Presenting the networked home: a content analysis of promotion material of Ambient Intelligence applications

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Abstract

Ambient Intelligence (AmI) for the home uses information and communication technologies to make users' everyday life more comfortable. AmI is still in its developmental phase and is headed towards the first stages of diffusion. Characteristics of AmI design can be observed, among others, in the promotion material of initial producers. A literature study revealed that AmI originally envisioned a central role for the user, convenience that AmI offers them and that attention should be paid to critical policy issues such as privacy and a potential loss of freedom. A content analysis of current promotion material of several high-tech companies revealed that these original ideas are not all reflected in the material. Attributes which were used most in the promotion material were 'connectedness', 'control', 'easiness' and 'personalization'. An analysis of the pictures in the promotion material showed that almost half of the pictures contained no humans but appliances. These results only partly correspond to the original vision on AmI, since the emphasis is now on technology. The results represent a serious problem, since both users, as well as critical policy issues are underexposed in the current promotion material.

Keywords ambient intelligence, networked home, ICTs, content analysis

Introduction

The Dymaxion House was probably one of the first so-called 'homes of the future', designed in the late 1920s by the American designer Buckminster Fuller. In the 1920s this house was way ahead of its time, because it was filled with communication technologies, such as a television set, a radio, a phonograph and several domestic office machines (Spigel, 1992). Since that time many projections of ever more advanced houses have been made. Today the 'house of the future' is often called 'smart home', 'connected home' or 'networked home'. Its design is materializing step by step due to the increasing potential of new technologies. Prototype 'smart homes' are being build worldwide and presented to visitors to see how developers and designers think people will live in the future. Rosen and Weil (1995) noticed that the 'home and office of the 1990s have become a show place for advances in computerized technology'. Hindus (1999: 200) sees the home as an important topic for technology research for a number of reasons (1) homes are technology-filled buildings; (2) homes and technology are too important economically to ignore and will become even more so; (3) it has the potential to improve everyday life for millions of users; (4) studying technology in homes is a rich research area; and (5) homes are a challenging design venue; they deserve the attention of talented practitioners and innovators.

There is a great diversity in terms indicating the home environment as the focus of research attention. Stewart (2003) argues that the home should no longer be the exclusive focus of research when trying to understand existing and future uses of 'home' technologies. Stewart prefers the term 'life space' to accommodate domestic activities that reach out of the home and non-domestic activities that drift into the home. Venkatesh, Kruse and Shih (2003) identified four stages of evolution of technology in the home: (1) the electrification stage; (2) the automation stage (smart home 1); (3) the intelligentification stage (smart home 2); and the (4) human substitution (robotics) stage (smart home 3). The third stage (intelligentification), the stage technology in the home is in right now, shows that companies are developing intelligent and programmable machines for home use and home communication systems at a very rapid pace. The names that refer to the home in the intelligentification stage are smart home, connected home, intelligent home, networked home and context-aware home.

‘Ambient Intelligence’, ‘Ubiquitous Computing’ or ‘Pervasive Computing’ is a vision on the future and the smart home plays an important role in that vision. The different names are often used as synonyms and, although different names are being used to describe the vision concerned, the aim is to make information and communication technologies (ICTs) unobtrusive and to connect them with each other through wireless networks, while also equipped with sensors to make them context sensitive (Fersch and Mattern, 2004). The European Information Society Technology Advisory Group (ISTAG) defines Ambient Intelligence in more general terms as a vision on how the information society will develop in the future. ISTAG assumes the convergence of ubiquitous computing, ubiquitous communication and intelligent user-friendly interfaces and assigns a central role to the user in the form of user-friendliness, user empowerment and support for human interactions (ISTAG, 2001, 2003).

According to Aarts (2003) the focus of AmI is on the usage of consumer electronics that will bring a new kind of interaction with technology into our homes and personal domains to enhance our experiences and lives. This interaction with technology will mainly be done through the use of ICTs. ICTs are a very important part of AmI. According to the advocates of AmI, ICTs will be better than today’s ICTs in several aspects such as smarter, user-friendlier, context-aware, etc. (Aarts, 2003; Fersch and Mattern, 2004). Because of the nature of the ICTs which are the building blocks for the AmI vision, we think that the appliances that are being developed for this vision can be partly placed under the scope of ‘new media’. Andriessen (1989) distinguishes three stages and six phases in the development and introduction of new media (see Figure 1). Andriessen’s phasing of the innovation process is based on Cozijnsen and Vrakking (1986), who initially outlined the phases in an innovation process.

-- Please insert Figure 1 about here --

The current vision of AmI can be located in the development phase. This vision is created by researchers, designers and policy or communication consultants as a vision on how the information society will develop in the future. In this phase the first designs are also being developed, tested and enhanced for future production. Companies are currently entering the market with prototypes that only partially follow the AmI vision. Actually, they are not fully developed real AmI appliances because they do not yet have all the required characteristics specifying AmI such as being adaptive, intelligent, embedded, etc. It would be better to see them as precursors. An example is the consumer product Ambilight developed by the company Philips, a lightning system that adjusts to the colors of a TV-screen.

When a design is developed into a product, the development stage is ended and the transfer stage is entered were the diffusion and adoption phases occur (see Figure 1). The small number of designs that already are transformed into consumer appliances and brought to the market, should be located in an early transfer stage (the diffusion and adoption phases), but for the main part the designs are not (yet) developed into products and ambient intelligence in the home can be located mainly in the development phase heading towards the diffusion phase. High-tech companies, who produce consumer products as examples of precursors of 'real' AmI products, exhibit their latest products in demonstration houses that are open to the public, expecting the public will become aware of the applications that are being designed and help the diffusion of the products. In this way, they primarily want to make the people aware of what is currently possible with the latest technologies and what the future could look like. Other phases such as those of the implementation stage where AmI applications will be introduced and incorporated in consumer households are obviously not yet reached by AmI.

Characteristics and design of Ambient Intelligence

Not only can the vision of AmI be located in the development phase, the first technical, social and policy aspects are also outlined in the development phase. These aspects are important for the transfer and implementation phases and for the realization of the AmI vision, because the basis of AmI is being created in this phase.

Ambient Intelligence is intended to be introduced to different domains such as the home, the office and the car. This implies that AmI will have a variety of implications for different kinds of people in different spaces of life. Although the technical aspects of AmI are currently emphasized, ethnographical, sociological and psychological research is needed to provide insight in this new research area (Stewart, 2003). The socio-technical context of the AmI vision should also be made more explicit (Punie, 2003: 18). The technical, social and policy aspects of AmI will be briefly outlined here to provide a better understanding of this vision and its characteristics.

Technological aspects such as the progress in communication and networking technologies and in the diffusion of and acceptance of ICTs are important enablers for the creation of the AmI vision (Punie, 2003). Ubiquity, transparency and intelligence are other technical aspects that will be characteristic for ambient intelligence environments (Aarts and Marzano, 2003). Nomadic, embedded and invisible are the three groups that Waldrop (2003) uses to describe the properties of AmI. According to Aarts (2003) the five key characteristics that are required for the realization of AmI: embedded, context-aware, personalized, adaptive and anticipatory. These characteristics are not (yet) developed to such an extent that they can be successfully built into actual AmI applications. Edwards and Grinter (2001) mention interoperability, manageability and reliability as technical issues that must be overcome before AmI can be fully realized in the home environment.

Next to the technical aspects, there are also several social and policy aspects that play an important role in both the realization of AmI and its possible success or failure. As Punie (2003: 17) points out, the AmI vision is enabled not only by technological progress but also by demographic and social trends, such as the emergence of individualism, diversity, mobility, and choice of personal life styles. Critical aspects related to AmI such as privacy, surveillance, power, control, reliability, social compatibility, and social acceptance (Bohn et al., 2004) also have to be considered carefully when trying to realize the AmI vision for people. Specifically looking at the home environment, Meyer and Rakotonirainy (2003: 160) state that ‘home activities are informal, not necessarily structured and focused on tasks that will make the occupants lives more: safe, supportive, convenient, pleasant, enjoyable, entertaining and relaxing’. Advocates of AmI are emphasizing that the activities in the home will be performed in a more pleasant and better way. This means that there are implicit presumptions which AmI encompasses about people and their interactions in everyday life. These presumptions appear in the design. For example, comfort, freedom, privacy, control and responsibility can be embedded in the design. To prevent confusions about our usage of the word design, we have to clarify what we understand by it.

Galle (1999: 63) defines ‘design’ or ‘designing’ as the production of a design representation. He further explains that a design representation plays two roles: that of a means of communication and that of a vehicle for exploration. Looking at the first role he argues that the representation is a means of self-communication for the designer and in the second role it is used to answer hypothetical questions which can be posed by the client, maker or the designer. We will use the concept of ‘design’ in a slightly different way, namely that we refer to the real characteristics of applications that are created according to the ambient intelligence vision and to perceivable presumptions about use and users that are communicated by the designer. Both characteristics and presumptions can be incorporated in the design of applications.

One of the main presumptions of user needs in the AmI vision is that users first of all want comfort in their daily lives and AmI will provide for this. Users will have to give up some freedom which means options of choice and action, as they leave them to be executed by the technology (Punie, 2003). It also is assumed by the companies that develop consumer appliances according to the AmI vision that consumers want to relinquish parts of their privacy in using this technology. The input and registration required enables both providers and people in the environment to derive personal information. People also have to leave control and responsibility to the technology in order to work in the way it is meant to be working according to the designers.

AmI is still in its development phase and therefore a lot of the above mentioned aspects and presumptions are not apparent yet. Still, designers, producers and policy makers will have to take them into account to make sure that people are the central focus of AmI and to anticipate on future problems with the technology in everyday life. Thackara (2001) points out that interaction design could help in shifting the focus of innovation from pure technology to the contexts of daily life.

The presumptions about use and users can be observed in different ways. The first way is to observe the materialized designs in the shape of consumer appliances or in the form of whole smart houses. The second way is to ask designers of the applications about their beliefs regarding use and users of ambient intelligence in the home. The last way is to observe and analyze the presentations of high-tech companies that are developing applications for the ambient intelligence vision. These presentations can have the form of promotion material made by these companies to make the public aware of their vision.

Currently, the first and second ways are followed in a project by the first author. The last way was followed in a preliminary investigation reported in this article. Presentations of promotion material of AmI were investigated by means of a content analysis. The results of this content analysis are published in this article.

Research questions

This study is a first step to get a better understanding of the representation by high-tech companies of ambient intelligence in the home, to be seen as a technological innovation that consists of enhanced ICTs. If this technological innovation will affect society as a whole and will become a reality in the future, it is important to know which ideas about use and users are currently displayed to the public to be able to anticipate and see what can be expected from ambient intelligence. Observing and analyzing the promotion material of high-tech companies that have smart homes and develop appliances for Ambient Intelligence we can gain valuable preliminary understanding about the presentation of users, use and the social and technical aspects of ambient intelligence. Therefore, our first research question will be as follows:

RQ1: What are the implicit ideas about users and use of Ambient Intelligence of high-tech companies that are developing consumer applications as made explicit in the attributes of these applications described in textual and visual representations of their promotion material?

Exploring the visual representations it will become evident which aspects are currently emphasized by the high-tech companies engaged in the development of applications that are supposed to realize the AmI vision. For example, is a central role really assigned to the user (see ISTAG, 2001)? Coleman and Wasike (2004: 457) argue that visual and verbal communication are not separate things, they influence each other in a reciprocal process. Through the analysis of both text and visual elements a better understanding of the content can be reached. Visuals have several effects, such as improving recall and comprehension (Paivio and Csapo, 1973), attracting readers to stories (Garcia and Stark, 1991), and influencing opinions and attitudes (Gibson and Zillmann, 2000). It is also known that the size of a photograph can influence readers' perception of importance (Wanta, 1988). Visual representations are the object of observation in the second research question:

RQ2: What is the focus of attention on the pictures that are used in the promotion material of high-tech companies in the field of Ambient Intelligence, specifically in the home environment?

To be able to answer research question two, the following sub questions concerning both the content and the form of the pictures, were formulated:

2a) is the focus of the pictures on humans, on technical appliances, or on both of them?

2b) what is the gender, age, sort of action performed by pictured humans and what is the goal of action of the humans pictured?

2c) what is the location of the pictures?

2d) what is the relative size of the pictured humans and of the technical appliances used in the promotion material?

Method

A content analysis has been used to analyze the documentation of international high-tech companies that are currently designing (prototype) consumer appliances for the ambient intelligence vision. Content analysis is used for communication messages to uncover the characteristics and the meaning of the messages. Krippendorf (1980: 21) defined content analysis as ‘a research technique for making replicable and valid inferences from data to their context’. The data for this study were collected in the period between April 2003 and December 2003, and the coding was completed from January through February 2004.

Sample

No list or framework of more or less official or acknowledged AmI companies was available when we started to collect promotion material about ambient intelligence applications. We had to make such a list ourselves. An internet search by means of the search machine Google (14 April, 2003) was conducted to see if there were companies operating in this field of ambient intelligence that could possibly participate in the study. The following search terms were used: intelligent home, digital home, connected home, networked home, smart home, interactive home, home of the future, ubiquitous computing, ambient intelligence, pervasive computing. The result of this search operation was a sample of companies who are developing (prototype) consumer applications in the field of ambient intelligence and/or companies who had a ‘smart home’. A total of ten international high-tech companies and institutions (Philips, Microsoft, Hewlett-Packard (HP), LGE, IBM Orange, Massachutes Institute of Technology (MIT), Living

Tomorrow, Georgia Tech Institute, and JEITA) were included in the sample. These companies were approached to send promotion material about ambient intelligence which is currently being used to communicate to a public of potential consumers. Next to Philips, two others companies replied (HP and Living Tomorrow) and did send promotion material and referred to their web site for more information about this subject. Three companies (Orange, LGE and Microsoft) replied that all the information about their vision on ambient intelligence and their (prototype) consumer appliances for the home could be found on their corporate website, and therefore we used their websites. Two companies (IBM and MIT) did not reply to our request. We decided to use the information on their corporate website which was relevant for this study in our analysis. One institution (JEITA) replied that they only had Japanese information about AmI on their website. Japanese and English words about AmI are not entirely similar. A valid and reliable content analysis had to be limited to English texts. This does not apply to pictures but we needed AmI comparisons with both verbal and visual presentations. Therefore the Japanese promotion material was not taken into account. From another institution (Georgia Tech Institute) we received slides of a research presentation. Unfortunately, the slides did not meet the criteria (see below) to be included in the sample, so these were also excluded from analysis.

The *research units* of this study were (parts of) brochures and printed websites of the above described approached companies and institutions[1] containing presentations of AmI in the form of text or visuals. Promotion material that has been included as a research unit for the content analysis was chosen on the following criteria: a) it had to come from high-tech companies and institutions which had a 'smart home' and or develop (prototype) consumer appliances in the field of ambient intelligence, b) it had to provide information about the company's vision on ambient intelligence and when available c) it had to provide information about the (prototype) consumer appliances for home usage in (e.g. purpose, price, expected data to appear on the market). Information related to the office, business environment or shopping was excluded from the sample just like purely technical aspects of appliances (e. g. speed, memory, etc.). The research units were divided into textual and visual units. The textual units were sentences of the promotion material and the visual units were pictures.

The *recording units* in this study were separate sentences and separate pictures. As for the pictures, this was the only generally available mode to portray AmI applications in the promotion material.

As mentioned earlier, next to brochures also printed web sites were used. Esrock and Leichty (2000: 329) argue that 'corporate websites should be viewed as an intentional act of communication that signifies an organization in its multiple facets to its multiple publics'. Because the aim of this study was to look at the communication of high-tech companies to the public about AmI the websites were also included in the sample. Relevant information was printed and navigation links on web sites were excluded from analysis. Hyperlinks were clicked on to see if they displayed relevant information for the study and if so, the text pages and pictures (if available) were printed as well.

The visual units of the promotion material contained primarily pictures about the home environment, but there were some pictures referring to the 'smart office of the future'. However, only the pictures that were related to the home were included in the sample. This could be evident from the picture itself or from the text accompanying the picture. Coders received instructions of selection accordingly.

The sample result was that 2400 sentences and 202 pictures of eight different international high-tech companies that develop consumer appliances in the field of ambient intelligence were analyzed.

Coding

A codebook was developed to record information on what the companies were presenting to the public. The codebook included different sections for the written communication and the visual communication. Two coders (both recently graduated masters in communication science) were involved in the coding process and were extensively trained on how to code the written and visual communication. The codebook contained a list of attributes[2]. The attributes are derived from the literature (Edwards and Grinter, 2001; Punie, 2003; Meyer and Rakotonirainy, 2003; Dovey, 1985) that indicate both social and technical attributes of ambient intelligence in the home. The words adaptability, comfort, busy, everyday life, flexibility, save time, improving quality of life, user-centered and utility were added by the authors, because of their relevance to the social and technical aspects of AmI.

In this study not only text was analyzed but also the visual elements in the form of pictures. The second section of the codebook related to the visual units of the promotion material. Bell (2001: 15) emphasizes that 'visual or verbal representations differ from each other in many ways - on many dimensions or qualities'. He suggests that variables should be defined in terms of one principal feature of representation to prevent ambiguous measures. The promotion material differed in size and the absolute size of the picture was not relevant for our research question. We were interested to see if there were differences in the size of the pictured humans and appliances. Therefore the absolute size (area in centimeters) of the picture is not an appropriate variable in this study. Instead, the relative measure (in cm^2) of the pictured human(s) and device(s) was taken into account.

The picture variables which were derived from the research questions 2a until 2d, included person or device depicted, age, gender, location, type of consumer appliance, sort of action performed by pictured human(s) and goal of action, and relative size of pictured humans and devices. The coders pre-tested the codebook for verbal descriptions and for the visuals and adjustments were made (e.g. alphabetizing the verbal descriptions).

Reliability

The coders worked independently in coding the material. To obtain intercoder reliability (κ), the coding coefficient calculation formula (see Siegel and Castellan, 1988) was used. Coders pre-tested the codebook and 10% of the material (both text and pictures). Cross-coding was conducted on 10% of the sample size for both text and pictures.

The intercoder reliability for the text was 100% ($\kappa = 1.00$). The intercoder reliability for the different variables between the two coders for the pictures was 100% (κ=1.00) with the exception of the variables which measured sort of pictured action of human(s) with the appliance and aim of action of the human(s) with the appliance (e.g. looking at pictures on the appliances, looking at information, visual communication). These variables had kappa's lower than .70 and were not taken into further analysis. Based on the obtained intercoder reliability results, the text and pictures were analyzed.

Results

For this study it was important to understand which attributes and applications are used by the high-tech companies in their communication to potential consumers about consumer devices that are being developed for the ambient intelligence perspective. The total sample of text contained 2400 sentences and 202 pictures. Philips was the largest contributor with 1274 sentences and 135 pictures, and Orange contributed the fewest with 66 sentences and eight pictures (see table 1). These unequal distributions were fully taken into account in the analysis. Each sentence and picture was coded according to the items in the codebook.

Text

The first research question explored which attributes are used in the text of the promotion material by the companies to communicate to the consumers. The results from the text analysis (N = 2400) showed that the following attributes were frequently mentioned in the promotion material: connectedness (218 times in total), control (174), easiness (168) and personal (157). Reliability and busy (4), freedom (5) and interoperability (6) were the least frequently mentioned attributes. As can be seen in Table 1, the sample did not contain equal amounts of sentences and pictures per company. Table 1 shows an overview of how frequent an attribute is counted per company in the 2400 sentences. Attributes that were counted less than 20 times in the sample were not included in table 1, these were: privacy (17 times in total), flexibility (16), save time (14), comfort (13), interoperability (6), freedom, (5), busy (4) and reliability (4).

To control for an effect of the unequal distribution of the sentences and pictures per company, the means of the attributes were analyzed using an unrelated one-way analysis of variance. When all means of the eight companies on a particular attribute were analyzed, most of them appeared to be significant at the 5% level of significance. See table 1. The attributes 'comfort' ($F = .27$, $df = 3, 1810$, $p = .849$), 'freedom' ($F = 1.58$, $df = 2, 1790$, $p = .207$), 'improving quality of life' ($F = .63$, $df = 4, 2003$, $p = .644$), 'reliability'($F = 2.57$, $df = 2, 1790$, $p = .077$) , and 'smart' ($F = 1.26$, $df = 6, 2127$, $p = .274$) were not significant between the companies' presentations. However, this result is not as extreme as it might seem at first sight. A Scheffé test, was used to compare pairs of group means in order to assess where exactly the differences lie among the attributes that did differ between the companies' presentations. Using this test it was found that at the 5% level of significance, the means for the attributes 'connectedness', 'control' and 'interactivity' did not differ significantly between the companies.

-- Insert Table 1 about here --

It was also found at the 5% significance level that there were differences between the companies considering the other attributes. MIT representations scored significantly higher on 'adaptability' than Philips, HP and Microsoft, but the means for the other companies did not differ from each other. HP presentations scored significantly higher on the attribute 'ambient' than Philips and MIT also scored significantly higher on ambient than Philips. For 'automation', there were no significant differences between the companies, with the exception of MIT. MIT presentations scored higher on this attribute than Philips. LGE presentations were higher on 'convenience' than Philips and Microsoft presentations. Microsoft also had a higher score on convenience than Philips. Microsoft presentations were higher on the attribute 'easiness' than all the other companies in the sample. Microsoft presentations also scored higher on 'enjoyment' than Philips and MIT presentations and Microsoft presentations scored significantly higher on 'everyday life' than Philips presentations.

As for the attribute 'mobility' HP presentations scored significantly higher than Philips, LGE and Microsoft presentations. HP presentations scored significantly higher on 'personal' than LGE presentations and Microsoft presentations also scored significantly higher on personal than LGE presentations. MIT presentations scored significantly higher on the attribute 'user-centered' than Philips and HP presentations and MIT presentations also scored significantly higher on 'utility' than Philips presentations. And considering the last attribute 'safety', Microsoft presentations scored significantly higher on this attribute than Philips presentations.

If we cluster the attributes that are related to each other in a semantic analysis, we can distinguish three main groups, which we named Convenience, Adaptation and Empowerment (see table 2). It appears that adaptation is the largest cluster, which could indicate that the focus of attention is currently on the technological attributes of ambient intelligence.

-- Insert table 2 about here --

Pictures

To understand what the focus of attention is on the pictures that are used in the promotion material of high-tech companies in the representation of Ambient intelligence, we tried to answer research questions 2a until 2d and therefore looked at the following categories: humans/no humans pictured, gender and age of humans pictured, which locations humans and devices pictured, what kind of devices, and size of humans and devices.

Humans were pictured on 45% of the pictures, 46% pictured contained no humans, only devices and on 9% of the pictures only hands could be seen holding a device. To control for an effect of the unequal distribution of the pictures per company, the means of the attributes were analyzed using an unrelated one-way analysis of variance. There was no significant effect between the companies on pictured humans or devices ($F = 1.87$, $df = 7, 194$, $p = .076$). Of the pictured humans, the most frequent pictured was a man (24%), followed by a woman (14%), man and woman together (6%) and on 0.5% of the pictures it was unclear if it was a man or a woman. Also here, there was no significant effect between the companies on gender of the pictured humans ($F = .40$, $df = 7, 194$, $p = .899$).

Young adults (26%) were the most frequently pictured humans, followed by children (10%), adults (7%) and elderly (2%). Nine per cent of the pictures were coded as 'not clear' considering the age of the pictured humans. There was a significant difference (F = 4.38, df = 7,194, p = .000) between the companies considering age of the pictured humans. Consequently, the Scheffé test was used to compare pairs of group means in order to assess where the differences lie. It was found that at the 5% level of significance that the means for age did not differ between the companies.

The appliances that are used in the pictures to represent consumer devices for the ambient intelligence vision at home were also analyzed to address research question 2c.The results show that a wide screen (45 times in total) was the most frequently pictured appliance, followed by a small screen (35), a home control panel (27) and a projection screen (25). The least frequently pictured appliances were the digital TV, digital video recorder, identification apparatus and the video phone (all 1). Table 3 shows an overview of the total score of how frequent a device was visible on the pictures (N = 202) per company. Appliances that were counted less than 10 times in the sample were not included in table 3, these appliances were: laptop (9 times in total), internet microwave oven (9), internet fridge (8), mobile phone (8), internet washing machine (7), digital video camera (7), computer with LCD screen (5), internet air conditioner (6), telephone (3), digital TV (1), digital video recorder (1), videophone (1), and identification apparatus (1).

To also control for an effect of the unequal distribution of the pictures per company, the means of the picture variables were analyzed using an unrelated one-way analysis of variance, see table 3. Looking at the four most pictured devices, the wide screen (F = 1.74. df = 7, 194, p = .102), projection screen (F = .41, df = 3, 171, p = .744) and home control panel (F = 2.72, df = 2, 144, p = .069) were not significant and the small screen was significant (F = 7.03, df = 6, 190, p = .000). Consequently, the Scheffé test was used to compare pairs of group means in order to assess where the differences lie. It was found that at the 5% level of significance, IBM (M = 1.50, SD = 1.73) pictured significantly more (F = 7.03, df = 6, 190, p = .000) small screens than

Philips (M = .13, SD = .34), HP (M = .14, SD = .35), MIT (M = .23, SD = .44), LGE (M = .18, SD = .40) and Orange (M = .13, SD = .35).

-- Insert table 3 about here --

The location of the pictured appliance was also analyzed in the sampled promotion material. The living room (27%) was the most popular place to portray an appliance, followed by a neutral background (26%) (a neutral background means that the appliance was pictured against a color or black and white background), bedroom (10%), ‘not clear’ (10%), kitchen (5%), bathroom (5%) and study/work room (2%). The ‘not clear’ category meant that it was not clear in what kind of room the appliances were portrayed to be used. There was no significant effect between the companies considering the pictured locations (F = 1.14, df = 7, 194, p = .339).

The relative size of the pictured humans and appliances was also analyzed to see if there are differences in size in the portrayal of humans and consumer appliances. The mean for relative size (in cm2) of the pictured humans was 13.69 (SD = 19.75) and the mean for appliances was 46.49 (SD = 37.35). There was no significant difference between the companies on the relative size for humans (F = 1.01, df = 4, 178, p = .405), but there was a significant difference (F = 6.09, df = 7, 194, p = .000) between the companies on relative size of the pictured appliances. Consequently, the Scheffé test showed, at the 5% level of significance, that was used to compare the pairs of group means in order to assess where the differences lie. It was found that, LGE pictures scored significantly higher (M = 96.10, SD = 12.93) than Philips (M = 44.03, SD = 34.81), Orange (M = 24.15, SD = 32.70), Microsoft (M = 7.59, SD = 6.88) and Living Tomorrow (M = 6.94, SD = 7.33).

Discussion

The study was conducted to get a better understanding of the current representation of ambient intelligence. This was done by a content analysis of promotion material of high-tech companies who are currently developing (prototype) consumer applications for in the home. The results showed that ‘connectedness’, ‘control’, ‘easiness’ and ‘personal’ where the attributes most frequently mentioned in the promotion material. Two of the four most frequent mentioned attributes, control and connectedness did not differ between the companies’ presentations. This increases the probability that they are considered to be attributes of ambient intelligence applications by all producers at the start of the 21st century. However, some significant differences were also found between the presentations of the companies. Among the attributes that did differ significantly between the companies, there was not clearly one company that scored significantly higher on all the attributes. More than half of the recording units in the sample and attributes were delivered by Philips. However, as showed by the Scheffé test this makes no difference for the results of the significant attributes.

By a clustering of the attributes, three main groups could be distinguished, namely Convenience, Adaptation and Empowerment. Adaptation was the largest group which consisted mainly of technical attributes of ambient intelligence and which also encompasses the most frequently mentioned attribute ‘connectedness’. Connectedness can be seen as both a technical and a social attribute of ambient intelligence. The technical attribute connectedness refers to the connecting of all home appliances in a network in the ambient intelligence vision. The social side of connectedness refers more to the provision of connections for humans living in the ‘smart home’, to make them feel ‘connected’ with their family and friends despite geographical distances. Dovey (1985: 44) describes the home as a series of connections between a person and the world in a way that it connects us with the past, the future, the psychical environment and our social world. The results of our study indicate that in the ambient intelligence vision, a more connected and engaged way of communication between a person and the world awaits us.

The convenience cluster mainly encompasses ‘easiness’ and this can be characterized as a social attribute of ambient intelligence. As mentioned in the introduction, the emphasis of ambient intelligence is among other things on greater user-friendliness and support for human interactions. Current ICTs are often a source of irritation for users and the promise of ambient intelligence is that it will make ICTs more user-friendly. Although the promise is that this technological vision is human-centered instead of technology centered, the social clusters Convenience and Empowerment were less emphasized in the promotion material than the technical cluster Adaptation. Further research should clarify whether this is caused by marketing preferences or that the developers of ambient intelligence really emphasize the technological aspects during the development of AmI applications.

The frequently mentioned attributes ’control’ and ‘personal’ are the main components of the Empowerment cluster. These attributes probably indicate that the high-tech companies understand that a potential main asset of ambient intelligence is more personal control over the ICTs by users and not the other way around, as is the case now with many ICTs. Further research has to clarify how much room the designers are giving to the people in the control of applications.

It is conspicuous that words such as privacy and security were less mentioned in the promotion material. These concepts are frequently debated in the literature (Beslay and Punie, 2002; Punie, 2003; Waldrop, 2003; Bohn et al., 2004) as important factors for the success or failure of ambient intelligence. Perhaps high-tech companies do not want to emphasize critical aspects, such as privacy and security that could deter users from ambient intelligence. Hilty et al. (2004: 869) found in their study that Pervasive Computing bears potential risks in several domains. They mention examples of stress imposed on users, restrictions of consumers’ and patients’ freedom of choice, and shifts of responsibility to computer-controlled environments.

The results from the picture analysis showed that although the aim of ambient intelligence is to be unobtrusive and to work in often invisible ways, a wide screen was the most depicted device in the sample. These findings could imply that although the wish is to make devices that are unobtrusive, this has not been realized yet. However, it could also be that they are harder to picture.

The user is the central focus of ambient intelligence (ISTAG, 2001, 2003), but this was not revealed in the analyzed pictures. On nearly half of the pictures no humans were portrayed and the relative size of the pictured appliances was much higher than the size of the pictured humans.

Of the humans pictured, males appeared more on the pictures than females. This could mean that although the whish is to emphasize the user in this vision on society and that this vision is meant to be for everyone, this is not what is represented in the promotional material of high-tech companies who develop the applications. Friedewald et al., (2005) point out that although there are opportunities for ambient intelligence, there are also risks concerning the development of ambient intelligence in the home environment and an important one is the unknown reaction of the user.

The results of this study indicate that in this stage of the development of ambient intelligence, the technical attributes are more emphasized than the user and social attributes. This does not concur with the ambient intelligence vision described above that stresses the user-centeredness of this innovation.

Some caution is needed when drawing conclusions which are only based on promotion material. The marketing department of a high-tech company can have different ideas about ambient intelligence than engineers and designers who actually create the ambient intelligence applications. It would be interesting to see on a deeper level how engineers and designers of ambient intelligence applications think about and create this new vision. In a study which is currently conducted, we observe how the ambient intelligence vision is realized in the production of applications by engineers and designers.

Future Research

Ambient intelligence is a vision on how the information society will evolve. If it becomes real, it could have many consequences for its users. The current stage of development of this technological vision is important because no standards are set and it is not yet decided were we are heading to. This study showed that although the aim is to give a central role to the user this is not yet shown, at least not in the promotion material of the high-tech companies. Ambient intelligence's success will not only be determined by a particular technological vision but also and probably more by social aspects (Punie, 2003). High-tech companies can learn a lot if they include users in the development of their applications to gain a better understanding of their wishes and needs. This has already been done to different degrees by some companies.

Furthermore, developers of ambient intelligence applications have to understand that the most frequently mentioned attributes (connectedness, easiness, control and personal) that were found in this study of promotion material do not have to appeal to future users. A step towards understanding future users of ambient intelligence applications is to examine what the real user needs are. Ultimately this can only be validly done in future phases of the ambient intelligence innovation process: adoption and incorporation.

End notes

For the sake of simplicity we will only refer to companies, recognizing that MIT is a research institution

[2] Attributes in codebook were: adaptability, ambient, automation, busy, comfort, connectedness, control, convenience, easiness, enjoyment, everyday life, flexibility, freedom, improving quality of life, interactivity, interoperability, mobility, personal, privacy, reliability, safety, save time, smart, user-centred, utility

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Table 1 Total count scores, means and standard deviations of attributes per company

Companies / Attributes	Philips (n=1274)	Microsoft (n=266)	MIT (n=253)	LGE (n=192)	HP (n=181)	Living Tomorrow (n=95)	IBM (n=73)	Orange (n=66)	Total (N=2400)
Connected-Ness	**126**	**18**	**14**	**26**	**19**	**1**	**6**	**8**	**218**
	.10(.35)	07(.27)	.06(.23)	.14(.37)	.11(.32)	.01(.10)	.08(.28)	.12(.33)*	.09(.32)
Control	**87**	**20**	**15**	**24**	**5**	**3**	**11**	**9**	**174**
	.07(.28)	.08(.28)	.06(.28)	.13(.39)	.03(.16)	.03(.23)	.15(.40)	.14(.43)**	.07(.29)
Easiness	**81**	**46**	**15**	**12**	**10**	**1**	**2**	**1**	**168**
	.06(.27)	.17(.39)	.06(.24)	.06(.26)	.06(.23)	.01(.10)	.03(.16)	.02(.12)***	.07(.27)
Personal	**82**	**26**	**17**	**1**	**20**	**4**	**-**	**7**	**157**
	.06(.26)	.10(.32)	.07(.25)	.01(.07)	.11(.35)	.04(.20)		.11(.36)**	.07(.27)
Interactivity	**86**	**-**	**17**	**3**	**3**	**2**	**1**	**2**	**114**
	.07(.27)		.07(.25)	.02(.12)	.02(.13)	.02(.14)	.01(.12)	.03(.17)**	.05(.24)
Smart	**60**	**-**	**11**	**3**	**13**	**2**	**3**	**4**	**96**
	.05(.22)		.04(.22)	.02(.12)	.07(.32)	.02(.14)	.04(.20)	.06(.24)	.05(.22)
Enjoyment	**34**	**18**	**1**	**4**	**-**	**3**	**-**	**1**	**61**
	.03(.17)	.07(.25)	.00(.06)	.02(.14)		.03(.18)		.02(.12)**	.03(.17)
Safety	**7**	**17**	**15**	**8**	**7**	**2**	**1**	**1**	**58**
	.01(.10)	.06(.36)	.06(.33)	.04(.29)	.04(.27)	.02(.14)	.01(.12)	.02(.12)***	.02(.21)
Mobility	**15**	**8**	**13**	**2**	**16**	**-**	**-**	**1**	**55**
	.01(.13)	.03(.19)	.05(.22)	.01(.10)	.09(.28)			.02(.12)***	.02(.17)
Automation	**20**	**6**	**16**	**6**	**2**	**1**	**1**	**-**	**52**
	.02(.12)	.02(.15)	.06(.29)	.03(.17)	.01(.10)	.01(.10)	.01(.12)**		.02(.16)
Ambient	**10**	**-**	**11**	**-**	**12**	**1**	**-**	**-**	**34**
	.01(.10)		.04(.22)		.07(.37)	.01(.10)***			.02(.17)
Convenience	**4**	**11**	**-**	**18**	**-**	**-**	**-**	**-**	**33**
	.00(.06)	.04(.20)		.09(.29)***					.02(.14)
User-centered	**11**	**-**	**19**	**-**	**1**	**-**	**-**	**2**	**33**
	.01(.09)		.08(.28)		.01(.07)***			.03(.17)	.02(.14)
Adaptability	**16**	**2**	**11**	**-**	**1**	**2**	**-**	**-**	**32**
	.01(.11)	.01(.09)	.04(.20)		.01(.07)	.02(.14)**			.02(.12)
Utility	**5**	**4**	**10**	**3**	**2**	**1**	**1**	**-**	**26**
	.00(.06)	.02(.12)	.04(.20)	.02(.12)	.01(.10)	.01(.10)	.01(.12)***		.01(.10)
Improving quality of life	**17**	**5**	**-**	**1**	**1**	**1**	**-**	**-**	**25**
	.01(.11)	.02(.14)		.01(.07)	.01(.07)	.01(.10)			.01(.11)
Everyday life	**3**	**8**	**3**	**-**	**2**	**2**	**-**	**1**	**19**
	.00(.05)	.03(.17)	.01(.11)	.01(.14)	.01(.10)	.02(.14)		.02(.12)**	.01(.10)
Total	**664**	**189**	**188**	**111**	**114**	**26**	**26**	**37**	**1355**

Table 2 Clustering of attributes (in parentheses total times mentioned in the sample)

Convenience	**Adaptation**	**Empowerment**
Easiness (168)	Connectedness (218)	Control (174)
Enjoyment (61)	Interactivity (114)	Personal (157)
Convenience (33)	Smart (96)	Safety (58)
User-centered (33)	Mobility (55)	Improving quality of life (25)
Utility (26)	Automation (52)	Everyday life (21)
Save time (14)	Ambient (34)	Privacy (17)
Comfort (13)	Adaptability (32)	Freedom (5)
Busy (4)	Flexibility (16)	Reliability (4)
	Interoperability (6)	
Total: 352	Total: 623	Total: 461

Table 3 Total count scores of devices, means and standard deviations per company

Companies **Devices**	**Philips (n=135)**	**HP (n=22)**	**Living Tomorrow (n=4)**	**MIT (n=13)**	**LGE (n=11)**	**Orange (n=8)**	**Microsoft (n=5)**	**IBM (n=4)**	**Total (N=202)**
Wide screen	**26**	**5**	**2**	**1**	**3**	**4**	**3**	**1**	**45**
	.19(.40)	.23(.43)	.50(.58)	.08(.28)	.27(.47)	.50(.53)	.60(.55)	.25(.50)	**.22(.42)**
Small screen	**18**	**3**	**2**	**3**	**2**	**1**	**-**	**6**	**35**
	.13(.34)	.14(.35)	.50(1.00)	.23(.44)	.18(.40)	.13(.35)		1.50(1.73)**	**.18(.47)**
Home control panel	**22**	**-**	**-**	**-**	**-**	**4**	**-**	**1**	**27**
	.16 (.39)					.50(.53)		.25(.50)	**.18(.41)**
Projection screen	**21**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**25**
	.16(.36)	.09(.29)		.08(.28)			.20(.45)		**.14(.35)**
Micro hifi system	**17**	**1**	**-**	**-**	**2**	**-**	**1**	**1**	**22**
	.13(.58)	.05(.21)			.18(.40)		.20(.45)	.25(.50)	**.12(.53)**
Digital pen	**12**	**2**	**-**	**3**	**-**	**1**	**-**	**-**	**18**
	.09(.33)	.09(.29)		.23(.44)		.13(.35)			**.10(.34)**
Remote control	**9**	**-**	**-**	**-**	**2**	**-**	**4**	**-**	**15**
	.07(.28)				.18(.40)		.80(.84)***		**.10(.34)**
Ambient lighting	**8**	**1**	**-**	**-**	**-**	**2**	**3**	**-**	**14**
	.06(.24)	.05(.21)				.25(.46)	.60(.55)***		**.08(.28)**
PDA	**-**	**5**	**-**	**3**	**2**	**-**	**-**	**1**	**11**
		.23(.43)		.23(.44)	.18(.40)			.25(.50)	**.22(.42)**
Intelligent label	**9**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**10**
	.07(.25)							.25(.50)	**.07(.26)**
Total	**142**	**19**	**4**	**11**	**11**	**12**	**12**	**11**	**222**