Affective Usability Evaluation for an Interactive Music Television Channel

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Computer-mediated television brings new requirements for user interface design and evaluation, since interactive television applications are deployed in a relaxed domestic setting and aim to gratify the need for entertainment. Digital video recorders, the generation of custom computer graphics on each digital set-top box, and the introduction of new advertising formats are important issues for research and practice. We explore the employment of an animated character and the dynamic insertion of advertising in the design of an intuitive user interface for interactive music-video television. We found that the animated character and the skippable video-clip feature seamlessly enhanced consumer satisfaction, as shown by affective usability questionnaires.

Categories and Subject Descriptors: H.1.2. [**Models and Principles**]: User/Machine Systems--*Human factors*; H.5.2 [**Information Interfaces and Presentation**]: User Interfaces--*Interaction styles; Prototyping; Screen design; User-centered design; Input devices and strategies;* H.5.1 [**Information Interfaces and Presentation**]: Multimedia Information Systems—*Video;* J.7 [**Computer Applications**]: Computers in Other Systems--*Consumer products*

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1. INTRODUCTION

Computer-mediated entertainment (CME) is emerging as a major economic force and scientific subject. In the past, military and space exploration drove scientific innovation that later became consumer products (like the PC and the Internet). More recently, forms of CME (e.g., video games) have been the main drivers of innovation, later applied to areas like scientific visualization, simulation, and education [Rosenbloom 2003].

Besides its scientific importance, CME has emerged as a major economic factor in the media industry (cinema, video rentals, music, books, radio, television), taking-up a large portion of consumer spending and leisure time. In particular, television, which has traditionally occupied the largest share of consumer leisure time, is now undergoing a process of technological transformation. Digital set-top boxes (STBs) and digital video recorders (DVRs) provide the platforms for new interactive television (ITV) applications. We employed the Virtual Channel user interface [Chorianopoulos and Spinellis 2004] in the implementation of an ITV application that allows the user to ask for information (e.g., trivia, current programs, coming attractions, etc.) and to browse through music video clips. Traditional human-computer interaction (HCI) settings, in contrast to computer-

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mediated leisure applications, involve a task-oriented approach where the human interacts with an application to accomplish a particular goal. The different environment and goals of computer-mediated leisure applications require a fresh view of current interaction paradigms. There is growing evidence that traditional desktop usability principles do not account for the pleasure of the user experience [Hassenzahl et al. 2000]. Affective usability studies provide an alternative idea of user goals such as enjoyment and relaxation [Hassenzahl et al. 2001; Draper 1999]. In light of the above, we employed an affective usability instrument to evaluate an interactive music television prototype.

The rest of this article is organized as follows: The next section presents a critical review of ITV application research, focusing on animated characters and video skipping. In Section 3 these features are used in a music ITV application and in an evaluation by consumers. Section 4 presents the results and discusses the usability evaluation test for each one of the ITV application's features. In the last section we present the implications of the study's findings for the media industry.

2. USER INTERFACES FOR INTERACTIVE TELEVISION

Previous HCI research about ITV was mainly focused on the design of the electronic program guide (EPG), and rarely considered the enhancement of the TV content. In particular, previous research approached ITV from a technological perspective [Carey 1997], and did not consider the ITV user as a TV viewer [Carey 1999]. While there have been numerous approaches for the design of ITV applications, few have focused on enhancing a traditional TV program type with only a standard remote control and a TV screen in a relaxed setting. We chose to study music video television, which is a commercially successful, popular, and widely available format. Music video clips have a long lifespan--compared to TV news, for example--which makes the experimental set-up and usability evaluation more convenient.

Video navigation for digitally stored video has been an active research area from the beginning of the 1990s. However, few researchers have studied the consumer UI for digital video libraries. The corresponding research is typically done from the perspective of the TV author and producer [Wactlar et al. 1999]. Researchers, for example, assume that users of digital video libraries sit in front of a desktop computer, which, by employing a typical PC GUI, can display tens of thumbnails and video sources at the same time. These assumptions break down in a living room where the user is far from a low-resolution TV and interacts with a remote control. A traditional comparative usability evaluation revealed that consumers prefer a UI perceived as fun and relaxing to use, although it was the worst in terms of efficiency and effectiveness [Drucker 2002]. Therefore, a consumer-level UI for video-skipping should be evaluated with affective usability methods, taking attributes like enjoyment and relaxation into account. Furthermore, there is no existing research on digital video navigation in close relationship with a specific type of TV content, such as music TV.

Animated characters in desktop computing have been widely studied, but the respective commercial implementations (most notably the infamous Microsoft Office Clip) are reported as annoying to end-users [Catrambone 2002; Schaumburg 2001]. An explanation might be that the attention-grabbing and interruption-prone nature of animated characters is inappropriate for productivity applications in a work context. On the other hand, television content has traditionally been about stories and character development [Lee and Lee 1995]. So animated characters might be viable in a domestic

leisure activity like watching television. In fact, there is evidence that animated characters are suitable in the entertainment domain: users liked and were more engaged with the UI version of an interactive game that displayed a face depicting the opponent player [Koda and Maes 1996]. Animated characters were also used in a consumer electronics application to set the right level of expectation and make errors from a recommendation engine more acceptable [Diederiks 2003]. Yet there are no available affective usability evaluations that compare animated characters with traditional presentations for television applications.

Leaving aside questions of content quality, some current interesting research on interactive television (ITV) interface design concern: (a) EPG navigation, (b) local storage navigation, and (c) presenting related information with an animated character. In this article we examine the last two issues by means of an affective usability evaluation of an ITV prototype.

3. A PROTOTYPE INTERACTIVE MUSIC TELEVISION CHANNEL

We designed and implemented an application that uses local storage to enable a television viewer to skip a music video clip. Commercial DVRs offer a 30-second skip button, but content and network providers are reluctant to adopt an STB technology that neglects their main revenue source (advertising), and are interested in alternative forms of television advertising. For example, TiVo is offering a special space ("TiVo Showcase"), where advertisers can store their ads and users can watch them on-demand. Alternatively, short ads (5 to 10 seconds) or video clip-like ads might be a choice when users skip recorded content; although a subscription service may still be ad-free. Synthesizing these options, we designed a video clip-skipping feature that inserts an ad before the next video clip begins (Figure 1). Unless the clip-skip button is pressed, there is a continuous flow of music video, just like normal music video television.

In addition to the video clip-skip, we also used the dynamic video-overlay property of our Virtual Channel programming library [Chorianopoulos and Spinellis 2004] to superimpose information over the music video. The MTV channel typically identifies the music video that plays next, a feature we made interactive by allowing the user to ask for "what is playing now and what comes next" on-demand. The dynamic insertion of information related to the music video raises the issue of presentation style. We implemented and tested two alternative presentation styles: (a) the traditional MTV information box and (b) an animated character with a balloon dialog box (Figure 3).

Experimental set-up. The central element in our experimental set-up is a portable PC running Microsoft Windows XP. We developed the prototype in VB.NET using the Virtual Channel programming library [Chorianopoulos and Spinellis 2004] and set the system to simulate a consumer ITV appliance. The PC's ATI display software was

Fig. 1. Interactive music video television channel with dynamic advertisement insertion.

Fig. 2. Low-budget setup for interactive television usability evaluation.

configured in the extended desktop setting (the desktop area extends beyond the PC monitor to the TV, connected through the TV-out port) and the ITV prototype was set to display on the TV (second monitor). Then the PC's TV and audio output ports were connected to the audio-visual inputs of a traditional analog TV set. The ITV application was designed to run in full-screen window-less mode, so that there was no visible indication of the underlying desktop environment. After starting the ITV prototype, we closed the portable PC's lid and placed it away from the TV.

To support relaxed control with a normal TV remote control, the PC's serial port was connected to an infrared sensor (http://www.evation.com/irman/) that receives signals from the remote control. The sensor's software driver and supporting applications were used to map the remote control's buttons to specific keyboard buttons. The whole set-up is unobtrusive and seamless to the television viewer (Figure 2). It also lets the experimenter do evaluations in consumer homes by using the familiar TV set and remote controls.

Experimental design. Traditional human-computer interaction settings involve a task-oriented approach where the human interacts with an application to accomplish a particular goal. Accordingly, usability evaluation techniques measure successful task completion, efficiency, and error-rate parameters that correlate positively with user satisfaction. Most notable among the recent findings about ITV applications is the realization that users' subjective satisfaction is at odds with performance metrics. For example, a usability test of three video-skipping interfaces (two commercial and one novel) revealed that user satisfaction is higher for an interface that required more time, more clicks, and had the highest error rate. In other words, the most usable interface was not the one most users preferred. Users justified their choice on the basis of the fun and relaxation offered by the interface [Drucker 2002].

Hence, in the context of CME, alternative criteria such as fun, trust, and engagement have been proposed [Draper 1999]. Pleasurable user experience [Hassenzahl et al. 2000] and consumer emotion [Desmet 2003] are the most relevant criteria in our setting**.** We

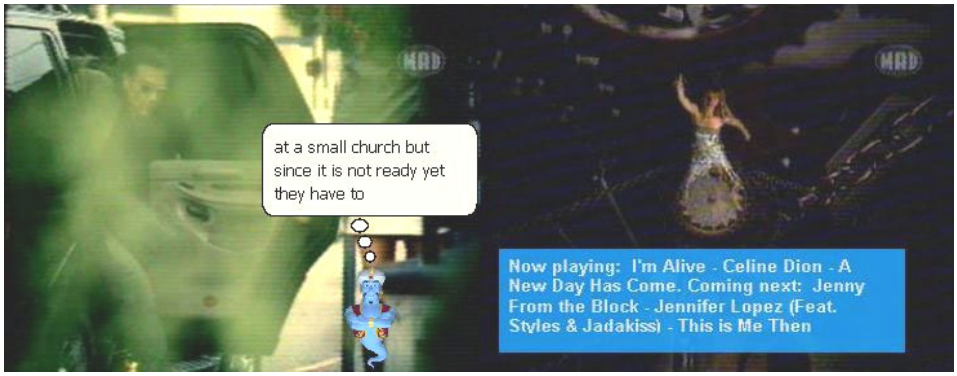

Fig. 3. The animated character (on the left, using the Microsoft Genie) and the traditional transparent box (on the right) for displaying dynamic video overlays.

chose the Hassenzahl et al. [2001] affective usability-measuring instrument because it is validated, freely available, short, and features an easy-to-understand verbal scale.[†] Furthermore, a fulfilling television experience depends on the subjective evaluations of its entertainment value [Lee and Lee 1995], a characteristic partially captured by the construct of Hedonic Quality.

The objective is to evaluate user preferences for an ITV application that offers clip-skipping and an animated character to present information. The experiment was designed to address two of the main issues in interactive television user interface design: (a) navigating local video storage through simple video clip track-skipping and (b) providing related information through alternative presentation styles. We were also interested in consumer preferences regarding dynamic ad insertion when users choose to skip a music video clip. We formulated our objectives in the following research hypotheses.

- *Hypothesis* 1. There is greater Hedonic Quality in using a clip-skipping TV channel than a fixed one.
- *Hypothesis* 2. For presenting related information, there is greater Hedonic Quality in watching an animated character than a transparent information box.
- *Hypothesis* 3. Consumers who use an ITV application with a video clip-skipping user interface with dynamic advertisement insertion will be exposed to more advertisements than in a corresponding linear TV schedule.

Each participant received two experimental treatments (within groups) of the user interface: (1) the animated character and (2) the transparent box; both set-ups offered

[*†] We used a seven-point semantic differential scale and reversed the polarity of every other pair: outstanding-second rate, standard-exclusive, impressive-nondescript, ordinary-unique, innovative-conservative, dull-exciting, interesting-boring. Scores were summed and then scaled from 0 to 10.

video clip-skipping with ad insertion. After each session, participants separately evaluated the "pleasurable" qualities of (a) traditional music-video television (all participants were frequent viewers of music TV); (b) music-video television with clip-skipping; (c) information presented in a transparent box; and (d) information presented by an animated character. We ran tests with 21 users between the ages of 22 and 35 (13 men and 8 women) recruited from the postgraduate and undergraduate departments of our university. Users were assigned to each treatment in random order; the order of the music- video clips was also randomized for each session. The video clip-related information and the remote control were the same for all sessions.

The study was performed in a relaxed setting, using a traditional TV set and a remote control. We used multiple usability engineering methods [Nielsen 1994]: (a) we observed user behavior during the testing session; (b) we kept a record of user actions in log files; (c) we had users complete questionnaires; and (d) we interviewed each user after the end of the testing session. In the beginning, the interviews were unstructured and directed by the users. Gradually, the interviews became more focused, repeating issues mentioned during the interviews or observed during the testing session.

The testing session contained 16 video-clips and an advertising break with three ads every four songs (approximately every 15 minutes), just like a commercial music-video channel. The study was in accordance with the selective-exposure paradigm. Users were free to choose whether to skip or watch the running video clip. In order to ensure selective exposure, users were allowed a maximum 1/3 watching time out of the total session [Knobloch. and Zillmann 2002], i.e., a maximum of approximately 20 minutes out of the 1-hour program. Users could press the power-off button on the remote to end the testing session, but were told to watch as much as they liked, between 10 to 20 minutes**.**

4. RESULTS AND DISCUSSION

Users not involved in computer research and development asked how video-skipping was possible and whether it was a commercially available product. Most other users were aware of an experimental system behind the TV program. But when asked whether they understood that there was actually a PC running the system, users said that it looked and felt like standard television. The use of a standard TV and a remote control contributed to the positive evaluations, but this could also be attributed to the Virtual Channel UI development toolkit that delivers familiar-looking television [Chorianopoulos and Spinellis 2004]. So the combination of a Virtual Channel programming library and an appropriate experimental set-up may be used to create high-fidelity ITV prototypes.

Video clip-skipping. We found (Table I) that the "hedonic" (pleasure-giving) quality score (from 0 to 10; scores less/more than 5 represent negative/positive attitudes) for the traditional one is close to neutral (average 5.1/10). This finding can be explained by the fact that music video television is pervasive and feels familiar to consumers, irrespective

Table I. Mean Hedonic Quality Scores for Clip-Skipping Music Video TV

Hedonic Quality (p=0.002, n=21**)**	Average	Std Dev
Music TV (traditional)	5.1	2.1
Clip-skip	7.5	1.6

of its delivery format. In contrast, video clip-skipping (average 7.5/10) allowed our experimental subjects to watch their preferred music video clips, and despite the dynamic insertion of ads, the hedonic quality score was significantly higher (two tailed t–test,p=0.002, n=21). Hence, we argue that simple video clip-skipping, similar to the track-skipping facility available in audio CD players, enhances the perceived television entertainment value when compared with a fixed TV channel.

Consistent with the selective exposure theory, users actively sought the video clips and songs they preferred. This interactive behavior may be due to the experimental setting and may not have external validity; users may have been more engaged than normal because the application was novel to them and they were specifically asked to use the new system. They reported using the skip functionality mainly to skip a music video that they disliked and, to a lesser extent, to get to a favorite one. Either way, despite the ad insertion, the clip-skipping feature was a favorite and provided a relaxed way to control the interactive music TV application, based on the dynamic video synthesis of music clips.

An animated character. We found that the "hedonic" quality (scale from 0 to 10; scores less/more than 5 represent negative/positive attitude) for a music video television channel is significantly higher (two tailed t–test, p=0.0002, n=21) when using an animated character to present dynamic video overlays (average 7.0/10) compared to the traditional transparent information box (average 4.4/10). Again, our experimental subjects were neutral toward the traditional information box, since it is widely used and presents information related to music video clips (Table II) in a familiar style. So we argue that an animated character could be used to enhance the consumers' entertainment experience.

Those who have been exposed to the Office Assistant (through Microsoft Office) will recognize the similarity (e.g., balloon-style dialog, standard for characters developed with Microsoft Agent) to the animated character in our study, despite use of a different character (the genie), instead of the Microsoft Office default paperclip. A few users reacted negatively to the concept of an animated character, so it may have a carry-over effect from the desktop to the ITV environment. Users already negatively predisposed to it will continue to be so, at the expense of their overall satisfaction with the entire TV program. Taking those users into account, we suggest that the animated character be an option; an alternative UI should be available to select it. Nevertheless, most users considered the character funny and less obtrusive than human presenters, who interrupt the flow of the video clips to present related information. Furthermore, users proposed that there should be a variety of animated characters (e.g., cartoons, heroes, personalities). Users also asked for more control of the character, like changing its placement on the screen. Finally, most of the users reported that the solid balloon dialog that stands over the character's head hides a considerable part of the TV screen. According to users' suggestions, the best form for the balloon dialog would be a transparent one across the bottom of the screen.

Dynamic ad insertion. We were interested in finding out how many ads users would be willing to watch as a consequence of using the music video clip-skip feature. At the moment, in a traditional music video TV channel it is approximately 12 ads for each hour of TV video (personal communication, executive of a European music television channel). The findings regarding dynamic ad insertion were very positive, despite the fact

Table II. Mean Hedonic Quality Scores for an Animated Character Compared to Traditional Box

Hedonic Quality (p=0.0002, n=21**)**	Average	Std Dev
Animated Character.	7.0	1.5
Box (traditional)	4.4	2.0

that advertising is one of the most controversial features of commercial television. During the interviews and observation sessions, we found that all the users saw dynamic ad insertion in a positive light. Additionally, the users justified the trade-off between skipping to the next video clip and watching a short advertisement. Interestingly, according to the log files, some users also tried to skip the ads, but with no effect, since the application was programmed to ignore the video-skip when inside an ad. Personalized ad selection and presentation would be a useful enhancement, but it is a separate research topic [Chorianopoulos 2003].

Log file analysis revealed that users actually watched double the number of ads compared to a normal broadcast session. But it is not clear what the cause for the above result is, since the system employed two innovative features that affect the number of ads shown. Inserting an ad dynamically every time the user skips a video clip increases the total number of ads shown. At the same time, apart from dynamic ad insertion, video clip-skipping also brings the user closer to the next scheduled ad break, thus increasing even more the total number of ad messages. Therefore, in order to draw cause and effect conclusions about the dynamic ad insertion feature and the number of ads watched, another experiment is needed: i.e., using the same video clip- skipping UI, the independent variable should be dynamic ad insertion (on or off).

Limitations and further research. Music video clips have a number of unique characteristics that facilitate further ITV development. Music content can be easily classified and filtered with open Internet databases and web services, classification schemes, and adaptation models developed for the popular MP3 music format [Pachet 2003]. Additional metadata that describe the emotional content (e.g., http://www.moodlogic.com) may also be used and combined with research about emotion in animated characters [Bates 1997]. The latter issue merits further research by its community, which has already put considerable effort in the investigation of animated characters for consumer electronics [Diederiks 2003].

The most interesting suggestions for future improvements concern augmentation of the music video clip-skip feature. Users familiar with CD players and the PC-based MP3 asked for more options when skipping a music video, such as repeat the same song, play a song from the same artist, or play a new song in same music genre. Moreover, information on a longer list of upcoming music videos would be welcome; among other things, it would allow users to organize their time more efficiently, since they could leave the TV and return when their favorite song came on. Using television as a tool to structure household activities and organize time has been documented in an ethnographic study of an STB trial [O'Brien et al. 1999]. Providing on-demand information about upcoming video clips supports the relaxed control of TV as a time-management tool, while the ability to dynamically alter the upcoming play-list supports interactive

behavior. For example, the user could bring up a play-list of 10 upcoming music videos and alter it dynamically along a number of parameters like genre and artist, or automatically create play-lists [Pachet 2003]. The user could also decide to skip directly to a music video by pressing the corresponding button on the numeric keypad.

We used complementary qualitative and quantitative evaluation methods during the limited duration of our controlled experiment, instead of testing unobtrusively during the everyday activities in consumers' homes. Previous findings on the usability of everyday technology demonstrate that the consumers' perceptions, and especially the mental models they form about new domestic technologies, are very elastic and prone to change with time [Petersen et al. 2002]. Therefore, a longitudinal study would have provided additional information about our research issues. A longitudinal study should employ an appropriate research framework, such as the experience sampling method [Kubey. and Csikszentmihalyi 1990]. In the context of ITV prototyping, adding a TV tuner would extend functionality to include synchronization between broadcast and local storage and provide the ability to perform more realistic TV experiments in consumers' homes over longer periods of time.

5. CONCLUSION

In the context of the commercial implementation of the video-skipping feature, who will control the rules for the dynamic synthesis of video and the dynamic overlay of data is a major open research question. For example, on the one hand, the media industry may choose to subsidize consumers' DVR STBs in exchange for increased control of what is stored and how it is played (e.g., targeted advertising and subscription services for personalized music/news channels for each STB). On the other hand, the consumer electronics industry may offer advanced general-purpose DVRs with DVD-recording functionality and Internet connectivity for downloading metadata and related information. The latter could be more complex to use but will offer increased consumer control, while the former will be introduced by established media brands and broadcasting services. Between these two extremes there is a continuum of alternative product and service offerings. Like the case with other consumer products, effective use of each offering's ITV applications, and applicability to the relaxed domestic setting, is likely to be a decisive factor for the success of the corresponding products, services, and underlying business models.

APPENDIX: THE VIRTUAL CHANNEL MODEL

The idea of a virtual channel is a tv channel that is not a fixed video signal shared by all TV viewers in the same way but a dynamic synthesis of discrete video, graphics, and data controlled by a computer program, which runs at each digital STB [Chorianopoulos 2003]. The traditional television experience consists of video and overlaid graphics-text created at the media source (the TV broadcast station or the TV production studio); thus it is fixed for all TV viewers. The virtual channel model shifts the decision-making about TV programming from the media source to the STB. The television experience is now created and controlled at the STB from a combination of locally stored material, real-time broadcast transmissions, and Internet resources.

The *virtual channel* is a conceptual model for user interface design; it augments the familiar access method to broadcast programming (i.e., the simple notion of a channel), to an integrated model for accessing multimedia content from diverse sources. First, the

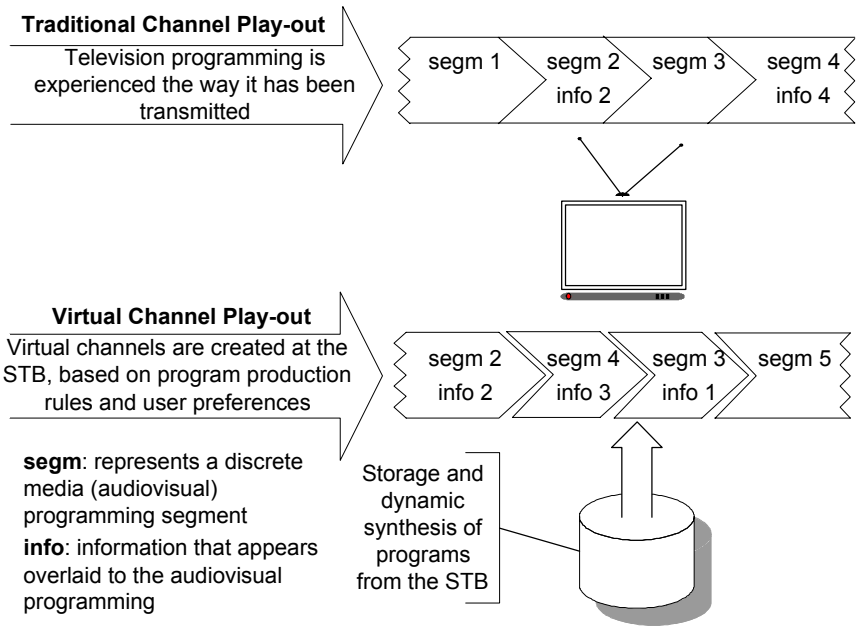

Fig. 4. Generic model of a system with the virtual channel metaphor, in contrast to the traditional broadcasting scheme.

organization of digital media content into a small number of spatio-temporally personalized virtual channels simplifies choosing from a vast array of available broadcasts, stored programs and Internet resources. Second, presenting media programming from virtual channels potentially gives more control to the user, who can actively shape the televised content. The virtual channel model suggests only a minimal shift from current media use, while it focuses further research on the design of a content-specific UI (e.g., music TV).

In brief, the main assertion is that neither the vision of 500 channels nor that of a single personalized channel is suitable for giving consumers access to the digital STB. Instead, we propose that a small number of dynamic virtual channels may offer enough choices for serendipity in media experiences, while simplifying access to vast and diversified sources of television content.

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