Chapter 5

Toward Next-Generation In-Flight Entertainment Systems: A Survey of the State of the Art and Possible Extensions

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5.1 Introduction

Traveling by air, especially long distance, is not a natural activity for humans. The combination of long flight duration, limited space, and an unusual cabin environment in terms of air pressure, humidity, and continuous noise causes physical and psychological discomfort and even stress for a large group of passengers. Excessive stress may cause some passengers to become aggressive and overreactive and may even endanger their health (Sophia 1998; WHO 2005). Airlines commonly install in-flight entertainment systems on long-haul aircrafts to improve passengers' comfort level. Usually, entertainment services are delivered via high-speed communication tools and state-of-the-art entertainment systems, which include audio/video on-demand, games, in-flight e-mail, Internet access, and ever-increasing digital entertainment options.

Comfort is a complex concept consisting of both objective ergonomics requirements and subjective impressions. Dumur, Barnard, and Boy (2004) identify four principles that should guide design of a more comfortable aircraft cabin for passengers: (1) affordance, which concentrates on the efforts the passenger must make to get the service; (2) situational awareness, which ensures that the passenger is aware of events surrounding him or her and of other passengers and the cabin crew in order not to feel lost or confused and to be confident that everything is under control; (3) individualization and customization, which address the individual differences in comfort needs for different passengers; and (4) variability and flexibility, which emphasize the diverse needs of passengers. Regarding in-flight entertainment systems, affordance of the entertainment relates to the efforts that the passenger must make to interact with the system to get personalized entertainment; situational awareness means that the passenger should be aware of what goes on around the in-flight entertainment system in order not to feel lost or confused and to be confident that the system is under his or her control. Because passengers come from highly heterogeneous pools, have different entertainment preferences, and experience different flight situations, individualization and customization of entertainment services can provide passengers better physical and psychological comfort. In addition to these four principles, Liu and Rauterberg (2007) point out the importance of improving the passenger's comfort by reducing his or her negative stress level.

In this chapter, we will describe various ways to extend the capabilities of in-flight entertainment systems to improve the passenger's comfort level. First, we present a comprehensive survey of the state of the art of the currently installed and commercially available in-flight entertainment systems. How these systems are designed and implemented to increase passengers' comfort level is analyzed and their limitations are discussed in Section 5.2. Some possible technologies to enable designing a more comfortable in-flight entertainment system for passengers are presented in Section 5.3. A new framework for next-generation in-flight entertainment systems is presented and research that is being conducted to concretize it are also outlined in Section 5.3.

5.2 Overview of the Current In-Flight Entertainment Systems

After World War II, commercial aviation flights became a daily event in which entertainment was requested by passengers to help the time pass. It was delivered in the form of food and drink services along with an occasional projector movie during lengthy flights. The in-flight entertainment systems were upgraded to CRT (cathode ray tube)-based systems in the late 1970s and early 1980s. Around the same time, CRT-based displays began to appear over the aisles of aircrafts. In the mid-1990s, the first in-seat video systems began to appear (see Figure 5.1), and

Figure 5.1 In-seat LCD-based in-flight entertainment systems. (From "Airbus A380 lands in Sydney," by Luke A., 2007. Retrieved March 27, 2008 from CNET's Web site: http://www.cnet.com.au/laptops/0,239035611,339283273-8s,00.htm.)

liquid crystal display (LCD) technology started to replace CRT technology as the display technology of choice for overhead video. In the late 1990s and early 2000s, the first in-seat audio/video on-demand systems began to appear (Wikipedia n.d.). Today, as technology advances, except for audio/video on-demand services, the entertainment services are also delivered in the form of games, in-flight e-mail, Internet access, and ever-increasing digital entertainment options.

In this section, the current in-flight entertainment systems in the aircrafts of major airlines are investigated. Then the latest commercially available in-flight entertainment systems provided by major players in this field are investigated. Finally, the current in-flight entertainment systems are analyzed to see whether they are designed and implemented in accordance with the five design principles listed in Section 5.1.

5.2.1 Currently Installed In-Flight Entertainment Systems

To allow each airline the freedom to configure its aircrafts according to its budgets and market demands, both airplane producers (Boeing and Airbus) and major in-flight entertainment system providers provide customized in-flight entertainment systems to their customers. Liu (2006) investigated the current installed in-flight entertainment systems in the aircrafts of airlines of Lufthansa, Air France, British Airways, American Airlines, Delta Airlines, and Japan Airlines, which are top airlines in Europe, North America, and Asia from a total scheduled passengers point of view (WATS 2006).

Generally, the in-flight entertainment services provided by these airlines might be divided into two categories. In passive services, the user-system interaction levels are very low; passengers simply enjoy a chosen form of entertainment presented to them in an organized and packaged form. Examples of passive entertainment services are audio and video on-demand, audio and video broadcasting, e-books, and moving-map systems. Active entertainment services allow users to actively interact with the entertainment system and to determine the entertainment service content by interaction with the system. Gaming is one example of this active entertainment. The exact entertainment services provided by an airline depend on factors such as the aircraft type, the business model of the airline, and class seats (first class, business class, and economy class).

All the in-flight entertainment systems installed in the investigated airlines' aircrafts are implemented on the basis of preset concepts of what customers like and require as a homogeneous passenger group with similar tastes and desires. The systems present the same interface and entertainment content to each passenger regardless of individual differences in age, gender, ethnicity, entertainment preferences, and so on. If the user wants specific entertainment services during air travel, he or she must interact with the in-flight entertainment system by means of touch screen, remote controller, or similar device (see Figure 5.2) to browse and select the desired entertainment services. If the user selects a game to play, he or she can use the remote controller to interact with the system to play the game. If the available choices are many, or if the passenger is not familiar with the service category structure, or if the interaction design is poor (e.g., Japan Airlines' remote controller has more than 20 keys), the passenger tends to get disoriented and may be unable to find the most appealing entertainment services. However, if the available choices are limited (e.g., most airlines investigated provide only a few movies during a flight), the chance for the passenger to find desired entertainment services is slim. Under these circumstances, the in-flight entertainment system does not contribute to improving the passenger's comfort level; on the contrary, it may exacerbate the passenger's stress.

Figure 5.2 Interactions between the passenger and the in-flight entertainment system. Left: KLM (n.d.). (From "Economy class," by KLM, n.d. Retrieved March 1, 2008 from KLM's Web site: http://www.klm.com/travel/au_en/travel_tools/book_a_flight/ebt_help/help_classes.htm.) Right: ArtsyKen (n.d.). (From "In-flight entertainment," by ArtsyKen, n.d. Retrieved March 1, 2008 from Artsyken's Web site: http://artsyken.com/2003_12_01_archive.php.)

5.2.2 Commercially Available In-Flight Entertainment Systems

Liu (2006) investigated the latest commercially available in-flight entertainment systems provided by three major producers: Panasonic, Thales, and Rockwell Collins. The Panasonic Matsushita X-series in-flight entertainment system is the first in-flight entertainment system to be based on the research of passenger preferences and consumer trends worldwide. The X-series delivers high-speed communication tools and state-of-the-art entertainment, including audio/video on-demand, in-flight e-mail, Internet access, and ever-increasing digital entertainment options. Passengers are in complete control of selecting from the options provided to them. TopSeries™ is Thales's premier family of in-flight entertainment systems that provides integrated solutions for entertainment, e-mail, Internet access, and in-seat laptop power. The latest system is I-5000 in which all digital video and audio on-demand with greater bandwidth use a Gigabit Ethernet network. TopSeries's efficient design integrates broadband communications, in-seat power, and entertainment capability onto one platform. The system's unique modular design can simultaneously support overhead, in-seat distributed, and on-demand content distribution on a single aircraft. Rockwell Collins provides several TES series in-flight entertainment systems. Among them, eTES has not only all of the benefits of TES, such as audio/video on-demand and interactivity, but also the same high-speed network connectivity that users experience at home and in the office. The system provides dynamically built menu pages, which are generated based on each request, creating a truly individualized passenger experience. For example, all eTES pages can be created in French if that is the language selected by the passenger; banner ads for Paris-based restaurants and tourist attractions can be automatically generated should the flight's destination be Paris. Passengers can select from the options provided to them. Movie titles, language choices; and start, stop, fast-forward, rewind, and pause controls are all at their fingertips. Not only will passengers enjoy content delivery the way they want it, but airlines will also know exactly what passengers are listening to and watching. eTES collects usage statistics to assist airlines in determining an optimal content mix, thereby minimizing content costs and maximizing passenger satisfaction.

5.2.3 Discussions and Conclusions

In this section, seven major airline currently installed in-flight entertainment systems were investigated. Five principles of designing a more comfortable in-flight entertainment system for passengers were taken into consideration—(1) affordance, (2) situational awareness, (3) individualization and customization, (4) variability and flexibility, and (5) negative stress reduction—and, the following conclusions were drawn:

1. All of the airlines investigated present the same interface and entertainment contents to each passenger. By means of a touch screen, in-seat controller, or remote control, the passenger can browse the same menu and select the desired audio/video programs from the provided options. However, finding

the desired program is not easy. First, the passenger must know how to use the interactive tools. Second, if the passenger is not familiar with the airline's specific entertainment service categories and the available options are many, he or she is forced to browse numerous selections before finding the desired audio/video program. On the other hand, if the available entertainment options are limited, the chances of finding the desired service are slim. The current systems have much room to improve in affordance, individualization and customization, and variability and flexibility design aspects.

2. None of the airlines that were investigated explored how entertainment services can be used to reduce passengers' negative physical and psychological stresses systematically, actively, and intelligently. For example, considering the limited space and safety constraints, the airlines usually provide some in-chair physical exercise tips either in paper flyers in front of the passenger's seat or in electronic texts in the entertainment systems (QANTAS Airlines n.d.). However, according to our investigation, most passengers tend to ignore these exercise tips. Therefore, a more engaging solution is necessary.

The latest commercially available in-flight entertainment systems provided by major players Panasonic Matsushita, Rockwell Collins, and Thales were investigated. Their latest products aim to provide customized in-flight entertainment to the airline according to the airline's budgets and market demands. For example, Rockwell Collins eTES aims to provide personalized entertainment services to the passenger by offering dynamically built personalized menu pages, collecting usage statistics to assist airlines in determining an optimal entertainment content mix, and so on. Thales's TopSeries I-5000 in-flight entertainment system's modular and functionality-based design makes it more flexible and extendable. However, as shown in Figure 5.3, these systems did not explore passengers' personal profiles, passengers' biosignals, the flight situation, or other factors, in order to provide

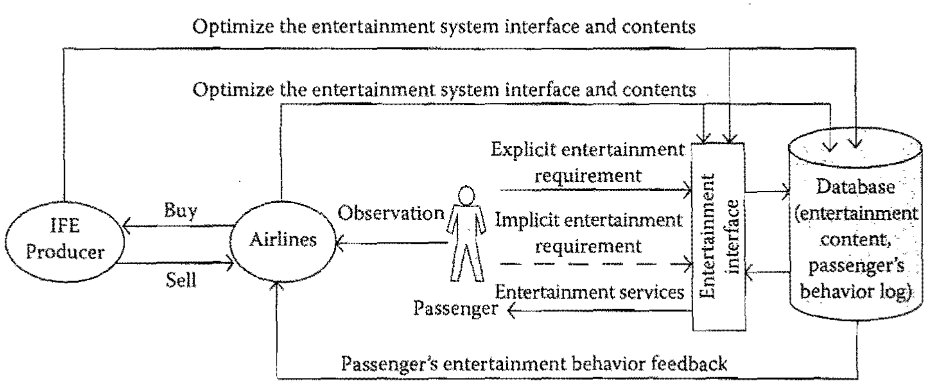

Figure 5.3 The adaptive relation between an in-flight entertainment (IFE) system producer, airline, passenger, and IFE system.

context-aware, personalized entertainment services intelligently. These systems also failed to explore how entertainment services can be used to reduce passengers' negative stresses systematically, actively, and intelligently.

5.3 Extending the Capabilities of In-Flight Entertainment Systems to Increase Passengers' Comfort Actively and Intelligently

In this section, technologies that enable a new in-flight entertainment system to increase passengers' comfort level actively and intelligently are identified. First, the context-adaptive system that enable context-aware in-flight entertainment service provision is explored. Second, user profiling, which can be used to personalize adaptations and decrease unnecessary dialog between the user and the system, is described. Third, the related works of using entertainment to reduce negative stresses are investigated. Fourth, the theory of cybernetic control systems, which use information, models, and control actions to steer toward and maintain their goals while counteracting various disturbances, is introduced. Finally, a new framework for next-generation in-flight entertainment systems that integrates the context-adaptive system, control system, user profiling, and methods of using entertainment to reduce negative stresses is presented, and various research opportunities for concretizing it are identified.

5.3.1 Context-Adaptive Systems

In the 1980s, the focus of user-adaptive systems was a user model defined by personal characteristics and preferences together with a task model defined by task characteristics (Edmonds 1981; Kobsa and Wahlster 1989). Later, in the 1990s, interest developed beyond user-adaptiveness and moved more generally to context-adaptiveness. Context may be defined as "any information that can be used to characterize the situation of an entity; an entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves" (Dey and Abowd 1999). In this abstract definition, "any" information that is relevant to characterize the situation of an entity is used to specify context. This definition is correct, meaning that for different domains and different purposes, context has specific definition elements. Early in the history of computers, they were only used for business. As information technology advanced, computers were also used for leisure and at places other than the workplace. It therefore made sense to include other dimensions in the definition of the context of use. Four dimensions often are considered for context: (1) the location of the user in either the information space or the physical space; (2) the identity of the user, implying the user's interests, preferences, and knowledge;

(3) the time of use (working hours, weekend, etc.); and (4) the environment of the current activity (Schilit et al. 1994; Dey and Abowd 1999). These dimensions are currently exploited for embedded, ambient, or disappearing computing (Streitz and Nixon 2005).

The architecture of a context-adaptive system includes at least context sensing, context modeling, context adaptation, and service delivery components (Baldauf 2007). With the support of the architecture, three adaptation steps can be distinguished: (1) the interaction logging function records and categorizes all incoming interaction events according to predefined dimensions of characteristics of the usage process (Rauterberg 1993); (2) the result of this recording and categorization is reported to a central adaptation inference function (Schröder et al. 1990); (3) this adaptation inference function analyzes the incoming interaction event messages, evaluates them according to predefined rules and algorithms, and generates specific adaptation activities to be performed (Bartneck et al. 2006).

There is already a long literature involving the successful context-adaptive applications in several areas. Three areas are of prominent importance: (1) mobile shopping assistants (Kaasinen 2003), (2) mobile tour guides (Petrelli and Not 2005), and (3) mobile learning assistance (Klann et al. 2005). In all these systems, the current location of the user and corresponding domain objects in the environment were continuously identified and mapped to the interests and tasks of the user.

5.3.2 User Profiling

The information about a user that reflects his or her needs, requirements, and desires (NRDs) on the preferred system behaviors, explicitly or implicitly, is called a user profile or a user model (Salem and Rauterberg 2004). It is usually integrated into the system to impart the user knowledge to the system to enable automatic personalized system behavior adaptations and avoid "unnecessary" dialog between the system and the user.

Kay (2001) identified three main ways that a user model can assist in adaptation: (1) It can interpret user actions, such as a mouse action or the user's speech via audio input, to eliminate the ambiguity; a user model can help the system interpret such information. (2) The user model can drive the internal actions of the system. This is the goal of systems that filter information, select the right system functionalities, and so on, on behalf of the user. (3) Machine actions can be controlled by a user model to improve the quality of the interaction. A very simple example might involve the system tailoring its presentation form to the user. More sophisticated cases involve the adaptation of the content as well as the form of the presentation.

An adaptive system, whether user-adaptive or context-adaptive, needs the user profile to represent a user's NRDs on the desired system behaviors to enable adaptations and avoid unnecessary user-explicit inputs. For user-adaptive systems in which the user and task characteristics are considered for adaptations, the formation of the user profile is a subset of the intersection between the real-world user model and the

system's available behaviors. For the context-adaptive systems in which the context of use is also considered for system-behavior adaptation, the main content of the user profile is a subset of the intersections among the real-world user model, the available system behaviors, and the context of uses (see Figure 5.4). Context of uses are the actual situations under which the service is delivered to the user. The information items in this subset can reflect the user's NRDs on the preferred system behaviors under the contexts of use explicitly or implicitly. For example, the user profile in Yu and colleagues (2004) is composed of two parts: user's preferences and history of activities (tracks). The user can update the preferences according to specific contexts of use. The history is ordered by a time–space and theme (e.g., a conference). In a similar example, presented in Suh and colleagues (2005), the user profile information is categorized as static or dynamic. Static information is personal information such as name, age, and address books. Dynamic information includes the user's system behavior preferences, which depend on the context of use.

Currently, the user-profile modeling approaches for adaptive systems fall into two categories: (1) in the hierarchical tree modeling approach, the user is modeled by dimensions (e.g., knowledge, interest), and each dimension can be further refined with subdimensions (Goel and Sarkar 2002); (2) in the rule-based language modeling approach, the desired delivery of services relates to the context of use with if-then logic (Oppermann 2005). The advantage of the hierarchical tree approach is that it is well organized and easy to understand; the disadvantage is that it can express only static characteristics. The advantage of the rule-based language approach is that it is based on clear formalism and can be used to express some of the user's dynamic characteristics, such as context-aware user preferences. The disadvantages are that its expressive power is limited, and it is difficult to model the relationships among rules.

Generally, there are three approaches to acquire user profile information: it is entered explicitly by the user, learned implicitly by the system, or both. For some static information about the user, such as demographic information, it is reasonable to let the user provide it. But it may not be ideal to let the user explicitly enter some of the dynamic information, such as user preferences, because such information depends on the context of use and may change over time. Prior researchers have

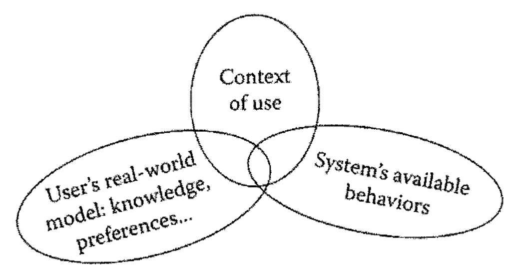

Figure 5.4 User profile for context-adaptive systems.

explored the usefulness of implicit feedback (Kelly and Teevan 2003) to acquire user preferences because the feedback is easy to collect and requires no extra effort from the user. Most researchers have succeeded in this and obtained good results.

5.3.3 Methods of Using Entertainment Services for Stress Reduction

As the first step toward a complete solution, this chapter explores how music and games can be used to reduce the listener's or player's negative psychological and physical stresses.

5.3.3.1 Music

There is much literature involving the use of music for stress reduction. David and Robert (1999) showed that "relaxing" music can be used to decrease stress and increase relaxation in a hospital waiting room. Steelman (1991) looked at a number of studies of music's effect on relaxation where tempo was varied and concluded that tempos of 60 to 80 beats per minute reduce the stress response and induce relaxation, while tempos between 100 and 120 beats per minute stimulate the sympathetic nervous system. Stratton and Zalanowski (1984) conclude that there is a significant correlation between degree of relaxation and preference for music. User preferences, familiarity with, or past experiences with the music have an overriding effect on positive behavior change than do other types of music. Based on these studies, a preassumption can be made that user-preferred music that is familiar and that has tempos of 60 to 80 beats per minute can have a better stress reduction effect than other music. Not only can the music be used directly for stress reduction, it can also be used to improve the user's positive performance. Lai (2005) presented an experiment on the effects of music on sleep disorders. He found that soft, slow music could be used as a therapy to promote sleep quality. The tempo of the music being listened to appears to be an important parameter here. Lesiuk (2005) measured the effect of music listening on state positive affect, work quality, and time-on-task of computer information systems developers. Results indicated that state positive affect and quality of work were lowest with no music, while time-on-task was longest when music was removed. Narrative responses revealed the value of music listening for positive mood change and enhanced perception on design while working.

5.3.3.2 Games

Muscle contraction is very important in reducing physical discomfort. Muscle activity helps to keep blood flowing through the veins, particularly in the deep veins. Depending on the genre and the playing devices of the games, the user must move

in certain patterns, resulting in exercise-like muscle activity (Nintendo n.d.). The user may thereby improve his or her physical comfort level through game play.

5.3.4 Cybernetics Control Systems

Cybernetics is the science that studies the abstract principles of organization in complex systems. It is concerned not so much with system components as with how the system functions. Cybernetics focuses on how systems use information, models, and control actions to steer toward and maintain their goals while counteracting various disturbances. Being inherently transdisciplinary, cybernetic reasoning can be applied to understand, model, and design systems of any kind: physical, technological, biological, ecological, psychological, social, or any combination of these (Heylighen and Joslyn 2001).

A simple control system scheme (see Figure 5.5) is a feedback cycle with two inputs: the goal, which stands for the preferred values of the system's essential variables; and the disturbances, which stand for all the processes in the environment that the system does not have under control but that can affect these variables. The system starts by observing or sensing the variables that it wishes to control because they affect its preferred state. This step of perception creates an internal representation of the outside situation. The information in this representation must then be processed in order to determine (1) in what way it may affect the goal and (2) what is the best reaction to safeguard that goal. Based on this interpretation, the system then decides on an appropriate action. This action affects some part of

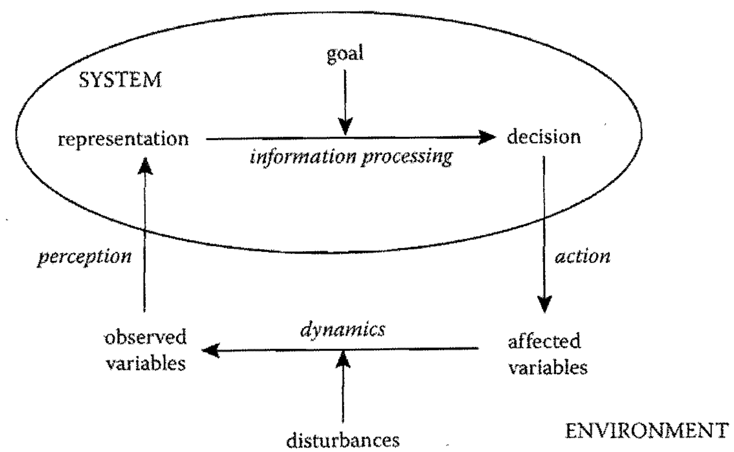

Figure 5.5 Basic components of a control system. (From Cybernetics and second-order cybernetics by F. Heylighen and C. Joslyn, 2001. In R. Meyers, Ed., *Encyclopedia of Physical Science and Technology*, vol. 4. Orlando, FL: Academic Press, pp. 155–170. With permission.)

the environment, which in turn affects other parts of the environment through the normal causal processes or dynamics of that environment. These dynamics are influenced by the set of unknown variables, which we call the disturbances. This dynamic interaction affects, among others, the variables that the system keeps under observation. The change in these variables is again perceived by the system, which again triggers interpretation, decision, and action, thus closing the control loop (Heylighen and Joslyn 2001).

5.3.5 A New Framework for Next-Generation In-Flight Entertainment Systems

In this section, we present a new framework for next-generation in-flight entertainment systems. It integrates the concepts of context-adaptive systems, user profiling, methods of the use of entertainment services for stress reduction, and cybernetics control systems to provide entertainment services that improve the passenger's comfort level during air travel. In Figure 5.6, the system starts by observing the passenger's physical and psychological states (modeled on the passenger's biofeedback signal) that it wishes to control. This step of perception creates an internal representation of the passenger's physical and psychological situation. The information in this representation must be processed in order to determine (1) whether the passenger is comfortable and (2) what are the best entertainment services to improve the passenger's comfort level. Based on this interpretation, and referring to the user profile, the system then decides on an appropriate entertainment service provision. The passenger is an adaptive system: his or her perception creates an internal representation of the entertainment service. This perception affects the passenger's physical and psychological states. During this process, the passenger's physical or psychological states may also be influenced by a set of variables such as unfavorable air pressure, humidity, and continuous noise in the aircraft cabin. The change in the passenger's physical and psychological states is again perceived by the system, again triggering the adaptation process and thus closing the control loop. The entertainment preference of the passenger depends on the context of use, which include, for example, the passenger's physical and psychological states and the activity he or she is pursuing. In Figure 5.6, if the system recommends entertainment services that the passenger does not like, he or she may reject the recommended services and select the desired entertainment or just shut down the system. By mining the context-of-use data, entertainment services selected by the passenger, and the passenger's explicit and implicit feedback on the system's recommendations, the system can automatically learn and adapt to the passenger's preferences. Thus, the more that the passenger uses the in-flight entertainment system, the more intelligent and personalized the system's recommendations become.

The following is a brief discussion of the framework for next-generation in- flight entertainment systems with the comfort design principles described in Section 5.1.

1. *Affordance*: This framework makes it possible for the passenger to get personalized entertainment services with less effort. For example, the more time that a passenger spends on board an airline's plane, the better the user profile and biosignal model based on his or her past behaviors can be built. Thus, more personalized services can be provided intelligently by the system.
2. *Situational awareness*: In the framework, if the passenger does not like the recommended entertainment services, he or she can decline the recommendation and personally select his or her preferred entertainment services. In this way, the framework ensures the passenger that the entertainment is under his or her control.
3. *Individualization and customization*: The user profiling technology used in the framework enables the personalized entertainment service provision. The user preference learning component ensures that the user's entertainment preference is tracked, learned, and updated.
4. *Variability and flexibility*: The framework enables the passenger to choose preferred entertainment services from among many options to fulfill different and diverse entertainment needs.
5. *Negative stress reduction*: As described in this section, the framework can provide the passenger with personalized stress-reduction entertainment services, actively and intelligently, if he or she is under stress.

To implement the framework into a real-world in-flight entertainment system, a lot of research must be done including:

1. Passengers' psychological and physical state modeling with signal outputs from biosensors that monitor, for instance, blood pressure and heart rate.
2. Passengers' personalized psychological and physical comfort points definition under different contexts of use based on psychological and physical state models.

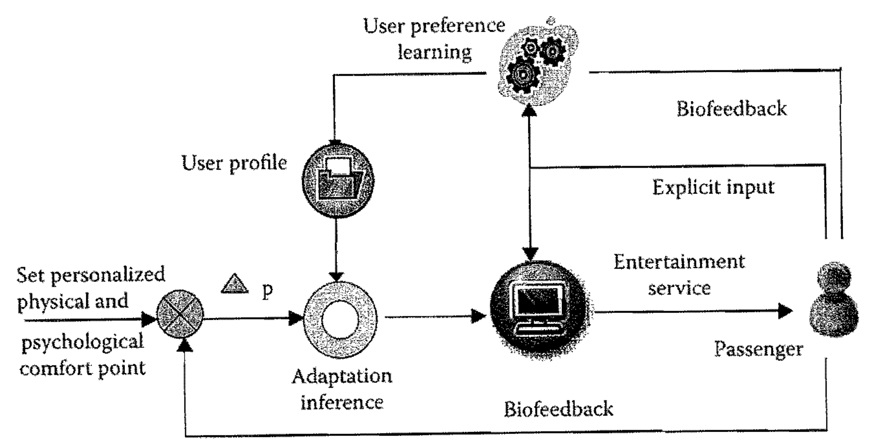

Figure 5.6 A new framework for next-generation in-flight entertainment systems.

3. A user profile model that reflects passengers' NRDs on preferred in-flight entertainment system behaviors, explicitly or implicitly.
4. A user preference learning algorithm that can learn the passenger's entertainment preference with as few explicit inputs as possible.
5. User-desired entertainment service recommendation algorithms that not only consider the possible change of available entertainment content but also avoid the "tunnel effect" of the recommendation.

5.4 Conclusions

In-flight entertainment systems play an important role in improving passengers' comfort level during air travel. Today, the current in-flight entertainment systems have made significant progress in providing user-preferred entertainment services with user-friendly interfaces, interaction mode design, ever-increasing entertainment options, and so on. However, despite all of these advances, the current generation of in-flight entertainment systems surveyed in this chapter still has much room for improvement so that systems intelligently provide personalized entertainment for recreation as well as personalized stress-reduction entertainment for stress-free air travel. In this chapter, we first introduced five principles to design a more comfortable in-flight entertainment system. Then, the currently installed and commercially available in-flight entertainment systems were investigated, and we checked how they are designed and implemented relating to these principles. The state-of-the-art enabling technologies that can be used to design a better in-flight entertainment system to improve the passenger's comfort level were explored. Finally, we presented a new framework based on the integration of investigated technologies for next-generation in-flight entertainment systems. We also identified research that is yet to be done to transform the framework into a real-world in-flight entertainment system. We hope that the framework presented in this chapter will advance the discussion in the aviation community about next-generation in-flight entertainment systems.

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He was a senior lecturer for usability engineering in computer science and industrial engineering at the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland, where he was later head of the Man-Machine Interaction (MMI) research group. Since 1998 he has been a full time professor of human communication technology, first at IPO Center for User System Interaction Research, and later at the Department of Industrial Design at the Eindhoven University of Technology, the Netherlands. From 1999 until 2001 he was director of IPO. He is now the head of the designed intelligence research group at the Department of Industrial Design at the Eindhoven University of Technology.

He was the Swiss representative in the IFIP TC13 on human–computer interaction (HCI) from 1994-2002, and the chairman of the IFIP WG13.1 on HCI and Education from 1998-2004. He is now the Dutch representative in the IFIP TC14 on entertainment computing and the founding vice-chair of this TC14. He has also been the chair of the IFIP WG14.3 on entertainment theory since 2004. He was appointed as visiting professor at Kwansei Gakuin University, Japan from 2004-2007. He received the German GI-HCI Award for the best PhD in 1997 and the Swiss Technology Award for the BUILD-IT system in 1998. Since 2004 he has been a nominated member of the Cream of Science Award in the Netherlands —the 200 top-level Dutch researchers—and amongst the 10 top-level Eindhoven University of Technology scientists. He has over 250 publications in international journals, conference proceedings, and books. He acts as editor and member of the editorial board of several leading international journals.

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