User Centered Research in ExperienceLab

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Abstract. With the introduction of the Ambient Intelligence vision, a shift from usability towards end user experience research has been proposed. Such experience research requires new methods and instruments beyond the traditional usability research labs. This paper describes the ExperienceLab infrastructure, its way of working and the lessons learned from using this infrastructure.

Keywords: User Centered Research, Ambient Intelligence, Experience research.

1 Introduction

The design of Ambient Intelligence (AmI) environments differs markedly from the design of classical single device systems. AmI environments introduce new options for services and applications, by focusing on the desired functionality, rather than on the devices traditionally needed for each individual function. The fact that the technology will be integrated in these environments introduces the need for novel interaction concepts that allow the user to communicate with their electronic environment in a natural way.

When aiming at user experiences, requirements engineering for AmI environments has to take a step beyond the development of scenarios and the translation of use cases into system requirements. System functionalities that generate true user experiences can be determined in a reliable way by exposing users to feasible prototypes that provide proofs of concept. These are called experience prototypes, and they can be developed by means of a user-centered design approach that applies both feasibility and usability studies in order to develop a mature interaction concept. More specifically, this means that laboratories are needed which contain infrastructures that support fast prototyping of novel interaction concepts and resemble natural environments of use. Moreover, these experience prototyping centers should also be equipped with an observation infrastructure that can capture and analyze the behavior of people who interact with the experience prototypes. Philips' ExperienceLab is an example of such an experience and application research facility. It combines feasibility and usability research into user-centric innovation, leading to a better understanding of (latent) user needs and the technologies that really matter from a user perspective [1].

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1.1 From Usability to User Experiences

Nowadays, the technological possibilities to enhance life are vast; to quote the prototypical engineer, "tell us what you want and we can make it". But, what do people really want? Once we better understand the needs and desires of people, the output of a structured idea generation process is expected to yield product or system concepts that show an increased potential to truly enhance our lives. In a first research and design phase, (latent) user needs are explored using various methods, such as focus groups, context mapping, ideation and scenario evaluations. Of course, such claims should be validated by evaluating the anticipated user benefits before a selection is made to bring certain concepts into a next research and design phase. In a next iteration cycle, more detailed user requirements need to be uncovered and fed into the generation and implementation of concrete design solutions. Next, the utility and usability of the proposed solutions can be checked by conducting carefully planned user tests. This iterative process which is carried out by multi-disciplinary teams and in which user involvement plays a crucial role is called User – Centered Research [2].

Throughout the User Centered Research cycle there is a strong involvement from end – users based on studies in *context* (e.g. context mapping studies), in the *laboratory* (e.g. the ExperienceLab) and in the *field* (e.g. longitudinal field trials). While the context studies are focused on the initial requirements for AmI environments, the laboratory studies will focus on the end –user's acceptance and the usability of the proposed AmI prototypes. Through field studies the longer term effects of the AmI prototypes will be investigated.

ExperienceLab, as an instrument for User – Centered Research, is designed to become the place where researchers and designers can team up with end-users to realize a shared and tangible vision of the future of electronic systems. Given the application domain of AmI environments there is a need to extend the traditional utility measures (such as effectiveness and efficiency) towards user experiences. The real user benefit of AmI environments will be found in their impact in terms of user experiences they generate. For this, the ExperienceLab offers a complete environment for the conceptualization, implementation and evaluation of Ambient Intelligence systems that bring true user experiences.

2 ExperienceLab

ExperienceLab offers a unique environment, both physically and intellectually, for researchers and their partners inside and outside Philips to give concrete form to the Ambient Intelligence vision. By developing and integrating advanced technologies in the area of Ambient Intelligence, ExperienceLab, currently consisting of a HomeLab, ShopLab and CareLab, is an innovation center for the development of novel consumer products and services, and it therefore makes a substantial contribution to the implementation of the Philips strategy in the domain of Lifestyle and Wellbeing.

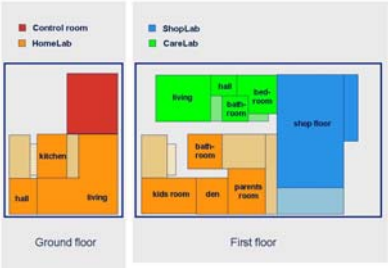

Fig. 1. The ExperienceLab floorplan (note: service areas surrounding the ExperienceLab are not labeled)

2.1 HomeLab

The HomeLab is build as a two-stock house with a living, a kitchen, two bedrooms, a bathroom and a study. At a first glance, the home does not show anything special, but a closer look reveals the black domes at the ceilings that are hiding cameras and microphones. Equipped with 34 cameras throughout the home, HomeLab provides behavioral researchers a perfect instrument for studying human behavior inside HomeLab. Adjacent to the Home there is an observation room.

When HomeLab started in 2001, one way mirrors were placed between the living and observation room. The idea was to have a direct view into the living. But time learned that observers preferred the camera images. The different viewing angels and possibility to zoom into details were reasons to abandon the mirrors. The observation room is equipped with four observation stations. Each station has a large high resolution flat screen showing a collection of six different images from the cameras in the house. The observer is free to choose which cameras he wants to use and what the pan, tilt and zoom position of every individual camera has to be. And he can route two of the roughly 30 available microphones to the left and right channel of his headphones. Each observer has an application running to feed the behavioral data to the storage system, synchronized to the video data. In the early days of HomeLab this setup was used in the real time situation. Four observers had a hard time to follow the progress of the experiment. Nowadays it is more common to first have the video data stored on the capture stations and do the behavioral data collection afterwards. Also events and sensor data are time-stamped and appended to the video data. This way of working is much more efficient and a single observer can collect all the relevant data.

Broadband Internet facilities enable various ways to connect parts of the HomeLab infrastructure to the Philips High Tech Campus network or even to the outside world. A wireless Local-Area Network (LAN) offers the possibility to connect people in HomeLab without running cables. However, if cables are required, double floors and double ceilings provide nice hiding places. Corridors, adjacent to the rooms in HomeLab, accommodate the equipment that researchers and developers need to realize and control their systems and to process and render audio and video signals for the large flat screens in HomeLab. Light control systems (LON and amBX) can be accessed by the researchers and offer their prototypes the possibility to affect the light settings in the rooms.

Fig. 2. HomeLab: user centered design environment for advanced studies in multimedia concepts for the home

2.2 ShopLab

The ShopLab research program builds on the insight, that shopping itself has become an important leisure activity for many people, and that flexible atmospheres are needed to enhance shopping experiences. On the other hand many retail chains want to maintain a clear house style for branding reasons.

This introduces the challenge of combining these two major aspects. One approach to this, studied in ShopLab, is that one atmosphere design will be sent to all stores and slightly adapted there to meet local conditions. With the introduction of solid state (LED) lighting, a wide range of new options to create such atmospheres using color and dynamic effects is becoming available. However, tuning these atmospheres requires controlling several hundred lamp settings, introducing a complex overall control challenge. Another approach studied to enhance the shopping experience is the introduction of interactivity, in the form of interactive shop windows, interactive signage and reactive spots. Adaptation of these shop atmospheres also requires input

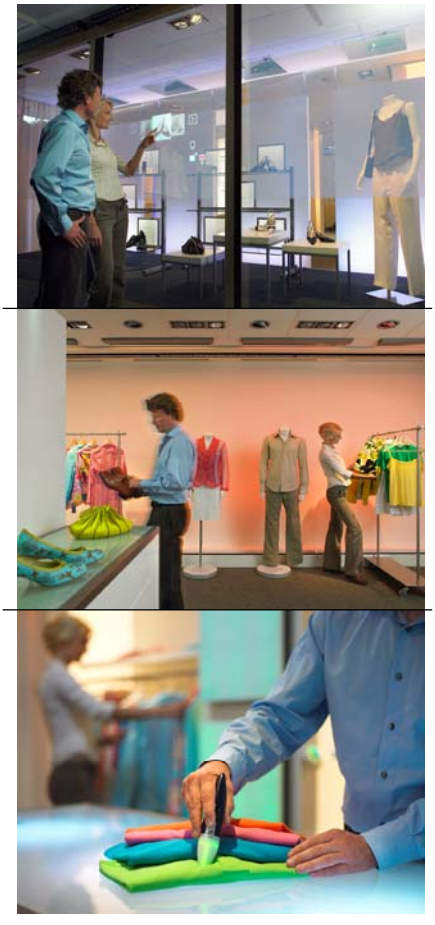

Fig. 3. ShopLab: augmented environment with advanced vision and lighting concepts for retail studies

from smart environments that detect people's presence and product interests while they are in or near a shop.

The ShopLab is used extensively to perform user studies, both with retailers and with end-users (shoppers). By involving these users in all phases of the design process, including the evaluation of the experience prototypes, important insights in the actual experiences of users are obtained early on in the development process.

2.3 CareLab

This CareLab resembles a one-bedroom apartment for seniors and is equipped with a rich sensor network to study the contextual settings in which people will use the health and wellness applications.

Fig. 4. CareLab: realistic aware environment with advanced sensing and reasoning capabilities to study consumer health and wellness propositions in a home context

The sensor information is processed and combined to extract higher-order behavioral patterns that can be related to activities and states, such as the presence of people, the state of the home infrastructure, etc. With the CareLab it is possible to explore at an early stage the user's acceptance for these solutions and to assess the interactive and functional qualities of these solutions before deploying these into field settings. Results will be used to improve applications of innovative technologies, to eliminate imperfections and to explore new applications.

2.4 Infrastructure

The possibility to study user experiences of test participants during their stay in ExperienceLab is one of its primary functions. A tailor-made control system has been developed in-house to collect and analyze observational data. The system controls the cameras and the routing of the video and audio signals. Human activities, postures, facial expressions, social interactions and user-system interactions can be recorded and digitally stored to study patterns, trends and relationships.

3 Studying User – System Interaction

When setting up an experiment in ExperienceLab, the researcher designs a coding scheme for the observation session. A coding scheme lists all prototypical behaviors that are expected to be observable during the session. These behaviors should be structured as an orthogonal classification system: during the classification of behavior it should not be possible to classify one behavior in more than one category. The observers mark the occurrence of these behaviors during the ExperienceLab session by means of pressing keys on a keyboard. Additional, more and more behavioral events are registered automatically through the use of sensors.

Once the coding scheme is developed it is saved into the scoring system. Very similar to questionnaires, the coding schemes are standardized and reused. For example, coding schemes for problem solving behavior or user-system interaction in voice controlled environments have been developed and reused over several experimental sessions.

If applicable, a detailed user profile for test participants is established in collaboration with a consumer marketing intelligence department. The user profile is then provided to a recruitment agency for test participant recruitment. As a rule these participants are externally recruited to not have any affiliation with Philips as such affiliation could influence test results. Depending on the focus of the research question a test methodology is designed. If longitudinal data collection is needed we setup field trials during which the experimental systems are installed into the homes of end-users.

Data analysis can consist of a simple frequency analysis up to a sophisticated data mining analysis for finding hidden patterns in the data set [4]. For this ExperienceLab is equipped with a software tool capable of detecting repeated patterns that are hidden to observers and very hard or impossible to detect with other available methods (Fig. 5). It is particularly suitable for analyzing behavioral data.

This tool 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 [3] and to identify the precursors or consequences of specific behavioral events. This

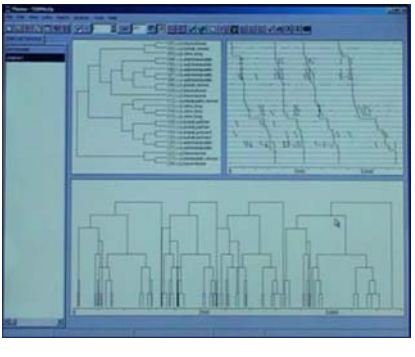

Fig. 5. Pattern analysis of behavioral data

tool has been used extensively in studies of human communication, spoken dialogues, gestures, protocol analysis, etc.

4 Lessons Learned

Since the opening of ExperienceLab in 2001, there are several lessons learned with respect to the use of the ExperienceLab.

1. *Real-time observation is less important, off-line scoring is preferred*. When equipping the ExperienceLab with observation tools, it was assumed that researchers would code observations in real-time. However, over the years we have learned that off-line scoring after the experiments is preferred. This has a consequence for the way data is collected and made available for scoring since now researchers need portable solutions and export the observational data from the ExperienceLab system.
2. *Developing good coding schemes is as much effort as developing a questionnaire*. Coding schemes provide an extensive classification of potential observable behavior. This coding scheme is used to code the recorded behavior. Developing good coding schemes takes time and reuse of these coding schemes (like for questionnaires) is desired.
3. *New methods and instruments to measure the subjective user experience in an objective way are needed*. Although the user experience is by nature subjective, there is a need to capture and analyze user experiences by means of objective methods.
4. *ExperienceLab is a catalyst for improving technology transfer into the business*. Traditionally, research results are communicated through scientific publications and presentations. Over the years ExperienceLab has proven to be a very effective communication tool within a large corporate environment. Although the original goal of the ExperienceLab was to support usability and feasibility research, there is a need to reserve capacity for demonstration and dissemination events.
5. *Having a support team is essential when operating an ExperienceLab*. Since the opening of the ExperienceLab there has been a permanent software engineering team available for technology integration and maintenance of the infrastructure. Similarly, there is a need for a team of behavioral scientists to guide the empirical research in ExperienceLab.

5 Conclusions

The design and assessment of interactive systems, that are targeted to be introduced into the market within a timeframe of five to ten years, remains a methodological challenge. Instruments such as the ExperienceLab provide research a powerful tool for testing early user acceptance and usability of futuristic AmI propositions.

Challenges for User Centered Research in ExperienceLab involve the development of innovative methodologies and tools for data collection and data analysis. As more automated data collection techniques (e.g. sensors) are becoming available there will

be a need for more suitable data analysis techniques to make sense out of the rich datasets that will be collected in AmI environments. The use of the T-patterns techniques has given some very promising results into the analysis of complex behavioral patterns as collected in AmI environments.

Although lots of data can be collected through observational techniques, the challenge of collecting data on subjective user experiences remains. Today we are using standardized questionnaires to assess the user experience that is subjective by nature. The future challenge will be to deploy psychophysiological techniques to complement or even automate the assessment of subjective user experiences.

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