Multimedia Chair Design for Improving the Experience of Hospital Stay for Children with Cancer: The Escape

Wout Kregting and Wei Chen

Department of Industrial Design, Eindhoven University of Technology,
Den Dolech 2, 5612 AZ, Eindhoven, The Netherlands
w.j.w.kregting@student.tue.nl, wjwkregting@gmail.com,
w.chen@tue.nl

Abstract. Children with cancer staying in isolation rooms at hospitals often feel lonely and disconnected from their family and friends. In this paper, we present the design and development of the Escape, which is a chair embedded with multimedia networks. The chair is designed and developed to a product ready for hospital use, in collaboration with VanBerlo Design, Catharina Hospital, Webchair, and MaraThOON Foundation of the Netherlands, for improving these children's experience of their hospital stay and enhancing their bonding with the outside world. The paper describes the user centered design process, multimedia technology integration, implementation and production of the ambient media system.

Keywords: ambient media, entertainment, children with cancer, multimedia chair, ambient intelligence.

1 Introduction

In the Netherlands, about 500 children are confronted with cancer every year and in the United States in 2007, approximately 10,400 children under age 15 were diagnosed with cancer and about 1,545 children will die from the disease [1]. These children's carefree life suddenly turns into a life in which they have to spend much time in the isolation rooms at hospital. They can't do the things they used to do and they can't attend school. They see their friends less and less frequently. Therefore, to improve their experience of the hospital stay and enhance their bonding with the outside world, we proposed and developed a chair embedded with multimedia networks called 'Escape', in collaboration with VanBerlo Design, Catharina Hospital, Webchair, and MaraThOON Foundation of the Netherlands.

Together with the development of the ambient intelligence concept [2], recent advances in sensor and multimedia networking technologies [3-5] enable the creation of a new generation of healthcare systems with smart environments. Ambient media and systems cover a wide range of applications, including healthcare, sports, work, entertainment, etc. For example, to improve the comfort of passengers by an adaptive entertainment system, non-invasive sensors for heart rate monitoring were embedded in the aircraft passenger seat, enabling the emotion model manager to choose the proper music in the database for reducing the stress of the passenger [6]. Another

C.T. Angelis, D. Fotiadis, and A.T. Tzallas (Eds.): AMBI-SYS 2013, LNICST 118, pp. 81–90, 2013.

example is to support economy class passengers to sleep well during a long haul flight. The sleeping posture of a passenger is detected by pressure sensors embedded in the aircraft seat, enabling the smart seat to provide support to the passenger [7, 8]. A user friendly EEG headset has been designed to enhance people's wellbeing based on bio-feedback[9]. For the elderly, unobtrusive sensor technologies for sleeping patterns [10] and health status of people living alone at home [11] have been reported. Intelligent designs for critically ill babies at hospitals have been developed in user centered approaches, such as vital signs monitoring for neonates [12-15], data transmission [16], a power supply for neonatal monitoring [17], neonatal behavioral state detection based on facial expression analysis [18], and a device to support cardiopulmonary resuscitation of neonates [19]. To increase the quality of life of children with bone marrow transplantation, the University Hospital Essen offers isolation rooms with multimedia facilities, such as a flat-screen TV, PlayStation 3 with Move, WebChair, Philips ambient light, etc..

In this paper, we present the design and development of the Escape, which is a chair embedded with multimedia networks. Multidisciplinary knowledge and collaboration are involved throughout the user centered design process. The comfort chair is designed with integration of the techniques and research from medical science and practice, ergonomics, materials, and multimedia technologies. The comfort chair is specially designed for children with cancer staying at hospitals. Our chair with multi-media functions will help them to stay connected and actively communicate with their family and friends. We have transferred the design from a full-scale prototype to a real product. The intelligent multimedia chair has been exhibited during the Dutch Design Week 2012 and by the end of the year the chair will be used in the wards of Catherina hospital in the Netherlands.

2 Design Process and Design Concept

2.1 Design Process

The design process to create the multimedia entertainment chair is shown in Fig. 1. In each phase of the process, iterations were carried out.

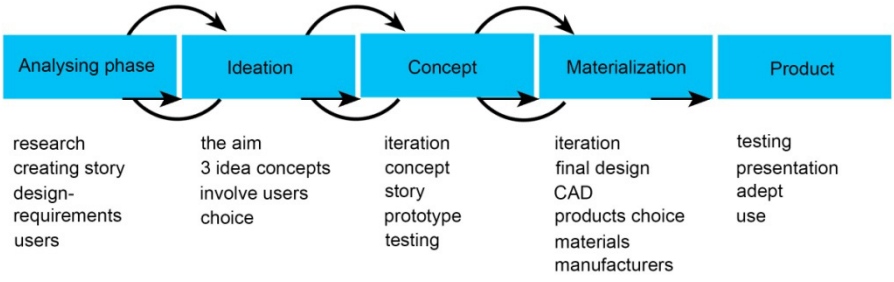

Fig. 1. Design process

The first phase is the analyzing phase. In this phase is knowledge gained from user study and background information will be translated into values and requirements for the design.

Sheldon [20] compiled a list of values that are important to humans. Which values are most important for the target group? The age of children with cancer can be range from 0 till 18 years old, but it is impossible the design a good product that fits all age-groups. Thus the age group of 8 -15 was chosen to design for. The children in this group are late elementary school to middle high school. They are usually familiar with multimedia systems for games or entertainments. Through interviews with doctors, healthy children and parents, the following values are found very important:

- *Relatedness;* contact with family and friends
- *Pleasure stimulation;* entertainment
- *Security;* safe feeling
- *Privacy;* an own place in a isolation room full of windows

Next to the value, design requirements are gained by age group research, trend research, and interviewing people at the Catharina hospital in the Netherlands, including doctors, technical employees, patients and isolation ward. The requirements are listed below:

General requirements

- The chair is suitable for children with cancer (weaker and less physically healthy than normal children
- The target group of the comfort chair is 8 till 15 years
- In the chair the nurses and the doctors are able to do the same tests as in the hospital bed
- The chair is cleanable by the standards of the isolation ward of the Catharina Hospital in the Netherlands
- The chair is mobile
- The chair fits to a door: length 2000mm, width 1000mm
- The chair meets the safety requirements of hospitals

Design and user aspects

- The chair is an eye catcher
- The chair fits in a hospital environment
- The design is understood by the user
- The chair has a safe look and feel
- The chair offers communication to friends, family and school
- The chair offers privacy for the patients
- The patient is visible for the doctors while using the chair (the doctors has to monitor the patients)
- The chair is safe for the user
- The user has influence on the environment (Cancer patients are dependent on their environments, so influence on the environment enables their feeling of having some control)

Technical requirements

- The electronics in the chair works with the European 220 -240 Volts sockets
- The chair includes entertainment with a CE hallmark
- The multimedia system provides video, music, games, and internet access
- The multimedia system should be compatible with the hospital environments
- The system should be easy to clean for hygiene purposes

After formulating the requirements and the values, the aim is important. The aim has a strong connection with the users. The users are the patients in the hospital. But these patients are almost the same as normal kids. During the user-research the focus was on healthy children, because the sick children want to be like the healthy children. And the healthy children are kids who go to school, play with their friends, communicate through social media etc. Concluding, the aim is a chair that fulfills the wishes of healthy children.

And then the ideation starts with ideas and sketches. Fig. 2 shows some sketches of ideas. During this phase the results of the analyzing phase are continuously used. The results of this phase were three idea-concepts. The chosen idea-concept focused on privacy, safe feeling, full entertainment and a patient's own place.

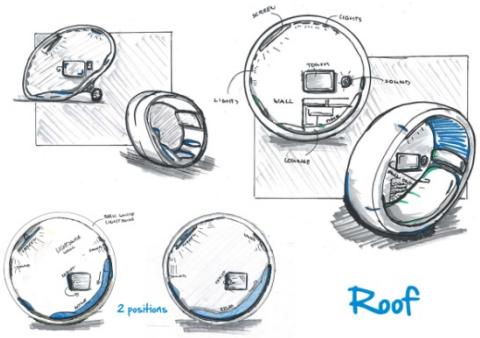

Fig. 2. Sketches of ideas

After the idea-concept choice, first iteration starts. Start from zero with this idea-concept and bring it to concept level. This means, adding materials, colors, ergonomics, multimedia details etc. To test the concept a scale model is made.

The fourth step is materialization. During this step, feedback from the previous phases has to be analyzed and serve as inputs for the new iteration. In this phase choices have to be made, nothing can be uncertain anymore. After this phase the design is producible by manufactures.

2.2 Design Concept

The design concept is to create a personal multimedia system for the patients, which is an escape from the isolation room, escape from the hospital, and escape from cancer. This place adapts to the user and creates a safe feeling. The technologies help the patient stay connected and provide entertainment options.

The basic idea is to create for the patient their own place in a chair, like a small room. This concept offers privacy, because the roof of the patient is covered, like sitting in an arcade-hall device. The person playing on the arcade unit game is totally in the game and feels like he has privacy, and in the meanwhile still a lot of people can see the person. The form of a circle came up by analyzing the patients during the analyzing phase. The patients live in a horrible circle of life. This design offers an Escape from the isolated life in a hospital ward through a circle shape chair.

Fig. 3. Design concept of a context aware multimedia chair

We envision a context aware multimedia chair as shown in Fig. 3. The chair will recognize the patient when he or she enters the chair. The chair will automatically change its preferences to the patient (sitting position, sound, ergonomics, lights etc.). The chair can give the patient information about its situation/disease. The chair can also adapt to the mood of the patient, for example cheer the patient up with entertainment suggestions.

The hard part of being a designer is to translate an idea-concept to a product. Based on the hardware availability and the requirements (e.g. hygiene, safety, etc.), only products with a CE mark will be integrated in the design.

Fig. 4 illustrates the concept of the multimedia chair. It is in a circled shape to provide a private and cozy feeling. The product concept needs a more defined multimedia and the experience we want to create. The multimedia technologies from WebChair BV (www.webchair.com) are integrated in the concept. With WebChair software and hardware, patients can communicate with their friends, family and school by using an all-in-one PC or tablet. The concept also consists of social media and web browsing by an Internet connection, Gameconsole (PlayStation 3) with online function to play games alone or with friends (multiplayer), and a big screen with stereo sound system for the great entertainment experience. In addition, an adjustable light strip is included to offer the patient some control in the environments. The chair is rotatable with flexible sitting positions, such as an active position for schoolwork etc., middle position for web browsing, gaming etc. and relaxation position for movies, sleeping etc. Medical casters are used for moving the chair to other locations if necessary.

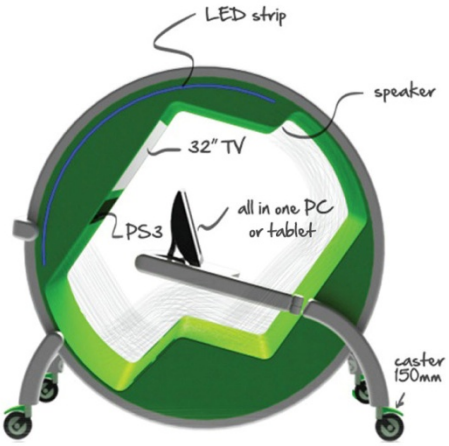

Fig. 4. Concept of the multimedia chair

By the design with the ambient multimedia systems, the child patient will forget that they are patients in a hospital and enjoy the multimedia and entertainment as a healthy child.

3 Prototype

To test this concept a prototype was made as shown in Fig. 5. This prototype is to see how the ergonomics are in this circle shaped chair, the feeling and how big it actually is.

Fig. 5. Prototype chair

The prototype was tested with 40 people. The most important part was the sitting position. Can a person sit well the circle of the "Escape". The ergonomics were

measured, but in reality it's always different. Overall the 1:1 model/prototype sits surprisingly well (especially for a wooden seat), but for people under the 1.70 has some problem with the seat length. Also the 1:1 model misses the lumbar and head support. This is necessary to sit for a longer time in the chair. The entertainment is on a nice distance from your body. With the overhead cover the users have the feeling that they have privacy. But still, the people around the chair can see the user. This is a very important part of the concept. Feeling privacy is important, but it is also important that the doctors can see the patient true the glass of the isolation room. And that the doctor can do checks while the patient is in the chair.

4 Product

After the materialization phase as described in Section 2, it is possible to produce the product. Figure 6 present the final design of the ambient multimedia chair - Escape.

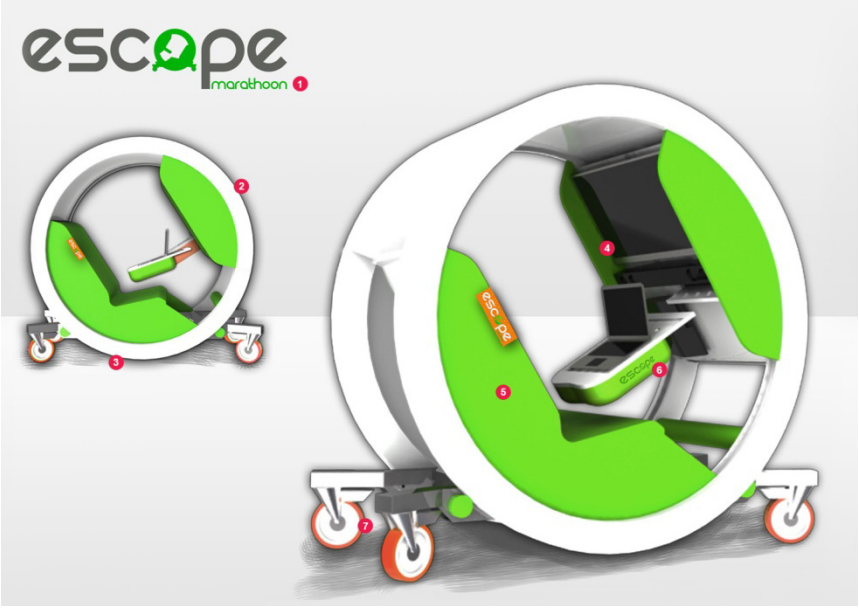

Fig. 6. Escape render with numbers

The key features of Escape is indicated on Fig. 6. They are the Logo, adjustable lamp, rotation and multi-sitting position, Multimedia networks for entertainment, easy clean and comfortable textile, removable desk, medical casters for mobility and fixation.

1. Logo

The escape is an iconic designed chair. The silhouette of the chair is represented within the Logo.

2. *Adjustable lamp*
This lamp is shown on this picture. But with this lamp the user has the possibility to adjust the color of the space around him/her. With this function, the patient feels like he or she has influence on the environment.

3. *Rotation and multi-sitting position*
The entire circle is rotatable; hence the chair can be adjusted to three stand/positions. Active position for schoolwork etc., middle position for web browsing, gaming etc. and relax position for movies, sleeping etc. The circle is rotatable because of the wheels placed on the steel construction at the outside of the chair.

4. *Multimedia networks for entertainment*
The escape has multimedia networks embedded for entertainment including a 32-inch 3D TV (Philips 32PFL6007), Playstation 3 with Move, Soundbar (Samsung HW-E350), Ultrabook (ACER ASPIRE S5) and lighting (Philips Living Colors). The multimedia networks have access to Internet so that children with cancer can communicate and stay connected with their family and friends. With the multimedia the patient can be virtually in the classroom (by using WebChair and the Ultrabook with webcam), play games in 3D (by the Playstation 3) with a controller but also with motion (Playstation Move), watch movies in 3D, brows over the web (by the Ultrabook and Playstation), use Social media (Ultrabook).

5. *Easy clean and comfortable textile*
The color green is chosen because of the positive emotions for children: Harmony, safety, growth and comfort.

6. *Removable desk*
The desk is included so the patient has a table to for example draw or make homework and also a place for the Ultrabook.

7. *Mobility and safe fixation*
The chair has to be mobile, but also safe. Medical casters are chosen for mobility and safe fixation.

Fig. 7. Product - The Escape

Fig. 7. shows the actual product to be used in the Catharina Hospital of Netherlands. The product has been exhibited in the Dutch Design Week in Eindhoven Oct. 2012.

5 Future Work

Further research and design will be conducted to design and implement the context aware multimedia chair to provide the adaptive personal entertainment experience. User research will also be carried out in hospitals to study the user experience with the proposed intelligent chair. The feedback from evaluations will be used as inputs for the design improvement.

6 Conclusion

Children with cancer staying in isolation rooms at hospitals often feel lonely and disconnected from their family and friends. In this paper, we present the design and development of the Escape, which is a chair embedded with multimedia networks. The chair is designed and developed to a product ready for hospital use, in collaboration with VanBerlo Design, Catharina Hospital, Webchair, and MaraThOON Foundation of the Netherlands, for improving these children's experience of their hospital stay and enhancing their bonding with the outside world.

Acknowledgment. The design process and manufacturing of the escape would not have been possible without the support and endless effort of a number of individuals. The authors are particularly grateful to Thomas Paulen and Prof. Ad van Berlo from VanBerlo Design, Graham Smith from Webchair, Dr. Natasja Dors, Dr. Edwin Knots and Dr. Vera Lagerburg from the Catharina Hospital Eindhoven, and Prof. dr. Sidarto Bambang Oetomo from Eindhoven University of Technology for their information, feedback and advising support. We thank Dr. Oliver Basu from the University Hospital Essen in Germany for hosting our visit to the hospital's high-tech isolation wards. We are very grateful to Harry-Anton Bloem from Foundation MaraThOON Netherlands for the advising and financial support.

References

[1] Childhood cancers, National Cancer Institute, `http://www.cancer.gov/cancertopics/factsheet/Sites-Types/childhood`
[2] Aarts, E.H.L., Encarnação, J.L.: True visions: The emergence of ambient intelligence, 2nd edn. Springer (2008)
[3] Tao, X.: Wearable electronics and photonics. Woodhead (2005)
[4] Yang, G., Yacoub, M.: Body sensor networks. Springer-Verlag New York Inc. (2006)
[5] Hwang, J.-N.: Multimedia Networking: From Theory to Practice. Cambridge University Press (2009)

[6] Liu, H., et al.: LsM: A New Location and Emotion Aware Web-based Interactive Music System. Presented at the Proceedings of IEEE International Conference on Consumer Electronics (ICCE 2010), Piscataway, NJ (2010)
[7] Tan, C., et al.: Sleeping Posture Analysis of Economy Class Aircraft Seat. In: World Congress on Engineering, London, U.K., pp. 532–535 (2009)
[8] Tan, C., et al.: Adaptive Framework and User Preference Modeling for Economy Class Aircraft Passenger Seat. In: Third UKSim European Symposium on Computer Modeling and Simulation, Athens, Greece, pp. 66–69 (2009)
[9] van Aart, J., et al.: EEG headset for neurofeedback therapy: enabling easy use in the home environment. In: International Conference on Bio-inspired Signals and Systems, pp. 23–30 (2008)
[10] Adami, A., et al.: Unobtrusive monitoring of sleep patterns. In: 25th Annual International Conference of the IEEE EMBS, pp. 1360–1363 (2003)
[11] Kaushik, A., Celler, B.: Characterization of PIR detector for monitoring occupancy patterns and functional health status of elderly people living alone at home. Technology and Health Care 15, 273–288 (2007)
[12] Bouwstra, S., et al.: Smart Jacket Design for Neonatal Monitoring with Wearable Sensors. In: Body Sensor Networks (BSN 2009), Berkeley, USA, pp. 162–167 (2009)
[13] Chen, W., et al.: Non-invasive blood oxygen saturation monitoring for neonates using reflectance pulse oximeter. Presented at the Design, Automation and Test in Europe - Conference and Exhibition 2010 (DATE 2010), Dresden, Germany (2010)
[14] Chen, W., et al.: Monitoring Body Temperature of Newborn Infants at Neonatal Intensive Care Units Using Wearable Sensors. To be Presented at the Fifth International Conference on Body Area Networks (BodyNets 2010), Corfu Island, Greece (2010)
[15] Potuzakova, D., et al.: Innovative Design for Monitoring of Neonates Using Reflectance Pulse Oximeter. In: 2011 7th International Conference on Intelligent Environments (IE), pp. 200–205 (2011)
[16] Chen, W., et al.: Wireless transmission design for health monitoring at neonatal intensive care units. Presented at the 2nd International Symposium on Applied Sciences in Biomedical and Communication Technologies (ISABEL 2009), Bratislava, Slovak Republic (2009)
[17] Chen, W., et al.: A design of power supply for neonatal monitoring with wearable sensors. Journal of Ambient Intelligence and Smart Environments 1, 185–196 (2009)
[18] Hazelhoff, L., Han, J., Bambang-Oetomo, S., de With, P.H.N.: Behavioral State Detection of Newborns Based on Facial Expression Analysis. In: Blanc-Talon, J., Philips, W., Popescu, D., Scheunders, P. (eds.) ACIVS 2009. LNCS, vol. 5807, pp. 698–709. Springer, Heidelberg (2009)
[19] Chen, W., et al.: Rhythm of Life Aid (ROLA) – An Integrated Sensor System for Supporting Medical Staff during Cardiopulmonary Resuscitation (CPR) of Newborn Infants. IEEE Transactions on Information Technology in Biomedicine 14, 1468–1474 (2010)
[20] Sheldon, K., et al.: What Is Satisfying About Satisfying Events? - Testing 10 Candidate Psychological Needs. Journal of Personality and Social Psychology 80, 325–339 (2001)