

Interactive TV Design That Blends Seamlessly with Everyday Life

Konstantinos Chorianopoulos

Department of Architecture
Bauhaus University of Weimar, Germany
k.chorianopoulos@archit.uni-weimar.de

Abstract. Television use does not require high skill or effort, which is ideal as a paradigm of use for ambient user interfaces. In this paper, universal access in ambient intelligence is modeled after the use of TV in everyday life. Instead of considering television only as a content medium and the focus of user activity, an alternative approach is to consider television use as a secondary function to other activities, such as socializing, domestic chores, leisure pursuits. For this purpose, the requirements for ambient user interactivity with TV are organized in a small set of design principles. The design principles have been selected, analyzed and synthesized from readings in previous works on media and ethnographic studies about television, and everyday life. It is suggested that universal access in ambient intelligence is promoted by considering design principles such as opportunistic interaction, user participation, group interactions, and multiple levels of attention to the user interface. Finally, the principles have been tested in the design of a user interface for interactive music television. This preliminary case suggests that the proposed principles facilitate the design of user interfaces that blend seamlessly with everyday life.

Keywords: Design principles, metaphors, paradigm of use, Ambient ITV, interactive TV, media studies.

1 Introduction

Television is one of the most pervasive mediums in daily life and it has traditionally occupied the largest share of domestic leisure time [33]. In sharp contrast to the also ubiquitous personal computer, television use does not require high skill or effort, which is an ideal paradigm of use for the design of ambient user interfaces. In this work, we propose that universal access in ambient intelligence applications could be modeled after TV use. Indeed, besides the ease of use, the pervasiveness of TV could be attributed to a focus on universal access. Historically, the design of TV systems has regarded all members of the society. For example, there are technical standards for closed captioning services (i.e. optional text captions for the hard-hearing people) that have been mandated by the government, in order to provide equal access to TV services for all. Traditional TV has been undergoing a process of transformation, due to digital storage, digital transmission, proliferation of alternative distribution channels, and active user participation. Therefore, developers of new interactive TV

(ITV) applications should be provided with design principles and technical standards that ensure universal access. Moreover, it is argued that the same design principles could also be employed in ambient intelligence applications that blend seamlessly with everyday life. In the rest of this article, ITV is considered as a paradigm of use and not as a technology for ambient intelligence.

Although interactivity offers additional benefits to the media audience, the introduction of interactivity in TV systems raises issues of increased complexity. Many ITV technologies and applications support the interactive display of additional information on the screen and the interactive manipulation of rich content, but without considering the design principles that could sustain ITV use as an integral part of everyday life activities. Contemporary ITV applications have been developed with traditional multimedia authoring tools that make many assumptions with regard to ITV user behavior. For example, there are some ITV applications that interrupt TV channel flow, take over the whole TV screen and do not proceed unless the user interacts with a few dialog boxes. Such a paradigm of use is very well suited for personal computer applications, when users perform highly structured tasks, but it is unsuitable for leisure or secondary activities, such as when users just want to keep an eye on TV news, or want to change the flow of the TV channel [4]. For this purpose, we investigate design principles that regard ITV as a secondary low demand activity, referred to as Ambient ITV.

Universal Access in Ambient ITV is promoted by a user interface (UI) that provides interactive access to multimedia information and communication services, but without any discount on the established uses and gratifications of traditional TV. Then, the requirement for Ambient ITV applications is to gratify entertainment needs and leisure activities in a relaxed setting. In this context, the mentality of efficiency and task completion found in traditional user interface heuristics may not be suitable. Indeed, there is a body of research work that has elaborated on the relationship between TV, viewers and daily life. The field of media studies has accumulated an extensive knowledge of TV usage and TV viewer behavior. Moreover, there are numerous ethnographic and longitudinal studies that describe the role of TV in everyday life. In the rest of this paper, media and ethnographic studies are analyzed and synthesized into a small set of design principles that facilitate the inclusive design of Ambient ITV applications. It is also expected that the same design principles apply to other types of Ambient Intelligence applications, especially in the context of leisure activities.

2 Design Principles

UI principles have played an important role in guiding the design choices of interactive computer applications, as it becomes evident by the wide acceptance and the many citations to the Macintosh Human Interface Guidelines report [1]. As a matter of fact, personal computer application developers have been accustomed to a standard set of principles (e.g. desktop metaphor, direct manipulation, etc), which are employed in computer applications. In addition, usability engineers employ the respective lists of UI heuristics to perform expert evaluations (e.g. consistency of buttons in dialog boxes, provide shortcuts, etc). Most importantly, UI principles

establish an implicit conceptual framework into developers' minds with regard to usability goals. For example, efficiency is a popular UI design goal, which is pursued with an effort to minimize task execution time. Arguably, task efficiency is not a high-priority requirement for Ambient ITV applications that blend seamlessly with daily patterns of life.

Design principles are important because they facilitate the process of designing a UI for a new application, but principles are also loaded with implicit assumptions with regard to the application domain, the context of use, and the user characteristics and goals. There are generic (e.g. "know the user") and more specific (e.g. "use red for urgent items") principles that address the multitude of issues associated with UI design, such as screen design, user needs and performance, input device, etc [24]. UI design principles usually stem from the extensive experience of a few HCI experts. HCI was mainly developed alongside the desktop paradigm of use and most of the current principles reflect a productivity mentality. It has been argued that most UI design principles are catholic and apply to many categories of interactive applications, but experts admit that there might be exceptions in new usage paradigms [23]. Indeed, it is argued that user interface requirements for Ambient ITV are quite different from those for desktop computer applications.

Universal access is often seen as providing everybody with the means to get information and to perform tasks within a reasonable time-span and with a reasonable amount of effort. Compared to the traditional usability definition, universal access emphasizes the diversity in the user population, in the application domain and in the context of use [29]. Universal access methods have been applied to facilitate the accessibility of information society services for the disabled, aged, and children, and should be updated for the case of ubiquitous computing applications [10]. Interactive TV is an information society technology that is employed in a leisure context of use, is targeted to the majority of the population, and provides a terminal for diverse activities, such as e-commerce, e-learning, and games. At first sight, contemporary universal access techniques seem to be appropriate for the design of ITV applications. Still, the TV audience has been accustomed to expect much more than ease of use. In particular, the TV audience receives information and expects to be entertained, in a lean-back posture, which does not require neither high skills, nor high effort. Besides being a unique requirement for universal access in ITV, this paradigm of use is rather suitable for modeling the design of other categories of ambient intelligence applications, beyond ITV.

Related work has treated some aspects of universal access to interactive TV, such as accessibility for specific populations such as the disabled [14]. Besides accessibility, the designers of ITV should also consider the needs and gratifications of the existing TV audience. Some researchers have emphasized that ITV applications are deployed in a relaxed setting and users have entertainment goals [3] [7]. Still, there is no research available about design principles that regard the interaction with TV as an ambient UI. Then, a major research question is:

'Which design principles promote Universal Access in Ambient ITV applications?'

Table 1. Differences in user requirements for Universal Access between desktop computing and Ambient ITV applications

Requirements	Desktop computing	Ambient ITV
Users	Employed, Disabled, elderly, children	Everyday roles
Activities	Focused, primary, structured	Peripheric, secondary, unstructured
Goals	Transactions, information seeking, health, communication	Entertainment, relaxation, information exploration
Context	Work, productivity	Leisure

In summary, universal access research has to consider the design requirements for Ambient ITV (**Table 1** provides an overview of the discussion in this section). Previous research in universal access for ITV has treated some aspects of the user studies [11], multimodal interfaces [3] and affective quality evaluation [7], but there is still limited research available for the design methods, techniques and principles, which fulfill the requirement of universal access in Ambient ITV applications.

3 Methodology

In this paper, Ambient ITV applications are considered as information and entertainment applications that blend seamlessly with daily activities. Here, daily activities are defined as those that take place in public or private settings and do not necessarily involve computing activities as the primary focus of activity. Examples of this type of activities include socializing, domestic chores, leisure pursuits. Then, the challenge is to design information technology that supports daily activities, without requiring high skills or effort to learn and use. Previous research in ambient intelligence has considered computing applications that are integrated with the physical environment (e.g. sensors, public displays), or mobile applications. In these cases, the main requirement for the design of the user interface is the automation of computing tasks and the minimal user intervention, which are based on detailed user models, sensors and context adaptation [27]. Although user profile and context are important factors in the delivery of effective ambient intelligence, designers should also consider ambient applications as being of secondary priority in performing other daily life activities (e.g. socializing at home or outside, doing house chores, relaxing, etc), which might have nothing to do with any computing devices. Overall, universal access in Ambient ITV applications is treated as a requirement for UI design that blends seamlessly with everyday life. For this purpose, we examine media and ethnographic studies of TV use.

Longitudinal studies about TV and the quality of life have revealed that there is a strong correlation between TV watching behavior and several aspects of daily life [13], [17], [20]. Audience surveys and ethnographic studies have shown that viewers appropriate TV content in many ways, such as selective distraction from home activities, conversation starter, structuring of time [18], [25]. Researchers have also

investigated how the domestic build environment affects TV use and found that different architectural styles of domestic space facilitate different patterns of TV use [26]. It has been also demonstrated that the introduction of electronic mediums in homes has influenced the design of architectural space [32]. Furthermore, there are studies of the use of TV in public spaces, which document the impact of TV well beyond the familiar domestic environment in to public spaces of work, commerce and leisure [20]. In brief, there is body of research work that considers TV viewing as part of daily life, instead of 1) focusing on the technical requirements, 2) analyzing only the effects of particular types of content, and 3) considering interaction with the user as if it was the main objective of user activity. Therefore, the consideration of ITV applications as part of daily life could encourage the specification of design principles for ubiquitous computing, in general.

Next, we explore the implications of media and ethnographic studies for UI design principles.

4 Design Principles for Ambient TV Interactivity

HCI research and practice has been benefited by a multidisciplinary approach to design problems. In this section, the design principles are formulated after a systematic and critical review of previous research in media and ethnographic studies. The most useful findings from each field are collected, analyzed and presented in an easy-to-use designer's checklist that should be addressed in the design and expert evaluation of an ITV application. In general, it is argued that these principles could aid the design of other ambient intelligence applications. In the description of each principle, we examine fallacies and pitfalls that should be avoided when designing for ITV. At the same time, the UI principles are formulated into short generic descriptions for ambient interactions.

4.1 Opportunistic Interaction

The introduction and wide adoption of the Web has been promoted and attributed to the interactive nature of the new medium. It often goes without much thought, that if something is interactive then it is also preferable. Interactivity with the user might seem as the major benefit of ITV, but this is a fallacy that designers with computer experience should learn to avoid. Most notably, there is evidence that in some cases interactivity may be disruptive to the entertainment experience. Vorderer et al. [30] found that there are some categories of users who do not like to have the option to change the flow of a TV story; they just prefer to watch passively. Indeed, the passive uses and emotional needs gratified by the broadcast media are desirable [18]. Still, there might be cases such as video games, in which the addition of interactive elements enhances the entertainment experience [19]. As a principle, the viewer should be empowered with features borrowed from a TV production studio. For example, ITV users could control the display of sports statistics and play along the players of quiz games. Interactivity should not be enforced to the users, but should be pervasive for changing the flow of the running program, or augmenting with additional information on demand.

4.2 Multiple Levels of Attention

A common fallacy is that TV viewers are always concentrated on the TV content, but there is ample evidence that TV usage takes many forms, as far as the levels of attention of the viewer are concerned. Jenkins [16] opposes to the popular view that ITV will support only the needs of the channel surfers by making an analogy: ‘With the rise of printing, intensive reading was theoretically displaced by extensive reading: readers read more books and spent less time on each. But intensive reading never totally vanished.’ Lee and Lee [18] found that there is a wide diversity of attention levels to the television set —from background noise to full concentration. For example, a viewer may sit down and watch a TV program attentively, or leave the TV open as a radio and only watch when something interesting comes-up [8]. These findings contrast ‘to the image of the highly interactive viewer intently engaged with the television set that is often summoned up in talking about new possibilities.’ [18]. Instead of assuming a user, who is eager to navigate through persistent dialog boxes, designers should consider that users do not have to be attentive for the application to proceed.

4.3 Relaxed Exploration

During the 90’s there had been a lot of speculation about the 500 channels future of ITV. In contrast, mass communication researchers found that viewers recall and attend to fewer than a dozen of TV channels [12]. The fallacy of the 500 channels future was turned upside-down into a new fallacy, during the first decade of 2000, when researchers put forward the vision of a single personalized channel. In sharp contrast, the study of TV consumption in the home reveals that TV viewing is usually a planned activity, which is a finding that sharply contrasts with the focus on the EPG as a method to select a program to watch each time a user opens the TV. Indeed, ritualized TV viewing was confirmed by a survey, in which 63% of the respondents had watched the program before and knew it was going to be on [18]. Still, there is a fraction of the viewers that impulsively selects a program to watch, especially among the younger demographic [13]. As a consequence, designers should consider that most TV viewing starts with familiar content and happens in a ritualistic pattern (e.g. early morning news, or late evening series), but it might continue with browsing of relevant items. Therefore, interactive TV applications should support relaxed exploration, instead of information seeking. This principle becomes especially important in the age of hybrid content distribution systems, which include peer-to-peer, IPTV and mobile TV.

4.4 Structuring of Time-Schedule

Using the television as a time tool to structure activities and organize time has been documented at an ethnographic study of a STB trial [25]. The fact that most TV viewing is considered to be ‘ritualistic’ [18] does not preclude the exploitation of out-of-band techniques for delivering the content at user’s premises. Broadcast distribution is suitable for the delivery of high-demand, high-bit rate items, which have a real-time appeal (e.g. popular sport events, news). Designers should justify the use of persistent local storage and broadband Internet connections, which are

becoming standard into many ITV products (e.g. video game consoles, digital media players). Digital local storage technology takes viewer control one big step further — from simple channel selection with the remote— by offering the opportunity for conveniently time-shifted local programming and content selection. As a principle, designers should try to release the content from the fixed broadcast schedule and augment it with out-of-band content delivery. Therefore, an appropriate UI for content delivery should allow the user to customize the preferred sources of additional and alternative information and video content.

4.5 User Contributed Content

TV content production has been regarded as a one-way activity that begins with the professional TV producers and editors and ends with post-production at the broadcast station. As a matter of fact, television viewers have long been considered passive receivers of content, but a new generation of computer literate TV viewers has been accustomed to make and share edits of video content online. The most obvious example of the need for user contributions in available TV content is the increased activity of TV content forums and related web sites. There are many types of user communities from the purely instrumental insertion of subtitles in hard-to-find Japanese anime to the creative competition on scenarios of discontinued favorable TV series (e.g. Stat Trek). In any case, there are many opportunities for user contributed content, such as annotations, sharing, and virtual edits. Furthermore, the wide-availability of video capture (e.g. in mobile phones, photo cameras) and easy-to-use video editing software, opens up additional opportunities for wider distribution of home made content (e.g. peer-to-peer, portable video players, etc).

4.6 Group Viewing

Most TV sets come with one remote control, which excludes the possibility for interactivity to anyone, but the one who holds the remote control. Despite this shortcoming, TV usage has been always considered a group activity [13] and it might provide a better experience when watched with family members [17]. In contrast, PC usage is mostly solitary, partly because the arrangement of equipment does not provide affordances for group use. Then, a possible pitfall is to consider only one user interacting with the TV, because there is only one remote control. Therefore, designers should consider social viewing that might take place locally. For example, an ITV quiz game might provide opportunities for competition between family members. In the case of distant groups of synchronous viewing, there are further opportunities for group collaboration, which are discussed next.

4.7 Content Enriched Communication

Besides enjoying TV watching together, people enjoy talking about, or referring to TV content [18]. This finding could be regarded as an overlap of the previous “Group Viewing” and “User Contributed Content” principles, but in an asynchronous, or distant communication fashion. Therefore, ITV applications should support the communication of groups of people who have watched the same content item, although not on the same time (e.g. family members living in the same or diasporic

households). Moreover, ITV applications should facilitate the real-time communication of distant groups of viewers, who watch concurrently TV. An additional aspect of this principle is that it poses an implicit argument against personalization. If TV content is such an important placeholder for discussion, then personalization reduces the chances that any two might have watched the same program. On the other hand, this social aspect of TV viewing might also point towards new directions for personalization, which are based on the behavior of small social circles of affiliated people.

4.8 Visual Language and Aesthetics

A difficulty in the domain of ITV UI design is the interface's inability to stay attractive over time. TV audiences have become familiar with a visual grammar that requires all programs, as well as presentation styles to be dynamic and surprising [21], which is in sharp contrast with traditional usability principle of consistency [24]. In summary, designers should enhance the core and familiar TV notions (e.g. characters, stories) with programmable behaviors (e.g. objects, actions). Then, an ITV UI might not look like a button or a dialog box. Instead, it could be an animated character, which features multimodal behaviors. Furthermore, user selections that activate scene changes should be performed in accordance with the established and familiar TV visual grammar (e.g. dissolves, transitions, fade-outs).

Table 2. Design principles for interactive television applications

Principle Name	Principle Description
Opportunistic interaction	Continuous flow of content manipulated by optional user interactivity
Relaxed exploration	Relaxed exploration, instead of information seeking
Structuring of time-schedule	Promote flexible structuring of daily life time-schedules
Group viewing	Affordances for social viewing in co-located groups
Multiple levels of attention	Attention may be on the periphery of vision or focused, or anything in between
Visual language and aesthetics	Familiar TV elements include characters and stories
User contributed content	The viewer as a TV producer could perform annotations, sharing, and virtual edits
Content enriched communication	Synchronous or asynchronous distant communication around TV content

The above table (**Table 2**) summarizes the design principles into a coherent list of principle name and the respective description for use by designers and developers of programming frameworks in ambient intelligence.

In the following section, a few of the above design principles are applied in the case of a simple ITV application for music videos.

5 Interactive Music Television

The music video is a commercially successful, popular and worldwide available format of TV content (e.g. MTV channel). Music TV channels are considered to be innovative, because they have a young and dynamic audience, so they can play the role of the Trojan horse for novel ITV applications. MTV was the first TV channel to offer information related to video-clips a while ago, and since then, there have been many followers, even in different program types. MTV has been also showing which music video comes next. Music information usually contains trivia about the artist, or biographical information and discography. Music TV channels had originally adopted the informational video-overlays, because they make viewers spend more time in front of the TV set, instead of listening to it, like a radio.

Next, music video TV is redesigned as an ITV application, by addressing the proposed design principles.

Opportunistic interaction: Music TV producers enhance the programs with song and artist related trivia, which could be inserted dynamically at the user's premise. The main objective in the design of an entertaining ITV application is to offer relaxed interactivity. In this case, relaxed interactivity is materialized in two ways: 1) music video skipping and 2) on-demand song information.

Relaxed exploration: The interactive music video application offers popular actions such as stop, play, and next, just like a normal CD player. Further navigation options could be available for music videos, such as genre, artist, mood, tempo, decade, etc. Textual information about a music video clip could be browsed sequentially, or could be organized in categories, such as biography, discography, trivia, etc.

Structuring of time-schedule: A music TV broadcaster might create an interactive complement to the existing fixed channel, or a consumer might arrange a virtual music channel by selecting the favorite music video clips from local storage and setting preference categories for pre-fetching. A virtual TV channel is created by arranging accessible content (video-clips and ancillary data on local storage and Internet resources) in play-lists and by retrieving additional content (audiovisual or textual).

Group viewing: The current application does not provide any support for group viewing. Still, music video TV offers many opportunities for computer mediated socializing. Music preferences are employed in social situations to communicate personality/interests and as discussion placeholder. Then, an ITV application could set-up ad-hoc discussion groups for viewers who listen to the same music bands, or genres.

Multiple levels of attention: The user may either just tune into the music channel and leave it playing as radio or watch attentively the related information. Unless the track-skip button is pressed, there is a continuous flow of music video clips, just like a normal music TV channel (Fig. 1). Overlay information appears automatically, but the user may navigate on demand music video information.



Fig. 1. Music video selection allows the user to direct the –otherwise– continuous flow of the program, thus supporting multiple levels of attention

Visual language and aesthetics: Static video is used only for the video clips. The rest of the elements are computer generated (animated character, overlay box). The animated character displays related information about each video clip (Fig. 2). There is also an option to display the related information with a semi-transparent overlay rectangular box, instead of the animated character. Still, the animated character offers many opportunities for further research. For example, it might react to the mood of the song, or it could play the role of an avatar for remote users.

User contributed content: The current application does not support user participation, but there are many opportunities for user-contributed content. For example, music video clips could be offered with alternative edits and visuals, thus allowing the distribution of user-edited versions of a given music video. Moreover, trivia about the music videos and the artist offer an unlimited space for content contribution by the users.

Content enriched communication: The current application does not support any means of personal communication, but it is straightforward to describe such features. One popular contemporary example is text messaging over a ticker at the screen. Such services have been already used by the majority of analog TV broadcasters and could be enhanced with instant messaging in the domain of digital TV. Besides real-time communication, interactive TV systems should allow the users to allow filter through programs that have been watched and edited by their peers, thus enhancing the sense of community.

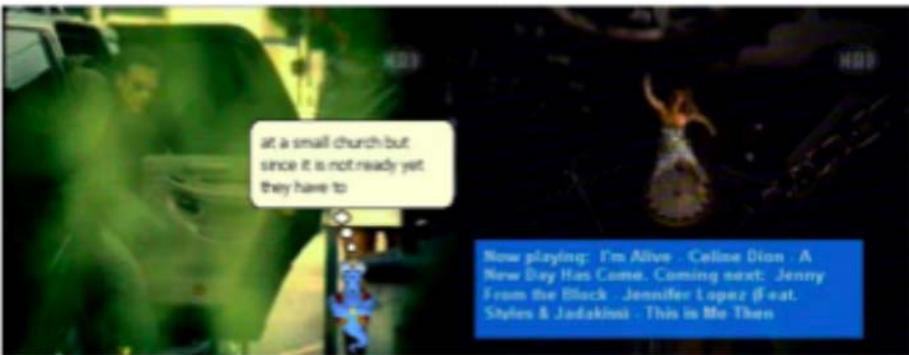


Fig. 2. Interactive graphics are embedded into the video, thus supporting TV grammar and aesthetics

In summary, the present section demonstrated how a simple ITV application was designed by addressing the principles. Moreover, it portrays that the principles could be also used to describe the features of that application in accordance to the established uses and gratifications of the TV audience, long before any implementation, and even before an early prototype has been constructed. As a proof of concept, the interactive music TV prototype was evaluated with end-users in a natural setting [4]. Although the prototype does not address all the proposed principles, the reaction of end-users was rather positive and motivated further research in the field of Ambient ITV.

6 Discussion

Some of the findings are opposed to the contemporary ITV design practice, while other findings reveal possible pitfalls for designers with desktop and web design background. In order to assist the design of ITV applications, the results of the literature review were formulated as design principles. Although principles are also employed in expert evaluation (e.g. heuristics) and for designing the syntactic details of the UI (e.g. specific guidelines for menus, icons, dialogs, etc), in the present work, we focused on the role of principles for facilitating the process of early-stage design for user interaction with ITV applications. In future research, the refinement of the proposed principles into more specific guidelines and could also be used for heuristic evaluation, as well. It is also proposed that the same design principles apply to Ambient ITV applications, especially in the context of leisure activities.

Ambient Intelligence and ubiquitous computing research could be broadly categorized along two dimensions of interaction design: 1) tangible user interfaces and 2) support for social activities [9]. Here, the work focuses on the social analysis of established and new technologies that support user interactivity during leisure pursuits in domestic settings. In contrast, the focus of previous work in related research, such as the cooperative buildings conference, was on the organizational aspects of collaborative work [28]. In this context, the concept of Ambient ITV was proposed as a metaphor for the design of UIs that are not work-related and do not require any training to use. Instead Ambient ITV UIs are seamless and a secondary part of daily life activities that are not related to computing. Indeed, the proposed design principles were elaborated from previous work in ethnographic and media studies research about TV and daily life, so they concern the use of electronic media technologies as a peripheric element of daily activities and thus, they are rather suitable for modeling ambient intelligence interaction design.

The design principles were conceptualized in the context of universal access in Ambient ITV applications, but there are some findings that could be applicable for other categories of ambient intelligence applications, as well. For example, television producers have an expertise in producing content that does not require any effort to use, to get informed and to get entertained (e.g. “relaxed exploration” principle). This type of experience could be very suitable for the design of private or domestic displays of information. In addition, some principles (e.g. “multiple levels of attention” and “opportunistic interaction” principle) promote a calm interaction paradigm with information technology [31]. This type of design support could aid the

developers of ambient intelligence and ubiquitous information systems. Finally, the majority of the population is rather familiar with the presentation of information on TV (e.g. “TV grammar and aesthetics” principle), which could be exploited by graphic and video professionals for the design of presentation mechanisms in ambient intelligence applications.

Existing work in universal access in ambient intelligence has highlighted the user interface requirements for people with disabilities in various domains such as health and safety [10]. The latter are complimented by the suggestion for inspiration from the TV paradigm of use (**Table 3**). Previous work on Ambient TV has focused only on the impact of public space traditional TV in everyday life [20], but it has not considered the additional challenges and opportunities introduced by interactive technology, such as opportunistic interaction, user-contributed content and content enriched communication. The study of interactive music TV has been an informative and feasible experience, but further research should also consider other types of ambient multimedia applications, in order to test the applicability of the proposed design principles.

Table 3. Issues for Universal Access and potential contributions from the TV paradigm of use

Issues	Desktop computer	TV as a paradigm of use
Physical Context	Domain specific (office)	Generic
Users	Computer literate	Low skill and effort
Goals	One user-one computer, information and transactions	Group activities, leisure time, socializing
Tasks	Application tasks is the focus of the user	TV is of secondary focus to main user activity

The intuition and the experience of each UI designer may translate the same design principles into different solutions, depending on other factors, such as business and technical requirements. In this research, the design principles were explicitly addressed in an ITV prototype that has been tested with users. It has been argued that the design based on human considerations is not enough because design can rarely be detached from implementation and that the UI development tools implicitly give shape to the final application [2]. Accordingly, the proposed principles have been implemented in a UI programming toolkit, which was exploited to develop the example interactive music video application [5]. Test users evaluated the application very positively, when compared with traditional fixed music video TV [6]. Further research will consider enhancements to the music TV prototype and consideration of other types of TV content, or novel ITV formats.

The proposed set of design principles was presented as a list of high-level and generic design factors, which define the design space of ITV applications that blend seamlessly with everyday life. Still, there might be design principles, which are specific and concern particular parts of the interaction, such as video overlays, transitions etc. Indeed, there are guidelines, which are quantitative reformulations of

principles. For example, the generic principle ‘respond fast to user commands’ may be transformed to ‘respond in 1sec to user commands’ as a guideline for a specific system. Then, the high-level ITV UI principle for ‘multiple levels of attention’ may be transformed to a more specific UI principle, such as ‘remove a video overlay, if the user does not interact with the TV system’, or transformed to a guideline such as ‘remove a dialog box, if the user does not interact with the TV system after 5 seconds.’ Therefore, further research should refine the proposed set of design principles into longer lists of more specific principles and guidelines for particular types of ITV applications.

Overall, the proposed principles facilitate the design process of early interactive prototypes. In particular, they facilitate the description of the design rationale, thus making the alternative, or progressive design decisions easily traceable and comparable. Most importantly, designers might use them to make decisions that regard important aspects of the interaction with Ambient Intelligence. In summary, the proposed UI principles consider the ITV user as a TV viewer and exploit IT in the home for seamless blending with patterns of daily life.

7 Conclusion

The following points summarize the contribution of this research with regard to ambient user interfaces:

- The TV is one of the most pervasive and familiar electronic mediums. TV content and viewers are continuously evolving, but there exists a small set of TV-related patterns of daily life that remain unchanged.
- The multiple uses of TV in daily life offer many insights for the design of Ambient ITV applications that facilitate the actual needs of users, instead of transferring paradigms of use from incompatible mediums (e.g. personal computer, web).
- The design of ambient user interfaces could be informed by the paradigm of use with TV. Universal access in ambient intelligence could be regarded as a seamless integration with daily activities and the consideration of the above principles could enhance user interface design.

Further research will investigate the translation of the design principles into technological requirements for the development of ambient intelligence systems that blend seamlessly with everyday life. Of particular interest would be the “content enriched communication” principle and the respective applications in domestic and public spaces, with the objective to facilitate sociability and to enhance public participation.

Acknowledgements. Parts of this work have been supported by the MEDIACITY project (<http://www.mediacity-project.com>), which is sponsored by the European Commission Marie Curie Host Fellowships for Transfer of Knowledge (MTKD-CT-2004-517121).

References

1. Apple Computer. Macintosh Human Interface Guidelines. Addison-Wesley, Reading, Mass., 1992
2. Baecker, R. M., Grudin, J., Buxton, W. A., and Greenberg, S. Human-Computer Interaction: To-ward the Year 2000, Second Edition. Morgan Kaufmann Publishers, 1995
3. Berglund, A., Berglund, E., Larsson, A., and Bang, M. Paper remote: an augmented television guide and remote control. *Universal Access in the Information Society*, 4(4): 300-327, 2006
4. Chorianopoulos, K. Virtual Television Channels: Conceptual Model, User Interface Design and Affective Quality Evaluation. Unpublished PhD Thesis. Athens University of Economics and Business, 2004
5. Chorianopoulos, K. and Spinellis, D. User interface development for interactive television: Extending a commercial DTV platform to the virtual channel API. *Computers and Graphics*, 28(2):157-166, 2004a
6. Chorianopoulos, K. and Spinellis, D. Affective usability evaluation for an interactive music television channel. *ACM Computers in Entertainment*, 2(3):14, ACM Press 2004b
7. Chorianopoulos, K. and Spinellis, D. User Interface Evaluation of Interactive TV: A Media Studies Perspective. *Universal Access in the Information Society*, 5(2):209-218, Springer, 2006.
8. Clancey, M. The television audience examined. *Journal of Advertising Research*, 34(4):2-11, 1994
9. Dourish, P. *Where the Action Is: Foundations of Embodied Interaction*. MIT Press, 2002.
10. Emiliani, P.L. and Stephanidis, C. Universal access to ambient intelligence environments: Opportunities and challenges for people with disabilities. *IBM Systems Journal*, 44(3): 605-619, 2005
11. Eronen, L. Five qualitative research methods to make iTV applications universally accessible. *Universal Access in the Information Society*, 5(2): 219-238, Springer, 2006
12. Ferguson, D. A. and Perse, E. M. Media and audience influences on channel repertoire. *Journal of Broadcasting and Electronic Media*, 37(1):31-47, 1993
13. Gauntlett, D. and Hill, A. *TV Living: Television, Culture and Everyday Life*. Routledge, 1999.
14. Gill J, Perera S. Accessible universal design of interactive digital television. In *Proceedings of the 1st European Conference on Interactive Television: from Viewers to Actors?* pp 83-89, 2003.
15. Herigstad, D. and Wichansky, A. Designing user interfaces for television. In *Proceedings of the conference on CHI 98 summary : human factors in computing systems*, pages 165-166. ACM Press, 1998
16. Jenkins, H. TV tomorrow. *MIT Technology Review*, May 2001
17. Kubey, R. and Csikszentmihalyi, M. *Television and the Quality of Life: How Viewing Shapes Everyday Experiences*. Lawrence Erlbaum, 1990
18. Lee, B. and Lee, R. S. How and why people watch tv: Implications for the future of interactive television. *Journal of Advertising Research*, 35(6):9-18, 1995
19. Malone, T. W. Heuristics for designing enjoyable user interfaces: Lessons from computer games. In *Proceedings of the 1982 conference on Human factors in computing systems*, pages 63-68. ACM Press, 1982
20. McCarthy, A. *Ambient Television: Visual Culture and Public Space*. Duke University Press, 2001

21. Meuleman, P., Heister, A., Kohar, H., and Tedd, D. Double agent—presentation and filtering agents for a digital television recording system. In CHI 98 conference summary on Human factors in computing systems, pages 3–4. ACM Press, 1998
22. Mountford, S. J., Mitchell, P., O'Hara, P., Sparks, J., and Whitby, M. When TVs are computers are TVs (panel). In Conference proceedings on Human factors in computing systems, pages 227–230. ACM Press, 1992
23. Nielsen, J. Traditional Dialog Design Applied to Modern User Interfaces. *Commun. ACM*, 33(10):109-118, 1990
24. Nielsen, J. *Usability Engineering*. Morgan Kaufmann, San Francisco, 1994.
25. O'Brien J, Rodden T, Rouncefield M, Hughes J. At home with the technology: an ethnographic study of a set-top-box trial. *ACM Transactions on Computer-Human Interaction (TOCHI)* 6(3):282–308, 1999
26. Pardun, C. and Krugman, D. How the architectural style of the home relates to family television viewing. *Journal of Broadcasting and Electronic Media*, 38(2):145-162, 1994
27. Schmidt, A. Implicit Human Computer Interaction Through Context. *Personal Technologies*, 4(2), 2000.
28. Streitz, N.A., J Gei ler, T. Holmer. Roomware for Cooperative Buildings: Integrated Design of Architectural Spaces and Information Spaces, *Lecture Notes in Computer Science*, Volume 1370, pp 4 – 21, 1998
29. Stephanidis C, Akoumianakis D. Universal design: towards universal access in the information society. In CHI '01: CHI '01 extended abstracts on Human factors in computing systems, pp 499–500, 2001
30. Vorderer, P., Knobloch, S., and Schramm, H. Does entertainment suffer from interactivity? the impact of watching an interactive TV movie on viewers' experience of entertainment. *Media Psychology*, 3(4):343–363, 2001
31. Weiser, M. and J. S. Brown. The coming age of calm technology. Technical report, Xerox PARC, 1996.
32. Wildman, M. Plugged-in: homes in the information age. Unpublished MSc thesis. McGill University, Montreal, Canada, 2001
33. Zillmann, D. The coming of media entertainment. In Zillmann, D. and Vorderer, P., editors, *Media entertainment: The psychology of its appeal*, pages 1–20. Lawrence Erlbaum Associates, 2000