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User Interface Design Principles for Interactive Television Applications

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Interactive Television (ITV) applications gratify entertainment needs and leisure activities in a relaxed domestic context. Then, the mentality of efficiency and task completion implied by many user interface heuristics may not be suitable for design and expert evaluation of ITV. In line with the contemporary movement towards the design of the user experience of computing systems, a set of design principles for ITV applications has been developed. Instead of information technology, the field of communication science was explored, which has accumulated an extensive theory of TV usage and viewer behavior. For the empirical validation, the principles were employed in the design of an interactive music TV application. The results suggest that a small set of generic principles could support the systematic design of ITV applications and produce a design rationale that is traceable and comparable to alternative solutions, during the process of early product development. In addition, the principles could be refined into specific guidelines and further employed to support expert evaluation techniques.

1. INTRODUCTION

Television is an information and entertainment medium that has traditionally occupied the largest share of domestic leisure time (Zillmann, 2000). In the past few years, it has been undergoing a process of gradual technological transformation, due to digital storage, digital transmission, proliferation of alternative distribution channels, and active user participation.

Interactive Television (ITV) is a name used for a class of TV services that could transform traditional TV watching in users' living rooms. Among the most popular contemporary ITV applications are the Electronic Program Guide (EPG), which displays an interactive index to the available channels and programs, and the Digital Video Recorder, which allows easy and instant time-shift of TV

content. Although personal computer (PC) applications are based on the desktop metaphor, employ a Windows-Icons-Menus-Pointer environment, and comply with a set of user interface (UI) principles, there are no design principles for ITV applications, which are deployed in a living room setting and controlled with a small remote device form a distance.

UI principles have played an important role in guiding the design choices of interactive computer applications, which becomes evident by the many citations to the Macintosh Human Interface Guidelines report (Apple Computer, 1992) and the citations to expert guidelines, such as those by Nielsen (1994). Design guidelines have been also extended to include the domain of Web pages (U.S. Department of Health and Human Services 2006) and of DVD menus (Kappel, Tomitsch, Költringer, & Grechenig, 2006). Moreover, contemporary research has identified the differences in the UI requirements between the PC and ITV, but there are still no design principles to address the idiosyncrasies of ITV users and applications.

However useful, UI principles establish an implicit framework into designers' minds with regard to user experience goals. As a matter of fact, PC designers have been accustomed to a standard set of practices, such as desktop-based metaphors, forms, menus, direct manipulation, and so on. In addition, usability engineers employ the respective lists of UI heuristics to perform expert evaluations such as "consistency of buttons in dialog boxes," "provide shortcuts," and so on. In most cases, efficiency is a popular UI design goal, which is pursued with an effort to minimize task execution time for a specific category of users.

Is the usability mentality of task efficiency suitable for ITV applications?

For this purpose, we turn our attention to communication science, which has analyzed TV content and TV-related behavior for a long time. Many of findings contradict previous ITV approaches (Figure 1), whereas other findings reveal possible pitfalls for designers with PC experience. To assist the design of ITV applications, the results of the literature review have been formulated in a coherent list of principles.

Principles and detailed guidelines are also employed in expert evaluation and in the design of the syntactic details of the UI, such as icons, menus, dialog boxes,
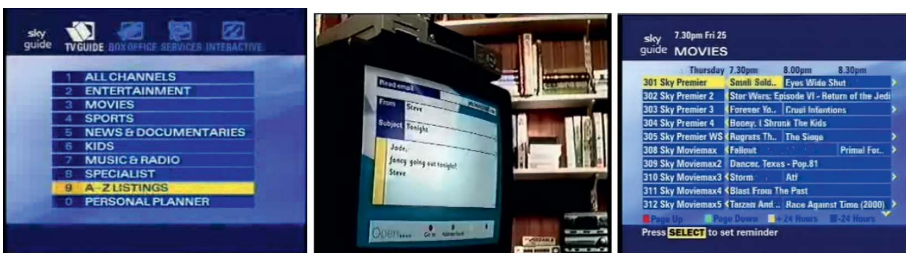

FIGURE 1 Many interactive TV applications have been designed with the "look and feel" of personal computer applications (Sky "Open" menu, e-mail, and Electronic Program Guide).

and so on. In the present study, the focus is on the role of principles in the process of early-stage ITV UI design. In future research, the refinement of the proposed principles into more specific guidelines could be used for heuristic evaluation, as well. Finally, we apply the proposed UI principles in the design of an interactive music TV application, to demonstrate their practical usefulness.

2. PRINCIPLES FOR USER INTERFACE DESIGN

Principles make UI design for new applications easier by transferring knowledge and previous experience in a condensed format, but principles are also loaded with implicit assumptions about the nature of the user experience. In turn, user experience quality depends on the application domain, the context of use, and the user characteristics and goals (Nielsen, 1994). 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 (Nielsen, 1994), such as screen design, user needs and performance, input devices, and so on. With exception of the high-level principles, it seems that the differences between PC and TV (Figure 2) suggest a need for design principles adapted to interactive TV applications.

It has been argued that most UI design principles are catholic and apply to many categories of interactive applications, but there might be exceptions in new usage paradigms (Nielsen, 1990). For example, researchers have formulated updated principles for the Web (Nielsen & Tahir, 2001, U.S. Department of Health and Human Services, 2006) as well as for the playability aspects of mobile phones (Korhonen & Koivisto, 2006). UI design principles usually stem from the extensive experience of a few HCI experts or companies (e.g., Apple, Microsoft, Nokia, Jacob Nielsen, and Donald Norman have published sets of UI design principles) or from reflective analysis of an extensive set of previous literature (e.g., U.S. Department of Health and Human Services, 2006). Differences between PC and ITV usability requirements were identified in previous HCI research (Brouwer-Janse et al., 1992; Herigstad & Wichansky, 1998; Mountford, Mitchell, O'Hara, Sparks, & Whitby, 1992), but these works have not provided any UI principles adapted to the design of ITV applications.

FIGURE 2   In addition to the contrast between lean-back versus lean-forward user posture, the TV environment considers a shared display and social activities in a relaxed domestic setting.

ITV applications are deployed in a domestic environment, and users have entertainment goals when compared to desktop computer applications, which are deployed in a work environment for productivity goals. In contrast, human–computer interaction (HCI) was mainly developed alongside the desktop PC and, as a matter of fact, most of the available principles reflect a productivity mentality instead of considering home entertainment activities.

HCI researchers have developed interest in the affective dimension of user interaction with computing systems, such as MP3 players (Hassenzahl, 2004). It is notable, that the affective movement in HCI has been motivated by the diffusion of computing systems into everyday life applications, such as listening to music and, in this study, watching TV.

The majority of previous research about ITV applications has addressed the EPG (Figure 3) and has proposed a few design guidelines for it (Baudisch & Brueckner, 2002; Bonnici, 2003; Burrnester, Koller, & Konig, 1996; van Barneveld & van Setten 2003), but there are no generic UI design principles for ITV applications. The only exception to this rule has been the effort to develop interaction design guidelines for ITV (Lu, 2005). Nevertheless, the latter describe only the syntactic level of the user interface (e.g., menu and icon design), and they have not yet been validated in an empirical way.

In general, previous approaches to the ITV applications have employed concepts, such as task efficiency and effectiveness. Several aspects of video search and navigation could be modeled after the traditional HCI tasks and goals. For example, the usability of the EPG is very similar to the usability of productivity software, because it involves more information processing than enjoyment of ITV content. Still, there are some aspects of the EPG design, and many other types of ITV applications, that would benefit by a consideration of the affective dimension of the UI. Therefore, there is a need for generic UI principles that regard the unique characteristics of emerging ITV applications.

Most notable among the recent findings for ITV applications is the realization that users' subjective satisfaction is at odds with the established notion of efficiency. A usability test of three video-skipping UIs revealed that user satisfaction
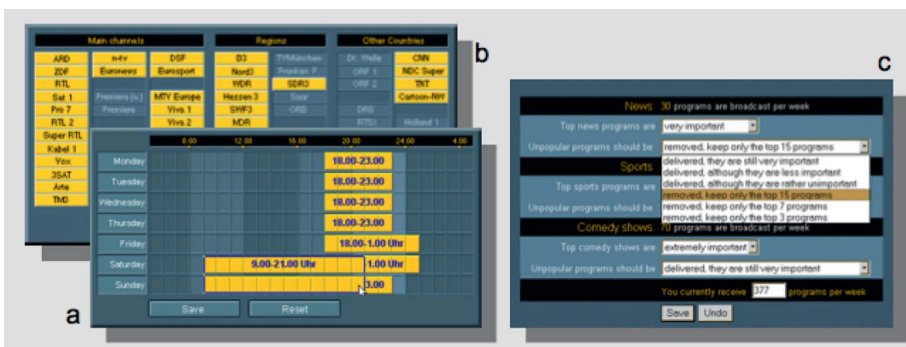

FIGURE 3   The Electronic Program Guide has been a popular theme in human–computer interaction and user modeling research (Baudisch & Brueckner, 2002).

was higher for the UI that required more time, required more clicks, and had the highest error rate. In other words, the most usable UI was not the most favored one (Drucker, Glatzer, Mar, & Wong, 2002). This result is opposite to the assumptions of the efficient usability paradigm, which conceives the efficient as more usable and thus preferable. One could not blame the designers of those efficient UIs (the widely acclaimed TiVo and ReplayTV), which have been designed according to the established UI principles (e.g., "provide shortcuts"). Nevertheless, the satisfaction questionnaires exposed that the users regarded their preferred UI as more relaxing compared to the most efficient one (Drucker et al., 2002). Then, a major research question is, Which are the principles for interactive television UI design?

HCI has been benefited by a multidisciplinary approach to design problems (Marcus, 2002). In the next section, the UI principles are formulated after a systematic and critical review of previous research in communication science and in ITV. The most useful findings have been 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.

3. DESIGN PRINCIPLES FOR ITV

In the following subsections, we examine contemporary practices as well as fallacies and pitfalls that should be avoided when designing for ITV. At the same time, the UI principles for ITV are formulated into short descriptions.

3.1. Viewer as a Director

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 better and it will be preferable. Interactivity with the user might seem as the major benefit of ITV, but this is a fallacy that designers with computer experience should overcome in the context of entertainment applications (Karat et al., 2002). Most notably, there is evidence that in some cases interactivity may be disruptive to the entertainment experience. Vorderer, Knobloch, and Schramm (2001) found that there are some categories of users who do not like to have the option to change the flow of a TV story (Figure 4); they just prefer to watch passively.

Indeed, the passive uses and emotional needs gratified by the broadcast media are desirable (Rubin, 1983). Still, there might be cases such as video games, in which the addition of interactive elements enhances the entertainment experience (Malone, 1982). Therefore, the inclusion of interactive content should be subtle and topical (e.g., closely related to the running content). A starting point would be to make interactive versions for most of the information that is embedded in the video signal at the TV studio. For example, users could control the display of sports statistics, vote, play-along the players of quiz games, or customize news and stock-market tickers (Figure 5). As a principle, *empower the viewer with features borrowed from a TV production studio*.

FIGURE 4 The show 'Pyramid Challenge' by BBCi encourages the viewer to get in the place of the main hero, to make choices, and to follow alternative paths inside a storyline.

FIGURE 5 On-demand sport statistics (TVC), music video clip trivia (MTV), and voting (NDR) bring the control of popular and familiar features from the TV studio directly into viewers' homes.

3.2. Infotainment

Similar to the fallacy of interactivity, many ITV applications support the presentation of generic information on the screen, instead of considering the augmentation of the entertainment experience. Although TV offers a wide variety of content that spans from pure entertainment to pure information, the content is usually presented in a captivating way, regardless of the type (e.g., documentary, news). From a media psychology perspective the entertainment experience is largely subjective, so the value of piece of ITV content is difficult to be determined in advance (Vorderer, 2000).

Therefore, it is suggested to employ informational elements to augment entertainment content (Livaditi, Vassilopoulou, Lougos, & Chorianopoulos, 2003). For example, a music video channel could insert interactive information related to the video clips, such as trivia, discography, or motivate direct sales and downloads of music. Furthermore, a quiz game might introduce an ITV application that allows viewers to play along with the contestants in the studio, to compete in the home or over a distance (Figure 6). As a principle, designers should *provide interactive entertainment elements or on-demand information elements that match the main TV content*.

FIGURE 6   Quiz games such as *Who Wants to Be a Millionnaire* have been a straight-forward domain for adding interactivity with the audience. The Living TV channel on Sky offers on-demand horoscopes, which matches the gossip, celebrity, and paranormal programming of the channel.

3.3. Participatory Content Authoring

Traditionally, the content follows a hierarchical flow from the professional studio to the broadcaster to the user. In that case, the end-user had limited interactivity, such as channel changing. In the 1990s, the red button era came along, which offered browsing of information pages. Contemporary research regards that the viewer is not the end of the content value chain. Instead, the viewer is considered to be a node in the production–distribution–consumption chain. In this way, the user can play different roles: distributor or even producer of content (Figure 7).

The success of Web sites that distribute users' content (e.g., YouTube) has demonstrated that end-users want to change the way they find and consume audiovisual media. Researchers have been developing novel ITV systems that allow users to create their own media and share it (Figure 7). For example, Goularte et al. (2004) presented an MPEG-4 system, which allows the end-user to
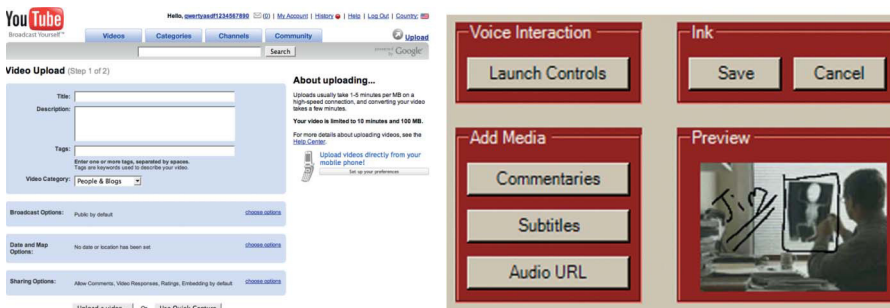

FIGURE 7   Hierarchical top-down content distribution has been disrupted with end-user content uploading (YouTube) and TV content enrichment (Cesar et al., 2006).

enrich television content. Cesar, Bulterman, and Jansen (2006) developed a similar system by employing Synchronized Multimedia Integration Language as the content modeling format. Therefore, designers should *involve the user in lightweight content editing, such as annotations and virtual edits*.

3.4. Diverse Content Sources

Despite the negative critique on the EPG, there might be good reasons to include similar applications in an ITV system. The fact that some of TV viewing is considered to be "ritualistic" (Rubin, 1984) does not preclude the exploitation of out-of-band techniques for collecting the content at user's premises. Then, additional dynamic information from the Internet could be combined with broadcast data. Broadcast distribution is only suitable for the delivery of high-demand, high-bit rate items, which have a real-time appeal (e.g., popular sport events, news, movies). The majority of the TV content and the complementary information could be delivered over broadband networks. For example, an EPG could be employed to reschedule the showtime of a favorite family show into a more convenient time and day that fits that family's particular schedule (e.g., during dinnertime 1 day later; Figure 8).

Overall, there are many opportunities to enhance the TV content, beyond the broadcast delivery. Designers should justify the use of persistent local storage and broadband Internet connections, which are becoming standard into many ITV products (e.g., media center boxes). Digital local storage technology takes viewer control one big step farther—from simple channel selection with the remote—by offering convenient time-shifting through content. As a principle, designers should try to *release the content from the fixed broadcast source 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 information and video content.

3.5. Social Viewing

Just like PC input devices, TV sets come with one remote control, which excludes the possibility for interactivity to all but the one who keeps the remote control.

FIGURE 8 The popular TiVo system (a combination of set-top box and service) always provides a choice of prerecorded content and suggestions about what to watch, based on collaborative filtering. Information related to the running program is placed in a semitransparent box that does not distract viewing.

Despite this shortcoming, TV usage has been always considered a social activity (Gauntlett & Hill, 1999, p. 35) and it might provide a better experience when watched with family members (Kubey & Csikszentmihalyi, 1990, p. 111). In contrast, PC usage is mostly solitary, 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. Indeed, a study of an ITV adaptive instructional program confirmed that people tend to choose the TV content that would fit the preferences of a certain group of viewers (Masthof, 2004).

Group adaptation has been also studied for the case of movie genres, and it was found that for a given group of people the recommended TV content was better liked when the system considers the profiles of the respective group (Goren-Bar & Glinansky, 2002). Social viewing has been also taken one step further to include situations of interpersonal communication over a distance (Figure 9), during synchronous media consumption (Regan & Todd, 2004). Therefore, designers should *consider social viewing and opportunities for social communication that might take place locally, or remotely*. For example, an ITV quiz game might provide opportunities for competition between family members, or remote users and drama series should provide facilities for online community building along the storyline of the broadcast (Abreu, Almeida, & Branco, 2002).

3.6. TV Grammar and Aesthetics

A common pitfall, which has been sometimes encouraged by authoring tools, is the employment of UI widgets that have been derived from the PC and the Web programming toolkits, such form buttons, icons, and links (Chorianopoulos & Spinellis, 2004). In contrast, it has been established that ITV producers prefer a TV-values information design and story-driven content (Jaaskelainen, 2001). An additional difficulty in the domain of ITV UI design is the interface's inability to stay attractive over time. One remedy is that novel TV and Internet technology should be employed within familiar visual structures and should match user behavior.

FIGURE 9   Joost provides instant messages, chat over a distance, and user groups organized around TV content. AmigoTV by Alcatel employs avatars or photos to represent distant viewers.
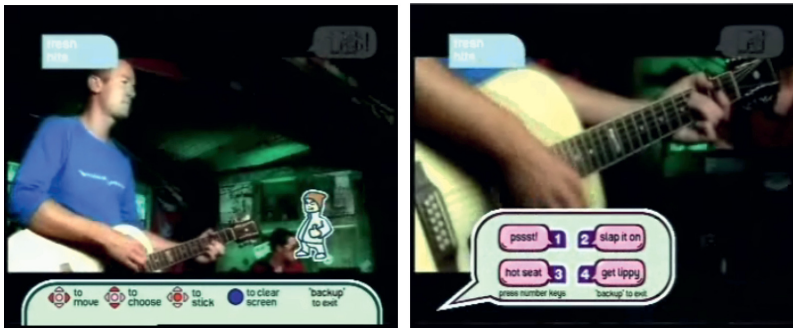
FIGURE 10 Electronic stickers that can be selected and placed over music video clips are hardly any useful, but they are very suitable for the audience of MTV. The main menu of that application does not follow any particular dialog design guidelines, but it might follow the aesthetics of the MTV audience.

TV audiences have become familiar with a visual grammar that requires all programs, as well as presentation styles to be dynamic and surprising (Meuleman, Heister, Kohar, & Tedd, 1998), which is in sharp contrast with the traditional usability principle of consistency (Nielsen, 1994). 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 (Figure 10). Instead, it could be an animated character, which features multimodal behaviors (e.g., text, motion, speech). Furthermore, user selections that activate scene changes should be performed in accordance with the established TV visual grammar (e.g., dissolves, transitions, fade-outs).

3.7. Relaxed Navigation

During the 1990s there was a lot of speculation about the 500 channels future of ITV. At that time, communication scientists were reporting that viewers recall fewer than a dozen of TV channels (Ferguson & Perse, 1993). Nevertheless, it has also been established that new technologies, such as remote controls, video recorders, cable television, and the EPG, have increased the channel repertoire of TV viewers (Ferguson, 1992; Kang, 2002). Therefore, it could be expected that the distribution of video over the Internet will increase the choice of content, and thus it demands enhanced content navigation support. For this purpose, the 500-channels future was turned upside-down by the user modeling research community, which put forward the vision of a single personalized channel. Nevertheless, it is acknowledged that TV content is a placeholder for discussion (Lull, 1980) and, thus, personalization reduces the chances that any two might have watched the same program (Figure 11).

The study of TV consumption in the home has revealed that in some cases TV watching is a planned activity, which is a finding that contrasts with the monolithic focus on the EPG (personalized or not) as a method to select a program to watch each time a user switches on the TV. On one hand, a fraction of the viewers

FIGURE 11 An EPG does not have to take over the whole screen and it could also allow relaxed navigation through the information on available channels without changing the current one (Burrnester et al., 1996). In addition, an EPG could employ additional modalities, such as 3D, summarization (Drucker et al. 2002), and time-based navigation (Pittarelo, 2002).

impulsively selects a program to watch, especially among the younger demographic (Gauntlett & Hill, 1999). On the other hand, there is also a need to support familiarity with a small set of channels (Chorianopoulos, 2004). As a consequence, designers should assume that most TV viewing starts with familiar content, but it might continue with browsing of relevant items. As a principle, *instead of information seeking, support relaxed exploration.* Therefore, content navigation support should be subtle and not be enforced to the users. For example, there could be a hardwired remote control button for changing the flow of the running program (e.g., channel-up or down), in which the channel browsing brings the user to thematically adjacent content, instead of switching to a preprogrammed channel position.

3.8. 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 (2001) opposed 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." Indeed, an ITV study has empirically confirmed the existence of readers and skimmers, as two distinct groups of TV viewers (Cappelletti, Nardon, Pianesi, & Zancanaro, 2003). Furthermore, the availability of small broadband multimedia devices (Figure 12) has allowed the development of mobile interactive TV (Knoche & McCarthy, 2005) and the development of multimodal systems that split the user interface over multiple screens (Robertson, Wharton, Ashworth, & Franzke, 1996).

Lee and Lee (1995) suggested 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 (Clancey, 1994). These findings contrast "the image of the highly interactive viewer intently
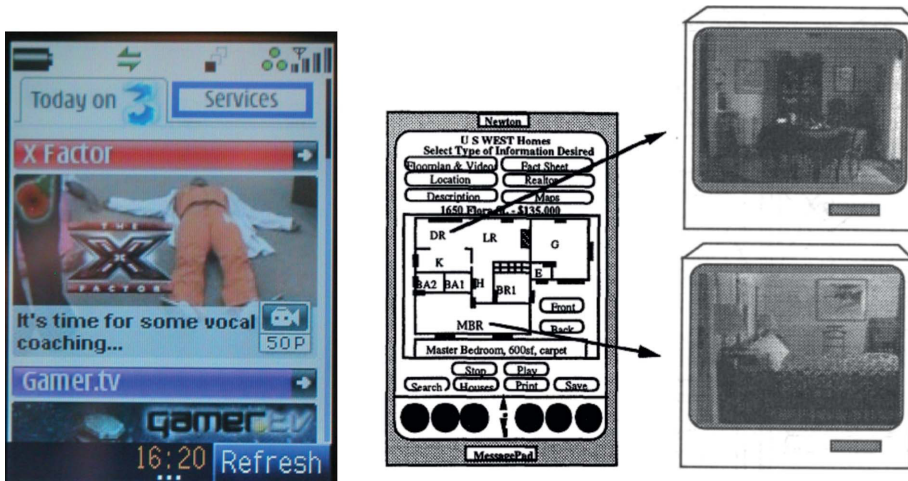
FIGURE 12   The ITV experience might also take place on the move (Knoche & McCarthy, 2005) or on complementary devices (Robertson et al., 1996).

engaged with the television set that is often summoned up in talking about new possibilities" (Lee & Lee, 1995, p. 12). Instead of assuming a user, who is eager to navigate through persistent dialog boxes, designers should consider that *users might have varying levels of attention to the main display device, or to the complementary ones*.

3.9. Summary of Principles

The design principles have been assembled in a way that addresses many aspects of UI design for ITV, such as features, "look and feel," and audience behavior. Moreover, the principles have been named and described in a way that outlines the design space. In this way, the principles might be suitable for a wide range of ITV applications. The design principles are organized in two categories that define the following:

1. *Which* are the most suitable features for interactive TV applications:

   - Viewer as a director
   - Infotainment
   - Participatory content authoring
   - Diverse content sources

2. *How* to design user experience that supports the novel features:

   - TV grammar and aesthetics
   - Relaxed navigation
   - Social viewing
   - Multiple levels of attention

4. EXAMPLE APPLICATION: INTERACTIVE MUSIC TELEVISION

The music video clip is a commercially successful, popular, and worldwide available format of TV content, which has been established by the 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, and since they started broadcasting in 1981, there have been many followers, even in different program types. MTV has also been 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 TV is redesigned as an ITV application, by addressing the proposed design principles.

- *Viewer as a director*: Music TV producers enhance the programs with song- and artist-related trivia, which could be inserted dynamically at the user's premise. In this case, the viewer is empowered with control of (a) music video skipping and (b) on-demand song information.
- *Infotainment*: The entertaining effect of music TV watching is enhanced with additional information about the music video clips, which could be browsed at the user's convenience, or left running along the video.
- *Participatory content authoring*: The audience of a music TV channel could be offered raw video material and create own versions of the video clips, which could be further shared with friends or submitted to competitions.
- *Diverse content sources*: 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 favorite music video clips from local storage and setting preference categories for prefetching. A virtual TV channel is created by arranging accessible content (video clips and ancillary data on local storage and Internet resources) in playlists and by retrieving additional content (audiovisual or textual).
- *TV grammar 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 (Figure 13). There is also an option to display the related information with a semitransparent overlay, instead of the animated character. The animated character offers many opportunities for additional features. For example, it might react to the mood of the song, or it could play the role of an avatar for remote users.
- *Relaxed navigation*: The main objective in the design of a captivating ITV application is to offer relaxed control. 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, and decade. Textual information about a
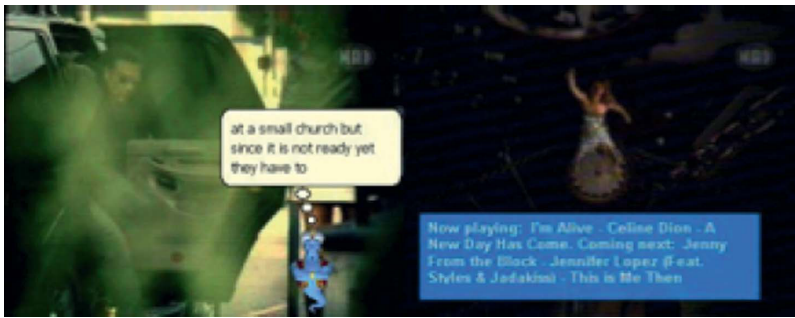
FIGURE 13   Interactive graphics are embedded into the video, thus supporting TV grammar and aesthetics.

FIGURE 14   Music video selection allows the user to direct the (otherwise) continuous flow of the program, thus supporting multiple levels of attention.

music video clip can be browsed sequentially or could be organized in categories, such as biography, discography, trivia, and so on.

- *Social viewing*: Music 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 might 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 (Figure 14). Overlay information appears automatically, but the user might also navigate on demand music video information.

This section demonstrated how an ITV application was designed by addressing the principles. Moreover, it portrays that the principles could also be used to describe the behavior of that application, long before actual implementation, and even before an early prototype has been constructed.

5. CONCLUSION

The intuition and the experience of each UI designer might translate the same UI principles into different solutions, depending on other factors, such as business and technical requirements. In this research, the UI principles were addressed in

an ITV prototype that has been tested with users (Chorianopoulos & Spinellis, 2004b).

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 (Baecker, Grudin, Buxton, & Greenberg, 1995, p. 313). Accordingly, the proposed principles have been implemented in a UI programming toolkit, which was exploited to develop the example interactive music video application (Chorianopoulos & Spinellis, 2004). Test users evaluated the application very positively, when compared with traditional fixed music video TV (Chorianopoulos & Spinellis, 2004b). Further research could consider enhancements to the music TV prototype or other types of TV content.

The proposed set of ITV UI principles (Table 1) was presented as a list of high-level and generic design factors, which describe the design space of feasible ITV applications. Still, there might be UI principles, which are specific and concern particular parts of the interaction, such as video overlays, transitions, sociability, participatory content authoring, multiple devices, and so on. 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

Table 1:   User Interface Design Principles for Interactive Television Applications

Applications	Principle Name	Principle Description
Interactive TV features	Viewer as a director	Empower the viewer with features borrowed from a TV production studio
	Infotainment	Provide interactive entertainment elements, or on-demand information elements that match the main TV content
	Participatory content authoring	Involve the user in lightweight content editing, such as annotations and virtual edits
	Diverse content sources	Release the content from the single and fixed broadcast source and augment it with out-of-band content delivery
Interactive TV experience	TV grammar and aesthetics	Enhance the core and familiar TV elements (characters, stories) with programmable behaviors (objects, actions)
	Relaxed navigation	Instead of information seeking, support relaxed exploration
	Social viewing	Consider social viewing and opportunities for social communication that might take place locally, or remotely
	Multiple levels of attention	There are varying levels of attention to the main display device or to complementary ones

transformed to a guideline such as "remove a dialog box, if the user does not interact with the TV system after 5 seconds."

Further research should refine the proposed set of UI principles into longer lists of more specific principles and guidelines for particular types of ITV applications. Notably, there are some product manufacturers that employ fine-tuned guidelines into the design of their products (Marcus, 2005), but this is not a common practice.

Overall, the proposed principles facilitate the design process of interactive TV prototypes. In particular, they facilitate the description of the design rationale, thus making the alternative, or progressive design decisions traceable and comparable. Designers might use them to make decisions that regard important aspects of the interaction. In addition, the principles might be used to evaluate early prototypes. In conclusion, the main thesis of this article is that novel TV and Internet technology should be actively employed within familiar visual structures and it should offered in a way that matches established TV viewer behavior.

REFERENCES

Abreu, J., Almeida, P., & Branco, V. (2002). 2BeOn: interactive television supporting interpersonal communication. In *Proceedings of the Sixth Eurographics Workshop on Multimedia 2001* (pp. 199–208). New York: Springer-Verlag.

Apple Computer. (1992). *Macintosh human interface gGuidelines*. Reading, MA: Addison-Wesley.

Baecker, R. M., Grudin, J., Buxton, W. A., & Greenberg, S. (1995). *Human-computer interaction: Toward the year 2000* (2nd ed.). San Francisco: Morgan Kaufmann.

Baudisch, P., & Brueckner, L. (2002). TV scout: Guiding users from printed TV program guides to personalized TV recommendation. *Proceedings of the 2nd workshop on personalization in Future TV*, pp. 157–166.

Bonnici, S. (2003). Which channel is that on? A design model for electronic programme guides. *Proceedings of the 1st European Conference on Interactive Television*, 49–57.

Burrnester, M., Koller, F., & Konig, T. (1996). A user interface for interactive pay TV: PREMIERE goes online. *Proceedings of ITV Conference*.

Cappelletti, A., Nardon, M., Pianesi, F., & Zancanaro, M. (2003). Readers and skimmers watching ITV: Evidences from interactive video-on-demand. In *Proceedings of the 3rd Workshop on Personalization in Future TV*, pp. 32–41.

Cesar, P., Bulterman, D. C. A., &Jansen, A. J. (2006). An architecture for end-user TV content enrichment. *Journal of Virtual Reality and Broadcasting, 3*.

Chorianopoulos, K. (2004). *Virtual television channels: Conceptual model, user interface design and affective quality evaluation*. Unpublished PhD thesis, Athens University of Economics and Business, Athens, Greece.

Chorianopoulos, K., & Spinellis, D. (2004). User interface development for interactive television: Extending a commercial DTV platform to the virtual channel API. *Computers and Graphics*, 28(2), 157–166.

Chorianopoulos, K., & Spinellis, D. (2004b). Affective usability evaluation for an interactive music television channel. *ACM Computers in Entertainment, 2*(3), 14.

Clancey, M. (1994). The television audience examined. *Journal of Advertising Research, 34*(4), 2–11.

Drucker S. M., Glatzer A., Mar, S. D., & Wong C. (2002). Smartskip: Consumer level browsing and skipping of digital video content. *Proceedings of the SIGCHI conference on Human Factors in Computing Systems*, 219–226.

Ferguson, D. A. (1992). Channel repertoire in the presence of remote control devices, VCRs, and cable television. *Journal of Broadcasting & Electronic Media, 36*, 83–91.

Ferguson, D. A., & Perse, E. M. (1993). Media and audience influences on channel repertoire. *Journal of Broadcasting and Electronic Media, 37*(1), 31–47.

Gauntlett, D., & Hill, A. (1999). *TV Living: Television, culture and everyday life*. New York: Routledge.

Goren-Bar, D., & Glinansky, O. (2002). Family stereotyping—A model to filter TV programs for multiple viewers. *Proceedings of the 2nd Workshop on Personalization in Future TV*, pp. 101–108.

Goularte, R., Cattelan, R. G., Camacho-Guerrero, J. A., Inácio, V. R., da Graça C., & Pimentel, M. (2004). Interactive multimedia annotations: enriching and extending content. In *Proceedings of the 2004 ACM Symposium on Document Engineering (DocEng '04)* (pp. 84–86). New York: ACM Press.

Hassenzahl, M. (2004). The interplay of beauty, goodness, and usability in interactive products. *Human–Computer Interaction, 9*(4), 319–349.

Herigstad, D., & Wichansky, A. (1998). Designing user interfaces for television. In *Proceedings of the Conference on CHI 98 Summary: Human Factors in Computing Systems* (pp. 165–166). New York: ACM Press.

Jaaskelainen, K. (2001). *Strategic questions in the development of interactive television programs*. Unpublished PhD thesis, University of Art and Design Helsinki, Helskini, Finland.

Jenkins, H. (2001). TV tomorrow. *MIT Technology Review*. http://www.technologyreview.com/Energy/12386 (last accessed: June, 2008).

Kang, M. H. (2002). Interactivity in television: Use and impact of an interactive program guide. *Journal of Broadcasting and Electronic Media, 46*(3), 330–345.

Kappel, K., Tomitsch, M., Költringer, T., & Grechenig, T. (2006). Developing user interface guidelines for DVD menus. In *CHI '06 Extended Abstracts on Human Factors in Computing Systems (CHI '06)* (pp. 177–182). New York: ACM Press.

Karat, C., Karat, J., Vergo, J., Pinhanez, C., Riecken, D., & Cofino, T. (2002). That's entertainment! Designing streaming, multimedia Web experiences. *International Journal of Human–Computer Interaction, 14*(3&4), 369–384.

Knoche, H., & McCarthy, J. D. (2005). Design requirements for mobile TV. In *Proceedings of the 7th International Conference on Human Computer interaction with Mobile Devices & Services (MobileHCI '05)* (pp. 69–76). New York: ACM Press.

Korhonen, H., & Koivisto, E. M. (2006). Playability heuristics for mobile games. In *Proceedings of the 8th Conference on Human-Computer interaction with Mobile Devices and Services (MobileHCI)* (pp. 9–16). New York: ACM Press.

Kubey, R., & Csikszentmihalyi, M. (1990). *Television and the quality of life: How viewing shapes everyday experiences*. Hillsdale, NJ: Erlbaum.

Lee, B., & Lee, R. S. (1995). How and why people watch TV: Implications for the future of interactive television. *Journal of Advertising Research, 35*(6), 9–18.

Livaditi, J., Vassilopoulou, K., Lougos, C., & Chorianopoulos, K. (2003). Needs and gratifications for interactive TV applications: Implications for designers. In *Proceedings of the HICSS 2003 Conference*.

Lu, K.Y. (2005). *Interaction design principles for interactive television*. Unpublished MSc thesis, Georgia Institute of Technology, Atlanta, Georgia.

Lull, J. (1980). Family communication patterns and the social uses of television. *Communication Research, 7*(3), 319–333.

Maddy D., Brower-Janse, Raymond W. Bennett, Takaya Endo, Floris L. van Nes, Hugo J. Strubbe, Donald R. Gentner. (1992). *Interfaces for consumer products: how to camouflage the computer*. *CHI*, pp. 287–290.

Malone, T. W. (1982). Heuristics for designing enjoyable user interfaces: Lessons from computer games. In *Proceedings of the 1982 Conference on Human Factors in Computing Systems* (pp. 63–68). New York: ACM Press.

Marcus, A. (2002). Chi as a cross-tribal community. *interactions, 9*(4), 31–35.

Marcus, A. (2005). The out-of-box home experience: Remote from reality. *Interactions, 12*(3), 54–56.

Masthoff, J. (2004). Group modeling: Selecting a sequence of television items to suit a group of viewers. *User Modeling and User-Adapted Interaction, 14*(1), 37–85.

Meuleman, P., Heister, A., Kohar, H., & Tedd, D. (1998). Double agent—Presentation and filtering agents for a digital television recording system. In *CHI 98 Conference Summary on Human Factors in Computing Systems* (pp. 3–4). New York: ACM Press.

Mountford, S. J., Mitchell, P., O'Hara, P., Sparks, J., & Whitby, M. (1992). When TVs are computers are TVs (panel). In *Conference Proceedings on Human Factors in Computing Systems* (pp. 227–230). New York: ACM Press.

Nielsen, J. (1990). Traditional dialog design applied to modern user interfaces. *Communications of the ACM, 33*(10), 109–118.

Nielsen, J. (1994). *Usability engineering*. San Francisco: Morgan Kaufmann.

Nielsen, J., & Tahir, M. (2001). *Homepage usability: 50 Websites deconstructed.* Berkeley, CA: New Riders Press.

Pittarello, F. (2002). Time-pillars: A 3D cooperative paradigm for the TV domain. *Proceedings of the AH2002 Workshop on Personalization in Future TV*, pp. 147–156.

Regan, T., & Todd, I. (2004). Media center buddies: Instant messaging around a media center. In *Proceedings of the Fourth Nordic Conference on Human-Computer Interaction* (pp. 141–144). New York: ACM Press.

Robertson, S., Wharton, C., Ashworth, C., & Franzke, M. (1996). Dual device user interface design: PDAs and interactive television. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '96)* (pp. 79–86). New York: ACM Press.

Rubin, A. (1983). Television uses and gratifications: The interaction of viewing patterns and motivations. *Journal of Broadcasting & Electronic Media, 27*(1), 37–51.

Rubin, A. M. (1984). Ritualized and instrumental television viewing. *Journal of Communication, 34*(3), 67–77.

U.S. Department of Health and Human Services. (2006). *Research-based Web design and usability guidelines.* Washington, DC: Author.

van Barneveld, J., & van Setten, M. (2003). Involving users in the design of user interfaces for TV recommender systems. In *3rd Workshop on Personalization in Future TV*, pp. 22–26.

Vorderer, P. (2000). Interactive entertainment and beyond. In D. Zillmann & P. Vorderer (Eds.), *Media entertainment: The psychology of its appeal* (pp. 21–36). Mahwah, NJ: Erlbaum.

Vorderer, P., Knobloch, S., & Schramm, H. (2001). Does entertainment suffer from interactivity? The impact of watching an interactive TV movie on viewers' experience of entertainment. *Media Psychology, 3*(4), 343–363.

Zillmann, D. (2000). The coming of media entertainment. In D. Zillmann & P. Vorderer (Eds.), *Media entertainment: The psychology of its appeal* (pp. 1–20). Mahwah, NJ: Erlbaum.