consumer electronics, movie and gaming areas, amongst others, have gradually helped to define the best market entry strategies for both concepts. As a result, the AmbiLight TV is currently on the market and it is a powerful discriminator in the Philips high-end TV line. amBX will be introduced onto the market this year in the form of gaming peripherals. In both cases early user studies in HomeLab played a key role in understanding the consumer insights and selecting solutions with the highest value for end users.

In all these cases – the Mirror TV, AmbiLight TV and amBX – HomeLab has been instrumental in showing the way along the hazardous path of business innovation.

Key factors to success

Innovative product development

Interview with Prof. Dr. Erik Jan Hultink *Technical University of Delft*



Estimates published in literature of the amount of product innovations brought onto the market that are indeed successful range from 5-60%. Apart from the large differences in these reported estimates, amongst others caused by differences in definitions of what constitutes ‘successful’, and by differences in the methods used to collect such data, it is clear that a great part of all attempts to bring out innovative products fails.

Research in Delft has indicated that the following four factors are seen as important for short-term and long-term success of new products: customer satisfaction, customer acceptance, meeting quality guidelines, and product performance level. And of these factors, customer satisfaction was found to be the most important measure.

Given that an important success factor in product launches is customer satisfaction, it is vital that companies find out what their customers want, before they start developing new technologies. The user-centric approach as adopted by Philips, in which consumer needs are being determined first and used as the starting point for actual technology development (technology pull rather than technology push), is well in line with this recommendation.

Research facilities such as HomeLab constitute useful tools in this approach, of course in combination with adequate methodologies for studying consumer responses to innovations in the various development and evaluation phases.

End-user driven innovation

Interview with Klaas Vegter *Philips Lighting*



The fact that HomeLab is now being extended with CareLab and Shoplab is an important development. Facilities such as these labs, and in particular the research that is carried out in them, are important to meet with the three pillars of Philips' brand promise. *Designed around you* requires that we have to understand what people need and desire; *Advanced* means that applications that are seemingly simple, still are capable of realizing complex functionality. *Easy to experience* demands that the applications shall be very easy to understand and to use by our customers.

End-user driven innovation

This all requires that Philips needs to shift from a technology-focused way of working to an end-user driven way. Why is end user driven innovation so important for Philips? In a market where consumers have the possibility to inform themselves thoroughly about consumer goods, comparing functionality and prizes before they make a decision what to buy, and where these consumers are

It is no longer sufficient to come with incremental improvements of existing solutions – we have to take bigger steps, and look for innovative applications that really improve people's lives.



looking more and more for additional features beyond the basic qualities and necessary functionalities, it is no longer sufficient to come with incremental improvements of existing solutions – we have to take bigger steps, and look for innovative applications that really improve people’s lives. And that really deliver the experience that people are desiring and needing. Also, there is a growing need for integrated solutions. To give an example from the Lighting domain: our consumers are increasingly looking for lighting systems instead of singular lamp solutions, for an integrated system that can provide more than just functional lighting, but a system that can support them in other ways as well (e.g. shop marketing), and that at the same time is reliable, easy to install and maintain, and easy to operate. This means that not only advanced lighting solutions are required, but also advanced interface solutions, and system management solutions. The best possible solution can only be realized, if we combine expertise from different divisions, and most importantly, if we start listening to our customers. And this involves end-user research from the start of a project, and continuing this end-user involvement throughout the project.

Working together

It is essential that this end-user driven approach is adopted Philips wide. In fact, the PDs should work together with

Research, Applied Technologies and Design – in order to maintain this user-oriented focus throughout the whole development chain, and translate consumer needs and motivations into valuable product propositions.

An example of how this cooperation and way of working indeed can result in successful propositions, is the recent initiative at the Catharina Hospital in Eindhoven, where Philips Medical Systems, Philips Design, Philips Lighting, Philips Applied Technologies and Philips Research work together in developing and evaluating a healthcare work setting that supports the medical staff in their jobs, and that provides the patients with optimal care and encouragement during their treatment. Technologies developed by the different partners in this project are brought together, to create an ambient healthcare setting that clearly meets the brand promise, and thus the end-user needs.

Also during this year’s CRE, a number of projects will be demonstrated in HomeLab, ShopLab and CareLab that are the result of cooperation between different partners within Philips. Each partner brings in the project its own expertise and know-how – and in joining forces, we will be able to fully realize our potential in meeting end-user needs.

The next phase in experience research Moving from HomeLab to ExperienceLab

Emile Aarts and Maurice Groten *Philips Research*



Five years of experience research in HomeLab has provided Philips with a wealth of consumer insights that

have led to novel product concepts. The bathroom with its *Light Atmospheres* controlled by touchless *Interactive Mirrors* and the living room with its *Active Ambilight TV™*, *Living Light*, *DreamScreens*, and *Adaptive Lighting* are just two examples of ambient intelligent rooms that were realized in HomeLab and have led to major business successes.

Now there is a need to extend the experience research concept of HomeLab to a broader domain that includes healthcare and retail. CareLab and ShopLab are the

Now there is a need to extend the experience research concept of HomeLab to a broader domain that includes healthcare and retail. CareLab and ShopLab are the resulting extensions of HomeLab.

resulting extensions of HomeLab and the combination of these three research environments constitutes the novel ExperienceLab.

HomeLab

The vision of Ambient Intelligence, which was developed by Philips Research and Philips Design in the 1999-2001 timeframe, has been the driving force behind the experience research program carried out in HomeLab over the past five years. The investigations were aimed at creating compelling experiences and intelligent environments that interact upon the presence of people.

The creation of experiences initially focussed on the LifeStyle domain. It is based on the application of state-of-the-art technologies, e.g. video and sound processing, and involves the addition of elements that really can create the experience. Our main focus has shifted from purely functional qualities, like picture and sound quality, to the creation of differentiating experiences that add value for end users. The HomeLab research program has delivered many examples and demonstrators of these experiences over time. These developments have led to a better understanding of customer insights as well as to novel product concepts.

ExperienceLab

The core function of HomeLab is not so much to provide a demo location, but to provide a center where researchers can work on the definition and creation of compelling experiences, on the development of the technical solutions that realize these experiences and, finally, on the validation of the experiences with end users, with an emphasis on the LifeStyle domain. The customer insights thus obtained have been developed and shared with business partners predominantly from Consumer Electronics and Lighting. The newly created technologies and products were transferred to our business partners, together with the validation methodologies that were developed to quantify experiences. Based on the success of HomeLab and in line with the company strategy, CareLab and ShopLab have been developed as two new experience laboratories adjacent to HomeLab. Together HomeLab, ShopLab and CareLab are referred to as ExperienceLab.

ShopLab

The ShopLab research program builds on the vision that personalized ambient atmospheres enhance the shopping experience. However, many shops and retail chains want



to maintain their house style for branding reasons. The challenge is therefore to find a way to combine these two major aspects, and one approach could be for a single atmosphere design to be broadcasted to all branches of a chain store and for this design to then be adjusted to suit the local conditions and personalized criteria. In order to tune these atmospheres it is necessary to control several hundreds of lamp settings, which represents a complex global control challenge. Adaptation of the ambient shop atmospheres also requires input from smart environments that can detect when people are present and their interest in products when they are inside the shop, or even earlier, when they are still outside, looking in the shop window. Intelligent Shop Windows are envisioned, providing shop owners with new ways to create experiences and therefore to attract customers, and providing shoppers with new ways to find out about the products available, even when the shop is closed. Investigations are being carried out into systems that are able to fulfill these requirements and the initial versions will be demonstrated at CRE2006.

CareLab

The CareLab research program will focus on solutions that bring interactive healthcare systems and services into

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the home environment. A small apartment block will be built, equipped with an advanced distributed sensor infrastructure that can extract context aware and personalized information from the occupants for a variety of use cases. The sensor information is then processed and combined to extract higher-order behavioral patterns that can be related to activities and states, such as the presence of people, their activities, the state of the home infrastructure, etc. One of the key focal points of the research in CareLab will be in the field of solutions for senior citizens. By applying appropriate data-mining techniques as well as knowledge representation and reasoning technologies, it will be possible to draw conclusions about concepts for enhancing personal safety and well-being. Validated concepts can be further investigated in real-life settings outside the CareLab.

ExperienceLab applies the end-user centric research approach to experience research with a clear focus on generating added value to the experience of end users in their context, based on a thorough understanding of the users' needs, wishes and motivation. One common approach involves the electronics and intelligence being embedded in the environment so that it is not at all visible or noticeable to the end users. This calls for extremely easy-to-use, intelligent interaction solutions

that are suitable for these complex integrated environments and their users in order to create a desirable experience. ExperienceLab is used to validate these claims together with the targeted users.

HomeLab





HomeLab

Wireless charging pad for mobile devices

Eberhard Waffenschmidt *Philips Research*

People own and use an increasing number of portable electronic devices like mobile phones, digital cameras, music players or handheld computers. These devices can all be used wirelessly, but they still need cables to be recharged. Reports from participants in many HomeLab studies indicate that they appreciate the freedom that wireless equipment brings, but they do not like the fact that each device comes with its own specific charging equipment – resulting in too many different chargers piling up. Now Philips Research has been investigating and improving a system that allows wireless charging of mobile electronic devices. It consists of a tablet the size of a mouse pad and it allows an arbitrary placing of mobile devices. There is no need for a separate power supply. Simply place the device on the pad to charge it – no hassle with cables and plugs. The wireless charging pad can be used in the home or office as well as in public places like hotel rooms or on trains or airplanes. The device consists of a matrix of

charger coils that can generate an alternating magnetic field. The mobile devices contain a receiver coil in which a voltage is induced. This voltage is used to power the device and to charge a battery. To enhance efficiency the charger coils can be switched locally so that only those close to a receiver coil are active. Ultimately, each mobile device, or at least its battery module, would need a receiver coil that is tuned to the individual power requirements of the mobile device. In this way, only one universal charging pad is required. Although the current application, shown in HomeLab, focuses on consumer devices, this technology will also be applicable in e.g. medical and healthcare environments. With the implementation in HomeLab evaluations are planned to be conducted to obtain user feedback on potential concerns and additional requirements, e.g. related to charging times.



Personal content management made easy

MediaBubble devices

Freddy Snijder *Philips Research*

With the proliferation of digital capturing devices, users are going to need intuitive and integrated solutions to deal with the ever-increasing amount of digital personal content they create. Photos and videos have always been a very important means for consumers to capture their experiences, share them with family and friends and express their creativity.

The physical nature of photos on paper has enabled users to deal intuitively with these photos because they are very familiar with paper as a medium.

However, digitization offers a host of new possibilities for dealing with photos and videos, such as easy and fast capturing, automatic annotation of content items with relevant metadata, although still an interesting research challenge, and browsing through hundreds or even thousands of content items. This creates a need for an intuitive and integrated solution for digital personal content management, combining the best of both worlds.

MediaBubble devices aim to provide such a solution.

These are a class of small form factor devices that integrate multiple technologies, such as processing, storage, wireless networking, sensors and display.

The combination of its small size and specific technology integration enable mediaBubbles to autonomously collaborate and allow users to intuitively perform content management tasks, by using the device itself as a “physical” user interface. Through collaboration, mediaBubbles can self-organize new content allowing users to always have the right content, available on the right device, automatically. Another example of mediaBubble collaboration is distributed semi-automatic annotation, helping the user to annotate any new content, by means of content analysis.

Since self-organization can result in mediaBubbles having a very specific content collection, the user could “physically” browse for those collections.

This makes mediaBubbles a kind of electronic photo-albums, automatically gathering the right content!

Other examples of the ‘physical’ user interfacing used are the intuitive initiation of uploading or sharing of content with a second mediaBubble simply by keeping the two mediaBubbles close together. The same method can be used to enable the user to initiate a content slideshow on a TV display.

Many concepts relating to mediaBubbles and its functionality need to be evaluated in studies with users. For instance, since users could have many mediaBubbles, this would require effective many-device-to-one-user interaction solutions that need to be developed and tested with real users. Realization and demonstration of mediaBubbles in HomeLab is the first step towards addressing these challenges.



Home video editing made easy

Edit while watching

Marco Campanella, Mauro Barbieri, Hans Weda, Prathana Shrestha Philips Research

With the rapid proliferation of digital video camcorders, more and more people are becoming involved in video production and editing. Not just amateur video enthusiasts but virtually anybody – even people with no previous experience of video production and editing – can capture their experiences and document their lives. People are generating a huge amount of personal content which, unfortunately, is often stored and never touched or watched again. The main reason for this is that unedited raw material is too extensive, boring, and lacking visual appeal. Users rarely find the time or have the skills to use video editing tools, which are tedious and difficult to use, and editing too time-consuming. Nevertheless, many home video users would like their video to appear like a professional production before they share it with family and friends.

The Edit While Watching system allows the user to automatically create and change a summary of a home

Many home video users would like their video to appear like a professional production before they share it with family and friends.



video in an easy, intuitive way. Whilst it is being downloaded from the camcorder to a stationary device, the raw home video footage is analyzed. Audio and video content analysis algorithms are applied for indexing, segmenting and combining fragments of video with proper music and editing effects. The result is an automatically generated home video summary that is shown to the user. In this process, content analysis and automatic editing are enhanced with a knowledge of professional film production rules, also known as film grammar. For example, film grammar discourages camera panning directly after zooming, and such camera motion patterns are therefore not included in the automatically generated summary.

While watching the resulting summary, users can easily alter parts by simply pausing playback and choosing one or two options. For instance, users can indicate whether they like a certain scene so that the system will adapt the summary to contain more content that is similar or related to the displayed scene. The system learns what is actually relevant for the user in the video content and takes this into consideration when refining future editing operations.

Since user interaction is of key importance, we are using a user-centric process. Edit While Watching does not

require a complex user interface: a TV and a few buttons on the remote control are all that is required.

A preliminary user study has shown that it is easy to learn to use and allows users to achieve predictable and satisfying editing results with little effort. This study also pointed out that a proper balance between automation and the user's control of the editing process remains an important issue. Thus, we aim to create technology and applications that will allow everybody to turn their home video footage into an attractive presentation quickly and without having to be bothered with difficult technical details.

A truly immersive experience for Home Cinema

amBX

Winfried Berkvens *Philips Research*

The amBX project aims to provide an enhanced and immersive experience for Home Cinema. This is accomplished by increasing the stimulation of all human senses, including senses like smell and touch. This can be achieved by adding effects to the content. The aim of the effects is to increase the realism of the entertainment content, thus allowing the consumer to become immersed in it, or to create an ambience that enables the consumer to enjoy the content more.

The huge success of movies and electronic games has already shown that people like the idea of being part of a virtual adventure. The consumer appeal of surround sound is another sign of the interest in more immersive experiences. And, of course, the current success of Ambilight TV indicates that consumers enjoy enhanced experiences, in this case created by coloured light effects.

The system implemented in the HomeLab shows video content enriched with effects created by actuators like

*In a test with users,
95% of the participants
found the amBX effects
to be highly appealing
and immersive.*



rumbler, fans and coloured light units. In order to be able to create the appropriate effects for the content that will give consumers an enjoyable experience, a description of these effects is required. This is done by means of scripts that contain high-level descriptions of the desired effects and that are based on 'artistic' input. Furthermore, a so-called amBX engine is used to map these high-level descriptions onto the available actuator devices in the living room.

Each script is linked to a particular content item and must be available for playback in combination with this content. In the current prototype the script is retrieved using a content identifier. The content is identified on the basis of content features in the video, known as 'fingerprints'. Fingerprints are very well suited for this purpose since they have good discriminating power.

In addition, it is very important to synchronise the effects with the content because users are able to discern timing differences of as little as 40ms, as has been shown in tests with users. To realise such an accurate synchronisation, the system uses an amBX engine clock which runs on the basis of time values linked to these fingerprints.

The main goal of the project is to provide our customer with a proof of concept of crucial parts of the system which is going to create this immersive experience for the consumer. In a test

with users, 95% of the participants found the amBX effects to be highly appealing and immersive. In the words of the participants: "The amBX light effects, rumble effects and fan were fantastic, it was like I was there", "I was drawn in", "It is not just sound and visual with amBX, it is as if there is an added dimension to it".

In further tests we shall be investigating the relative importance of different output modalities for the creation of an immersive experience. Tests will also be performed on an evolved system to find appropriate means for automatic installation and dynamic configuration of the actuator devices and to investigate how context information on lighting conditions, for instance, can be used to adapt the system.



Active beam manipulation LEDs in lighting applications

Rifat Hikmet and Ties van Bommel *Philips Research*

Lighting is an essential ambience element in our lives. People like to be able to adapt the lighting conditions to suit the activities in which they are engaged. For example, a spotlight used for task lighting, e.g. for reading, in a living room needs to be switched to a more diffuse and warm lighting if friends come over for a visit. Similarly, spotlights suspended above the dining table should provide warm light during dinner, but a larger area needs to be illuminated when the table is not in use. At the moment, there are no easy-to-use solutions for switching lighting conditions between various states to suit different requirements. As a result, this still needs to be done manually by changing the direction of spotlights by hand or by dimming various light sources separately.

Since the introduction of solid state lighting (Light Emitting Diodes or LEDs), it is now very easy to switch between saturated colors and to obtain any desired color temperature from a light source. In addition to these

In a home environment the shape and direction of the beam can be switched between various states depending on what the user is doing.

possibilities with LEDs the *Active beam manipulation* project offers simple thin switchable flat optical elements to enable us to control the shape, direction and collimation of a light beam. These elements do not have moving parts and can simply be placed in front of a luminaire so that the small form factor of LEDs is retained. Application of a voltage from a variable source changes the characteristics of such an optical element,

which in return adjusts the beam. The technology for producing these optical elements is simple and suitable for mass production so that the elements can be introduced onto the market quickly.

In a home environment the shape and direction of the beam can be switched between various states depending on what the user is doing. There are also plenty of opportunities in other domains as well. The beam control function at the moment is in its infancy. It is therefore important to investigate possible new applications for this technology. With the demonstrator in HomeLab and ShopLab we can investigate how consumers would like to use this technology and what kind of user interfaces for light beam control would be preferred.



DreamScreen: Virtual Windows

Evert van Loenen, Willem Oosting, Ingrid Vogels, Tatiana Lashina, Rick van Haasen, Corinne Staats, Onno van Tertholen, Aad Sempel *Philips Research*

Windows play an important role in people's lives. Windows provide daylight in indoor spaces, and allow us to stay in touch with what is happening outside. It is well-known that people generally dislike being in rooms without windows for longer periods of time. Nevertheless, there are a lot of rooms like this, for example meeting rooms, offices, bathrooms or other spaces that are simply not adjacent to an outer wall. In other cases there is a window to the outside but the view from it is very unattractive (for example a blind wall).

To understand and address these issues, two types of virtual windows have been created: one that provides light with a surface area and brightness comparable to that of sunlight (created by one of Lighting's Vision teams in cooperation with Research), and one that uses a display to provide virtual views of the outside world. For the generation of the virtual sunlight window, a large flat, high-brightness lamp is used, that can be tuned to mimic the color of, for example, the sunrise, noon or

sunset. For the virtual view window, a large flat display is used. A simple image or video, however, gives a poor representation of a window view because it lacks depth and is invariant with respect to a user's head position. To create a more realistic window view experience, studies with users have been performed on the application of occlusion and motion parallax principles to generate depth perception in 2D images.

The results have been incorporated in the prototype window: the view adapts to changes in the position of a viewer's head, as would be the case with a real window view.

The two solutions represent the two key characteristics of a complete window view. They are mounted behind identical, real window frames fitted with glass and sun shades in the (windowless) kitchen of HomeLab to enable feasibility and user studies in order to come to optimal solutions for the creation of virtual window experiences.



Lagom: Automatic music mix

Dennis Luijer, Vincent Buil, Gerard Hollemans *Philips Research*

People listen to music together for many reasons: to share the joy of a performance, to dance at a party, or to listen to each others favourites at a gathering with friends. But it can be hard to find music that truly appeals to everyone. In a mixed group, the music selection often suffers from the 'Beatles effect': acceptable to many – because it contains popular songs, but liked by few – because of overexposure to these songs.

The LAGOM system addresses this problem. It allows users to bring their own music to a party, just like they did when they were teenagers, but now on a USB stick or MP3 player. Instead of a few self-appointed DJs who decide what will be played, the LAGOM system will make sure everyone's music will get equal playtime.

The LAGOM system can be put on top of stereo equipment, with multiple USB ports placed on a circle outlined by LEDs. Users can place their stick or player in one of the ports. When the current song ends, the system will randomly select one of the inserted USB devices.

This action is shown by a circling light at the top of LAGOM, like the ball on a roulette table. Alternatively, a user may press the centre dial to move to a new song. From the USB device at which the light ends an MP3 file is selected and cross-faded with the currently playing song.

Via a Value Proposition House analysis, we have targeted LAGOM to social gatherings in the home. Further research should answer questions such as: does LAGOM indeed satisfy the targeted need, and in what situations is this need felt most strongly? What level of control do users want over the selection process, and how should the system handle song transitions? For example, the LikeMusic algorithm could be used to select a next song similar in sound to the currently playing song, but not necessarily of the same genre.

Furthermore, through its LEDs, LAGOM makes it possible to experiment with light effects being steered by the music, as is being developed in the Music Living Light project.



Feeling the intimacy of words in music

Lyrics synchronization

Steffen Pauws, Jan Korst, Fabio Vignoli *Philips Research*

Music and words are magically connected in many Classical and Popular music like opera, German lieder, rock music and rap. However, this relation starts to miss its marked effect to the music listener, if digital music comes without its booklets and if the words are hardly intelligible in their musical context, even for native speakers.

Automatic lyrics synchronization enables people listening to music to read the words at the same speed as they occur in the music. By these means, listeners can fully and directly experience the intimacy between the words and music or easily grasp the meaning of the words. Furthermore, they can easily jump to and listen to different sections in a song or even sing along with the music.

Lyrics synchronization starts with gathering and editing the lyrics of a given song using on-line services. The lexical

and phonetic properties of the lyrics and their rhyme and form have to be analyzed. In rock music, for instance, a verse-chorus form is often used in which each verse contributes to a developing story by presenting new lyrical material and a chorus repeats a general message. Since a similar form is represented in the musical structure of the song, the audio content of the song is subsequently analyzed to ascertain the tempo, meter and chord progression to reveal the time values that demarcate this form. These time values already provide a synchronization in which the words of the verses and chorus are displayed at the time they are heard. Further synchronization on phrase, word or even syllable level is possible by forcing an alignment between the audio content and the phonetic transcription of the lyrics.



CareLab





CareLab

A sleep and care solution

smartBed

A. Brauers, X. Aubert, A. Douglas *Philips Research*

The smartBed takes care of you while you are sleeping. It can help you stay fit, and it can also improve the quality of life for people with a heart disease. It can save lives by monitoring people in their familiar surroundings, i.e. their own home. To do so, the relevant parameters have to be measured and translated into the required medical information. Recommendations or problems that are detected are fed back to the user by the system or with the aid of their physician.

A bed is an ideal place for monitoring people's cardiovascular and respiratory performance and, of course, their sleep. The smartBed project aims to develop monitoring solutions that do not hamper the user's sleep comfort and are perfectly integrated into the sleeping routine without requiring additional user action. To this end, we investigated sensors that are completely unobtrusive to the user. Doctors and patients who are at risk of heart failure have confirmed in interviews that these concepts are attractive and that the patients would like to use them.

The smartBed takes care of you while you are sleeping, it can improve the quality of life for people with a heart disease.



The challenge within the project is to obtain information unobtrusively about standard vital body signs using novel technology in such a way that the measurements are also accepted by the medical community. The sensors are integrated into the mattress, bedstead or textiles to allow for completely transparent use, rather than being attached to the body, as they would be in a hospital setting. The signals obtained from these integrated sensors are far from standard. The parameters considered so far are: presence (in the bed), weight, body and limb movements, breathing rate and heart rate, in order of increasing complexity of the algorithms required to extract and interpret these parameters.

The CareLab demonstration shows how these parameters are measured in an ordinary bed and what type of information can be given to the user/patient or a carer after a complete sleep cycle. This information can be used to coach users, e.g. to improve their sleep-related habits, or to supply doctors with the information needed to optimize treatment of e.g. heart failure patients.

An attractive outlet for this technology is for monitoring and surveillance in the care of the elderly. Both application scenarios are evaluated in detail in clinical and user trials.

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ILSA

Boris de Ruyter, Warner ten Kate, Peter van Grinsven, Herman ter Horst, Kero van Gelder, Jurjen Eisink, Richard Doornbos, Declan Kelly, Sheng S. Kim, Elly Pelgrim *Philips Research*

The 'Intelligent Life Style Assistant' (ILSA) system is an intelligent and adaptive home environment system that can help people to maintain an adequate quality of life in their own home as they get older. In addition to providing a sense of security for senior citizens, it provides a remote monitoring service that alerts care centers or relatives in accordance with the wishes of the occupants. The ILSA project is targeted at developing interactive solutions for people, like the elderly, who might need assistance following a traumatic experience, such as losing their partner, or who are at risk, e.g. of falling. The technology realized in this project includes an intelligent monitoring system based on the integration of a range of distributed sensors. This system has a context-aware reasoning engine in order to translate sensor data into meaningful events. The project also comprises a flexible platform to allow interaction with the services chosen by the user. This system can offer a range of comfort services to senior citizens at home and

The primary goal of the 'Intelligent Life Style Assistant' project is to enable people to maintain an active, healthy and independent lifestyle.



can alert care centers or relatives when necessary. The primary goal of the ILSA project is to enable people to maintain an active, healthy and independent lifestyle. This could give rise to numerous benefits at the various levels of the healthcare supply chain. As the initial focus of the project is the more senior segment of the population, the anticipated benefits for this segment and their relatives are:

- Help for the elderly in maintaining an independent lifestyle
- Enhanced sense of security and well-being
- Peace of mind for relatives of senior citizens
- Reduced burden for the caregiver and minimum risk of burnout.

The ILSA system not only contributes to the senior citizens' well-being, but also generates cost savings at various levels in the healthcare supply chain:

- For the elderly, because it delays or even eliminates the need to live in alternative but expensive care facilities
- Reduces the burden on the healthcare system because care providers are able to devote time to other high-risk patients
- Eliminates the need for elderly people to visit hospitals frequently for check-ups because remote monitoring means fewer visits

Systems such as ILSA are so valuable because they successfully address an obvious user need. The development of application and services propositions for personal healthcare and well-being requires thorough feasibility and usability testing before they can be deployed in field settings. A laboratory infrastructure that simulates real-life situations is required for this. The Philips CareLab offers such a controlled yet realistic testing environment where feasibility and usability tests can be carried out on personal healthcare and well-being concepts before they are validated in field settings.

Later Life Lighting

Esther de Beer, Luc Schlangen, Ariadne Tenner, George Kok, André van der Putten *Philips Lighting*

As people grow older, many of their bodily functions start to deteriorate: hearing, vision, physical mobility and cognitive/memory performance. Elderly people also increasingly find that their sleep patterns become disrupted, they wake early or late, take daytime naps, etc. Philips Lighting closely collaborates with the home care industry and care institutions to develop lighting solutions that facilitate elderly care and improve the well-being of the elderly.

The aim of the project is to design and test lighting solutions tailored to the needs of elderly people.

The lighting products are designed to enhance the quality of life through improved visibility, sleep quality, health and sense of well-being. The project involves designing, end-user testing and claim validation of product concepts.

The first line of product concepts relates to the general lighting level suitable to reduce the risk of falling and to create favourable conditions for elderly people to continue visual activities like reading, playing cards,

embroidery, etc. It is known that these activities improve the cognitive/memory performance and sleep-wake rhythm. In order to compensate for poorer eyesight, elderly people may require lighting levels that are 3-5 times higher than those required by younger people, but they are also more sensitive to glare. In the project appropriate lighting solutions are designed and tested extensively by end users in their own living environment.

A second line of product concepts is aimed specifically at improving the sleep-wake rhythm. During later life the prevalence of sleep disturbances increases. Daytime naps are frequently taken to compensate for lack of sleep at night, leading to a further de-regulation of the natural sleep-wake rhythm and a further decline in health. Light treatment is a non-pharmacological approach to improving the day-night rhythm and has virtually no adverse side effects. This is particularly relevant for the elderly, many of whom are already taking a range of drugs for their various health problems.

A key challenge in the project is how to design products that not only offer the proper lighting conditions but are also appreciated by the end users for their aesthetics and user-friendliness. A successful lighting solution should fit seamlessly into the living environment and daily routines of end users. The demonstrator in CareLab enables us to evaluate these aspects.



ShopLab





ShopLab

Towards interactive shopping experience

DreamScreen: Intelligent Shop Window

**Evert van Loenen, Tatiana Lashina, Mark van Doorn, Kero van Gelder, Vic Teeven,
Werner de Bruin, Rick van Haasen** *Philips Research*

The DreamScreen project aims to create attractive experiences by augmenting or replacing the view through otherwise transparent windows. Our goal is to find out at as early a stage as possible what value propositions can be created based on end user insights, to identify the requirements for the technologies that are needed, and eventually to create complete prototype systems including appropriate interaction solutions.

In the first phase of the project an inventory was made of user benefits for a broad range of DreamScreen applications in the professional, public, automotive and home domains. An Intelligent Shop Window was identified as a potentially attractive concept for the retail business. In this concept, the shop window can provide shoppers

The Intelligent Shop Window provides shop owners with powerful new tools for changing the appearance of the shop window.



with relevant information related to the products they see through the window, triggered either explicitly by the user through simply touching the interactive screen of the shop window or intelligently through detection of the shopper's interest in a particular product. The Intelligent Shop Window is aware of the presence of people nearby, whether they are just passing by or approaching the shop window, and can adapt its behavior accordingly. It can accommodate multi-user situations by providing, amongst others, localized video and audio output for each individual user.

Such a shop window addresses the need of shoppers to be better informed about the products available and it allows them to explore the assortment or even reserve or buy products when the shop is closed. At the same time, it provides shop owners and window dressers with powerful new tools for changing the appearance of the shop window, allowing them to express their brand image and target group lifestyle and thus attract customers.

To find the solutions that best address actual user needs, our approach is a user-centred one: we observed shoppers and interviewed shop owners to find out how and why they use shop windows today. We developed usage scenarios for future Intelligent Shop Windows.

We then used these to derive user, system and interaction requirements. They were also visualized photo-realistically to enable evaluation of their value for potential end users (shoppers and shop owners).

It is of great importance that the shop windows are extremely easy to use and experience because we cannot expect the end users to spend time learning how to use them. To be able to directly evaluate the feasibility, usability and actual end-user appreciation of different Intelligent Shop Window implementations, a fully functional test setup was developed and integrated into ShopLab: a controlled, yet realistic shop environment for the study of future shopping experiences. Here it is possible to compare side by side different implementations, for example with explicit, implicit or combined interaction solutions.

IIIA – Intuitive Interaction for Lighting Atmospheres

Richard van de Sluis, Tom Bergman *Philips Research*

The IIIA project aims to define a new style of user interaction for creating and controlling lighting atmospheres. The retail domain is taken as the starting point, since studies indicate that there is a strong need for easy ways to change the atmosphere in shops. Product collections in shops are being refreshed at an increasing frequency, especially in fashion.

Shopping has also become one of the most important leisure activities in the western world. It is important to realize that people do not only go shopping because they need certain goods. In many cases it is the shopping activity itself that fulfils people's need to experience nice atmospheres and to discover new trends and attractive products. Pleasant atmospheres in shops will also mean people want to linger for longer and this will increase the chance that they will come back. And if people revisit a shop after several weeks, they would like to see

something new. Shops therefore want to always appear new and fresh by continuously updating both the product collections and the atmosphere in the shop.

Light is an effective means for creating an atmosphere in a shop and advances in lighting technology bring new opportunities offering color, dynamics and interactivity. However, it should be possible for a person, such as the shop manager, to change the atmosphere in an easy and enjoyable way. For instance, this person may want to change the color of the luminaires, adjust the light intensity distribution in the shop or define a dynamic lighting atmosphere.

One problem with color control is that people have difficulties navigating in a colored space because they are unfamiliar with it. When people have to choose or describe a color they often use a color in the



Three other interactive shop lighting concepts are being explored: the interactive clothing rack, the automatic color-changing display cube and the adaptive spotlight.

The interactive clothing rack creates a dynamic spotlight on the clothes that people are looking at. It responds subtly to people's interactions with the clothing in the rack and should give them the feeling of being noticed and appreciated.

The color-changing display cube is a display cube – like those commonly used in shops to display fashion accessories – with added integrated color lighting and a camera. The camera is used to determine the prominent colors of an item on display and the light color of the inside of the cube is changed accordingly. As a result, the color of the display cube can be changed automatically and there is no need to repaint the cubes when the items on display are changed.

The adaptive spotlight is used to attract the attention of customers. The spot simply changes its beam shape if a person is standing in front of a product on display. LED spots from the Active Beam Manipulation project are used for this purpose.

environment as a reference. In the IILA project a number of different color control concepts are being investigated. The LightWand concept addresses the case where many colored luminaires need to be controlled. The LightWand is a color scanning and pointing device which enables the user to 'paint with light'. It allows a user to pick a color by either pointing to a colored luminaire or by touching a colored surface in the environment and to 'paint' this color by pointing at the target luminaire. In-depth user studies will be carried out in the ShopLab to help us to understand the advantages and disadvantages of the LightWand and to identify possible improvements.



Towards flexible light management systems

LightMan

Mark Verberkt *Philips Research*

Developments like solid-state lighting and the experience economy are changing the focus of the lighting business from functional lighting with stand-alone lamps towards lifestyle lighting in systems with many connected lamps. This is clearly apparent in the retail domain.

Market research into retail lighting shows that many shops (particularly high-end fashion shops) change their interior regularly, as often as once a month, to continuously reinforce the attractiveness of the shop. These changes, which involve selecting different accessories, re-painting walls and re-adjusting the lamp control parameters, are at present costly and time-consuming. However, an easy way to design light and an automatic process for rendering the light in a shop would significantly reduce this effort and increase the flexibility and value of light.

The LightMan project provides the technology that enables attractive light atmospheres with such a networked lighting system to be created in an easy and

Many shops change their interior regularly, to continuously reinforce the attractiveness of the shop. LightMan offers an easy way to design attractive light atmospheres for shops, but also other domains.



flexible way. Although these solutions are currently targeted at shops and chain stores, they can also be applied in the hotel and consumer domains.

The LightMan technology consists of an atmosphere description language, a rendering pipeline and an infrastructure of networked lamps. The xml-based atmosphere description language enables a lighting designer to describe the desired light for a shop or even a complete shop chain, regardless of the layout and lighting infrastructure of a specific shop. The language contains concepts like light types (focused light, ambient light, etc.), a functionality-based location model (e.g. cash register, entrance or winter collection) and a timing model.

Incorporation of sensor information (e.g. occupancy) allows for adaptive atmospheres. The rendering pipeline then translates the abstract light description into specific control values for the light sources in a given shop, using information on the available light elements, sensor values and time constraints. Runtime control is realized in a networked light management system featuring robust communication (wireless and wired connectivity, distributed light operating system) with easy set-up and maintenance.

The CRE prototype shows automatic rendering of an abstract light description on a complex (several hundreds



of control parameters) lighting system with a mix of wall washing, spot lighting and ambient lighting. The system's flexibility is demonstrated by changing the shop, e.g. moving furniture and changing the functional layout or lamp availability. User tests with lighting designers will be carried out in the newly built ShopLab to validate the power of LightMan's abstract description language and rendering algorithms.

Shop lighting adapting to your needs automatically

Saint

James Chen, Mylan Chen, Willem Fontijn and Mark Verberkt Philips Research

Shop lighting is seen as a promising domain for LED technology. One application in which owners of high-end fashion shops have expressed an interest in is an advanced relaxation area. Shop owners commented: "The fact that the husband is hanging around, bored and eager to leave, puts pressure on the wife to hurry. To improve sales, we need to eliminate this need to rush and an advanced relaxation corner would seem an interesting option." Shoppers are likely to spend more time shopping if their companions are enjoying themselves.

Another, separate issue is that shop owners are also interested in information such as how many people are in the shop at any time, what routes buyers and non-buyers take and where they spend their time. This information can be very useful for optimizing the layout of the store.

We demonstrate an adaptive rest corner for shopping companions where the lighting atmosphere and

A wireless sensor network is deployed throughout the ShopLab, demonstrating the translation of raw sensor data into a meaningful description of human activities.



Shoppers are likely to spend more time shopping if their companions are enjoying themselves.

conditions change to suit their activities. The system can gauge whether a person is interested in shopping or not by analyzing clues such as body movements. A shopper usually goes directly to the products on display, while a bored companion just hangs around the main aisle. If an inactive person is detected the system will attract him to the relaxation area where there is a bookcase full of books and a number of seats. Different functional lighting is provided automatically, without explicit control, based on the activities of the customer. For example, when the customer opens a magazine the lighting atmosphere changes to suit the theme of the magazine. If the customer sits in one of the seats but does not start reading, a soothing lighting script provides relaxation.

A wireless sensor network is deployed throughout the ShopLab, demonstrating the translation of raw sensor data into a meaningful description of human activities.

The activity recognition system analyzes the sensor data and outputs the detected context information to the lighting management system. The context information provided includes customer location, interaction with objects and the state of objects.

Up to forty AquisGrain sensor nodes are being used, attached to objects and the ceiling. Each sensor node connects to one or more sensors. The sensors used include PIR (Passive Infra-Red), 3-D accelerometer, binary switch, light and temperature sensors.

*“If possible, please send
already entrance ticket
for next year.”*

“Invite me! Again!”

*“I found the HomeLab
tour inspiring, it was a pity
there was no time
to play with it!”*

Visitors HomeLab tour CRE 2005