Congresso Internacional

COMUNICAÇÃO E LUZ

Madalena Oliveira & Sílvia Pinto (Eds.)

CS Atas

Título Atas do Congresso Internacional Comunicação e Luz

Editores Madalena Oliveira & Sílvia Pinto

ISBN 978-989-8600-58-5

Capa Imagem: António Silva / Composição: Pedro Portela

Formato eBook, 335 páginas

Data de Publicação 2016, abril

Editor CECS - Centro de Estudos de Comunicação e Sociedade
Universidade do Minho
Braga . Portugal

Diretor Moisés de Lemos Martins

Vice-Diretor Manuel Pinto

Formatação gráfica e edição digital Ricardina Magalhães

CECS
centro de estudos
de comunicação
e sociedade
PUBLICAÇÃO

Sumário

Da luz e do sentido 6
Sílvia Pinto & Madalena Oliveira

I. Luz e Pensamento 10

Sobre o conceito de *luz* na metafísica neoplatónica 11
Tomás N. Castro

A (à) luz do panoptismo: retidão e sinuosidades das omni e pluri modernidades 24
Pedro de Andrade

O fogo de Prometeu e a sociedade da comunicação 45
Alberto Filipe Araújo & José Augusto Ribeiro

A luz da espiritualidade na cultura pós-moderna 58
Dalila Monteiro, Paula Mascarenhas & Jean Martin Rabot

II. Ciência, pedagogia e visibilidade 73

Iluminando as mentes: da observação à disseminação dos fenómenos científicos 74
Luís Pinto

A Cultura Visual da Medicina e os prodígios da fotografia 87
António Fernando Cascais

A luz para além do visível 97
Sílvia Pinto & Sara Anjos

Let there be light... 105
Aida Alves, Celeste Magro, Conceição Marques, Dulce Geraldo, Fátima Bento, Isabel A-P. Mina, Jorge Pamplona, Luís Cunha, Luís Gonçalves, Paula Martins, Teresa Viseu & Alexandra Nobre

III. Perceção, tempo e cibercultura 117

The luminous shadow of materialism 118
Alex Gomez-Marin

Perception relativity simulacrum – how light becomes perception 129
Pedro M. Azevedo Rocha

Imagem, imaginário e o fenômeno glocal interativo: reflexões sobre a teleexistência conformada pelo neonomadismo 142
Lygia Sousa Ferreira & Lourdes Sousa Ferreira

Luz ou Escuridão? Um estudo comparado entre Brasil e Espanha 163
Alina Freitas Praxedes & Francisco Hugo Gutiérrez Iglesias

IV. Luz e o contorno dos espaços 174

Arquitetura essencial: luz, gravidade, ideia 175
José A. Domingues

A luz como material de construção: a Piscina das Marés em Leça da Palmeira 181
Eduardo Fernandes

***Lightning (from) the backstage*: Trienal de Lisboa / Bienal de Veneza - interações geradas pela Comunicação na mediação de eventos expositivos de Arquitetura** 192
Ana Vilar, Helena Pires & João Rosmaninho

À Luz da acessibilidade e da usabilidade em cidades/espaços urbanos: ecologia comunicacional inclusiva 208
Augusto Deodato Guerreiro

V. Arte e design pela luz 221

El binomio luz y pigmento, cinética del color. Caminos de expresión en la pintura 222
Guillermo Bellod & Francisco Javier SanMartín

Fiat lux, lux in tenebris, fiat lux et pereat mundus 238
Raquel Leite

A luz como matéria de projeto na licenciatura em Design de Produto da Universidade do Minho 244
Paula Trigueiros & Bernardo Providência

Augmented reality: the augmented construct of communication 257
Pedro M. Azevedo Rocha

VI. Projeções de luz 269

O papel da luz no desenvolvimento do cinema de animação 270
Alícia Moreira & Pedro Mota Teixeira

Luz e sombra na densidade dramática de uma personagem animada 282
António Ferreira, José Pedro Teixeira & Pedro Mota Teixeira

NOISEwear: development of an interactive garment that emphasizes noise through light 296
André Paiva, André Catarino, Isabel Cabral & Helder Carvalho

A luz no cinema de João César Monteiro 309
Henrique Muga

Será o videoclipe aos olhos dos jovens a "Luz" da comunicação da música? 317
Maria Joana Alves Pereira

O excesso de luz e a fragilização do ouvido 329
Madalena Oliveira

Paiva, A.; Catarino, A.; Cabral. I. & Carvalho, H. (2016). NOISEwear: development of an interactive garment that emphasizes noise through light. In M. Oliveira & S. Pinto (Eds.), *Atas do Congresso Internacional Comunicação e Luz* (pp. 296-308). Braga: CECS.

André Paiva, André Catarino, Isabel Cabral & Helder Carvalho
dmpaiva.s@gmail.com; whiteman@det.uminho.pt;
diascabral@gmail.com; helder@det.uminho.pt

University of Minho, Dep. Textile Engineering (Portugal)

NOISEwear: development of an interactive garment that emphasizes noise through light

Abstract

One of the factors that determine the quality of our daily lives are sound and noise. They can be a positive contribution to it, or a burden and stress factor, or even a health risk factor. Based on the premise that it is harder to ignore what we see than what we hear, the team developed a garment that senses environmental noise and shows it through lighting. In this way, people are made aware about the noise around them. In this paper, we describe and discuss the design process of the interactive garment developed, which communicates with the user and other people around through light.

Keywords

Interactive fashion; e-textiles; lighting textiles; wearable technology

Introduction

In our daily lives, we are constantly exposed to the physical phenomenon of sound. This can differ from very pleasant sounds to unbearable ones that cause pain to the ear – noise. However, it is ignored very often. When do we hear it? When one pursues silence or can't bare it, or when it is not like usual sounds. Since sound pollution is a current environmental and health concern, it is important to call society's attention to this issue. To do so, we intended to create a garment that would interact with the user and the environment, by transforming sound into light, considering that it is harder to ignore what we see than what we hear.

According to van Ligtenberg and Wanink A. (1982), Sound is the result of air pressure changes which are detected by our ear and interpreted by the brain as music, discourse and other forms of sound. The human ear is able to detect pressure changes between 20mPa and 100mPa, which represents a difference between 0dB and 120 dB.

Noise or sound pollution are the name given to unpleasant or undesirable sounds. According to Luigi Russolo (1967), noise didn't really exist until the 19th century. It only came along with the advent of machinery. The author considers that nature is usually silent and that was how life went on for centuries, except in some special cases, such as storms, hurricanes, waterfalls and some exceptional telluric events.

Sound pollution is one of the major issues related to urban degradation and it is a matter of public health (World Health Organization, 2011). Agents responsible for sound pollution include transports, industrial and commercial activities or simply loud music.

Results from studies that have been carried out to understand the relationship between noise and human health show that people may suffer psychological or physiological changes due to continuous exposure to noise (Chambel, 2005).

Some health issues related to noise include morning fatigue (Kluisenaar, Janssen, van Lenthe, Miedema & Mackenback, 2009), increase of anxiety (Hardoy et al, 2005), sleep disturbance (Hume, Brink & Basper, 2012), prevalence of mental disorders (Rocha, Pérez, Rodríguez-Sanz, Obiols & Borrel, 2012) or emotional responses such as anger (Miedema, 2007).

Given that sleep is fundamental for mental recovery (Breslau, Roth, Rosenthal & Andreski, 1996), it is suggested that subjects with a lower quality of sleep will be less capable of instantaneous reactions (reflexes) and more susceptible to mental disorders (Sysna, Aasvang, Aamodt, Oftedal & Krog, 2014).

The study conducted by Babisch, Berele, Schust, Kersten and Ising (2005) reveals that vision can predict the level of noise annoyance. Pauvonić, Jakolievć and Belojević (2009) suggests that, during the day, noise annoyance will be related to the number of transports, whilst, at night, it is related to the type of transport. Given the number of different noises, it is harder to recognize the origin of each singular noise during the day. On the other hand, due to a smaller number of noise sources at night, it becomes easier to recognize its origin and type. This relationship suggests that the recognition of sounds may increase noise annoyance, thus vision is an important sense to predict noise annoyance. This statement confirms the premise of "it is harder to ignore what we see than what we hear".

State of the art

Clothing is a skin that separates us from and connects us to environment. It is a constant communicator of emotions, experiences and meanings (Seymour, 2009). Today, fashionable wearables (garments, accessories or jewellery that combines style and functional technology) are a mediator of information and an amplifier of fantasy (Rheingold, 2000). According to Kirsten, Cottet, Grzyb and Thörster (2005), "clothing is the environment that we need and use every day".

Several smart clothing and interactive fashion projects have been reported in the literature. Some of those projects use light and sound to improve the functionalities and expression of the garments or to enable social interactions.

The Heartphones (Poh, Kim, Goessling, Swenson & Rosalind, 2005) combine light and sound, where sound is presented in the form of music and light has been used to measure heart rate. The system comprises a reflective photosensor that includes a phototransistor and a red LED, a processing unit, a display device and a radio transceiver. The sensor was inserted into the earbud, which is placed against the tragus when worn in the ear and the changes in path length of the incident light, caused by the volumetric changes in the blood vessels during cardiac cycles, indicates the timing of cardiovascular events and, consequently, the heart rate. The user can access this vital information through a mobile application. Light is here used as an input signal, instead of an output signal. In this project, function is more important than expression.

The HEART-DONOR (Beloff, 2008) is a vest created by Laura Beloff and Erich Berger that connects people through the display of heartbeats and the presence in social networks. A sequence of up to 30 heartbeats for each of the selected friends and family are recorded. These heartbeat rhythmic patterns are then displayed in a series of small lamps, one for each person, attached to the front of the garment. Each lamp is controlled by the heartbeat's "owner" Skype account: they will change from green to red and from red to green when the person goes offline or online, respectively.

Profita, Roseway and Czerwinski (2015) present a series of Lightwear (light-emitting wearables) designed to assist the treatment of Seasonal Affective Disorder (SAD). The brown golfer's hat is one example of the prototypes reported, which combines the looks of a classic male hat with the light therapy functionality. The attention given to emotional and social factors (i.e.: self-expression and social acceptance) is clear, since there was always the concern to create a garment that the person would want to wear, besides having its therapeutic benefits.

Yossifova and Kim (2004) have designed the HearWear, an electronic skirt that, just like NOISE, reacts to environmental noise and shows it through moving light patterns. It not only addresses the issue of urban noise, but enables people to visually express their noise experiences. According to the authors, the shared experience becomes fashion.

In the deep ocean (four to five thousand meters), where there is no sunlight, there are bioluminescence creatures that can create their own light. Vera Wang tried to present them to the world through her *Into the Deep* collection, where she used electroluminescent panels in fashionable garments to simulate the light those creatures can create. Alpha Lyrae is another one of her projects, but this time she puts light into clothing, displaying images that show the story of construction of the Universe (Flood, 2012).

When observing the evolution of smart clothing research, one can notice that there has been an increase in design concerns, rather than technology only. Although the first projects described in the literature were mainly technology driven, concerning only the exploration of new functionalities, the more recent projects also involve human aspects, physically, psychologically and socially.

Materials and methods

The starting point of the project follows a thought from Shiefferstein and Hekkert (2008) that highlights the importance of defining the concept and interaction before actually considering a specific type of product. Calling people's attention to environmental noise and using light as the primary feature set the framework for the experiment conducted.

After setting the concept, it was decided that clothing would be the platform to give shape to the communication of sound through light. Several garments were designed and one was chosen according to its relationship with the concept. The textile substrate – a black jersey knit fabric – was selected according to the garment's intended expression. The result was a black dress designed to show different colors in different areas of the garment, according to the noise level.

The next idea was to build the garment first and attach the LED strips to its surface. This would mean that the strips and the conductive yarns would be shown and that kind of expression wasn't desired. For aesthetical purposes, it was decided that the LED strips would be inserted in an inside layer to hide the strip and just show the LEDs, which led to repeating the cut and sew process, but now with a different approach. It was firstly thought that the LEDs could stay behind the black jersey knit fabric, but the dark color absorbs more light than lighter colors and that way the light would be expressed as weak dots, which wasn't the intention (Figure 1). It was thus decided to cut holes to show the LEDs, which meant to design a pattern of white dots along the dress, for when the system was disconnected. That means that the technology would affect the garment's aesthetics. The dress would be no longer a black dress.

Single color LED strips in three different colors were selected as the light emission material. Several ways of cutting and reconnecting LED strip segments were explored, including sewing textile conductive yarn. For aesthetical and functional purposes, the electronic components applied – control unit, sound sensor and battery – were located in the back, inside a pocket. Two functional issues were found in this construction: the connections between LED segments weren't strong enough to allow movement and, because the conducting yarns weren't isolated, it wasn't possible to build all the circuits necessary to connect the control unit to all the LED parts – back and front torso, skirt, sleeves and hood multiplied by three colors – since the yarns would touch each other.

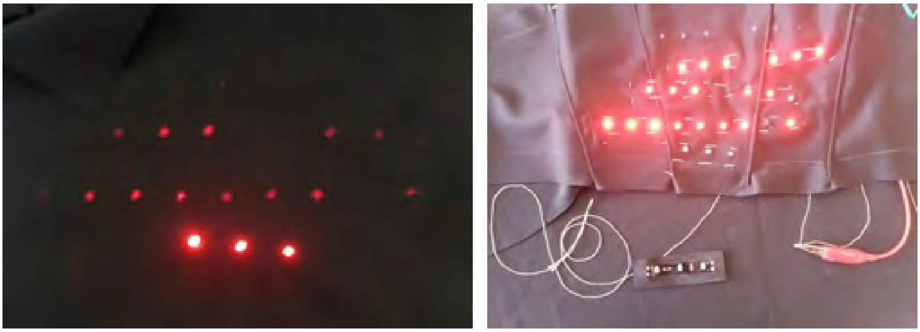

Figure 1: Light intensity difference between hiding the LEDs behind a black jersey fabric (left) and showing them (three stronger dots in the left figure and right figure)

The experience earned before by working and learning with the materials and the problems encountered in the first system led to the design and construction of a second prototype. The black dress was replaced by a white male jacket and the white dot pattern was now covered by a textile layer that would protect the LEDs from weather conditions (ex.: rain) and diffuse the light.

A polyester (PES) waterproof fabric was chosen as the outer shell and a 100% polyamide (PA) fabric for the lining. Although not entirely textile, a concept of a 3-layer interactive fabric was developed. The first layer is the lining, where the LED strips where attached. The middle layer is the PES fabric with holes cut, which are consistent with the LEDs positions. The outer layer is a waterproof fabric that protects the LEDs from moisture whilst allowing the light to pass through.

The jacket patterns were taken from the Gerber Technology book, *Méthode de trace de vêtements masculine sportswear.* The positions for each single LED were marked in the PES fabric and holes were cut. For a better finishing, ferrules were inserted in each LED hole (Figure 2). The conventional sewing method was used to join the parts, although ultrasound sewing would be preferable to make the garment truly waterproof.

The system includes a sound detector module from Sparkfun to measure the environmental noise, an Arduino Nano microprocessor and an EGLO 13532 RGB LED (light emitting diodes) strip set with infrared controller and power driver. From this set, the IR control was eliminated and wires were soldered to the power driver control inputs that were in turn connected to the Arduino PWM outputs, allowing control of LED's color and intensity. A pack of three Li-Ion rechargeable batteries (3x3,7=11,1 V) was used as the power supply. To carry the electronic system, a box was designed and printed in 3D (Figure 3).

The LED strip was cut in several spots that were then reconnected by soldering thin, isolated electric wire between them. This allowed the creation of a matrix pattern on the front and the back of the jacket. For the other electronic components, a pocket located in the back of the jacket was provided.

The system was programmed so the colors and intensity would change according to the intensity of the measured noise. A weak, slow white fade represents total silence and rapid blinking intense red shows the highest noise levels. Between these two, a continuous intensity increase, as well as a continuous color change from green to red, passing through blue, displays the measured noise level.

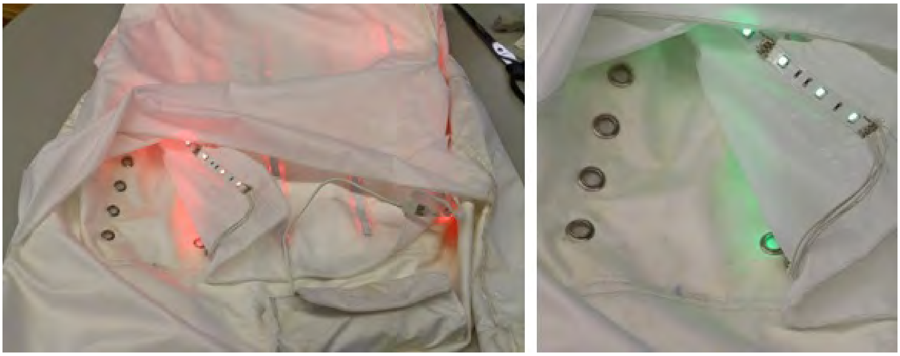

Figure 2: Jacket's interior (Left: Overview, Right: detail of ferrules and connections)

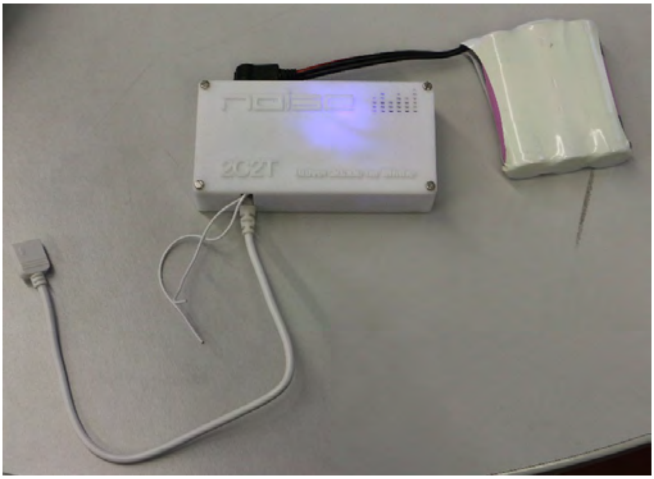

Figure 3: Electronic system inside a 3D printed box

To study how the garment would interact in different environments and how people react to this new form of fashion, a field study was conducted comprehending direct observation and video recording. Although this kind of fashion is becoming popular in some places around the globe, it is not much known in the small town of Guimarães, Portugal.

Results and discussion

When the jacket was tested in different environments (Figures 4 to 8), one could see the colors changing the way that was expected most of the time. In silent places, the jacket kept the white color, but a vehicle passing nearby was enough to change the color of the jacket – it would go from green to red, depending on the distance between the garment and the vehicle. Inside a bar with loud music, the jacket hardly changed from red to another color. When it changed, it would stay between blue and red, so the image was purple.

Figure 4: Outside, in a silent place (left); Walking on the street (right)

Figure 5: Near a bus, the LEDs turn to red and blink (left); The LEDs turn to green when talking (right)

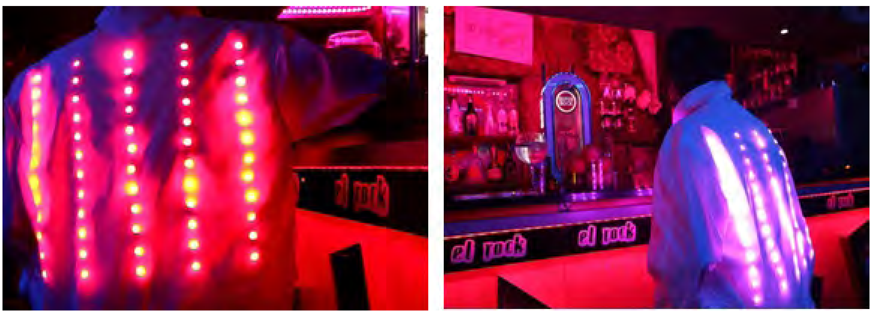

Figure 6: Inside "El Rock" bar; loud music; visual effects: purple (right) and intermittent red (left)

One of the problems detected was that in order to have more accurate results, the person wearing the jacket had to be still. Motion or the sound of the shoes when walking, for instance, was enough to produce a significant effect on the display. Since the jacket wasn't tight to the body, the system would move when the person moved, reacting to the noise of the box rubbing against the fabric, producing a false indication of environmental noise. Also, the connection between the LED strip and the control system broke after sitting and lifting up a few times, since it was located in the hip line.

The materials used in this first prototype are not suitable for a commercial application. As said before, the connection between the LED strips and the core system was broken. The changes between sitting and lifting up caused enough fatigue in the material to break. Another problem is the lack of flexibility of the materials, mainly the copper material. When bended, it stays bended until one turns it into its original form. Metal is also known for its plastic deformation. When bended, it forms cracks in the microstructure that continue to grow the more a person bends and unbends the materials, until it finally breaks. These are important aspects to take into consideration in future work.

It is important to observe a significant point in the design method of both prototypes.

For the first one, the shape of the garment was designed without a full understanding of this new material (how it expresses and how to work with it) which raised functional and aesthetical issues, as mentioned. However, it created the knowledge necessary to redesign the new garment. Light was explored again but not in the same way. The decision to replace the black with a white textile attained a relevant change of the garment's lighting expression. Only one RGB strip instead of several strips in different colors was used, which required a new way of designing with LED strips.

Designing with interactive materials demands for new approaches and design methods. Working with such new materials, the designer will have to acquire new skills and background knowledge (Berglin, Ellwanger, Hallnäs, Worbin & Zetterblom, 2005), meaning that a new method must be followed, as was observed in this project. Having a system that measures noise levels, analyses the data received and uses light as an output to show that information, changed the way the garment's design and development had to be thought. For instance, the same jacket could have been built with only one layer of fabric, but the insertion of an interactive system adds two more layers (although only in the areas where the LEDs are located). It changed the garment itself, but it also changed de process of making the garment, which follows Mazé and Redström's (2010) idea that the designer will have to rethink the design process.

As expected, it was possible to use light as a visual manifest of environmental noise. As stated by other authors, transports and loud music are primary noise agents and that was seen during the experiment. Although it wasn't possible to watch its reaction in a factory or nearby a building under construction, one can assume that it would react the same way, given the previous results.

It was also interesting to observe the effects that the garment had on people. Although it is not possible to state that the concept was consciously understood, no one was indifferent to the light interaction. Surprise and admiration for such a garment were stamped on people's faces and many comments were heard, pointing to the fact that it may well be "harder to ignore what we see either what we hear". Although specific colors were chosen to express different noise levels, the ingredient that probably evoked such emotions was the light and the way it changes with sounds.

Conclusions

Given the observations made during the experiment, it can be concluded that sight is an important factor to understand the effect of noise on people, as also discussed by other authors. People may ignore sound, but they will hardly ignore an image, especially if it is changing.

A concept of a 3-layer fabric with LEDs was shown. The goal for the project was not to pursue a higher level of integration, but inserting LEDs and electric circuits in a fabric during the weaving process is desirable and would be an interesting subject of study. A fabric with these components using a jacquard textile machine was already proposed in (Schifferstein & Hekkert, 2008), but the LEDs were soldered after the fabric was finished.

It was also possible to analyze that people were receptive to the experience created through the Noise jacket interaction. However, it cannot truly be stated that they are culturally ready to start wearing such interactive garments. The tests conducted to the garment were mainly technical and related to the light's expression. These are not enough to fully understand social variables. Future work will approach a survey research to further elaborate on this statement.

The issues detected were mainly design oriented, as well as the solutions. For the problem of the broken connection, a simple solution is to move the core device to another part of the garment or to further protect the connections mechanically. Besides that, the project requires a review of the materials and construction decisions in order to optimize the garment usability and interactive behavior. This will make possible the application of similar systems in other context, such as in sports, rehabilitation, and other areas, for example as a visual indication of danger, effort or accomplishment of objectives.

Acknowledgement

This work is supported by Portuguese National Funding, through FCT – Fundação para a Ciência e a Tecnologia, in the framework of project UID/CTM/00264/2013.

References

Babisch, W.; Berele, B.; Schust, M.; Kersten, N. & Ising, H. (2005). Traffic noise and risk of myocardial infarction. *Epidemiology*, 16, 33-40.

Beloff, L. (2008). The Curious Apparel: Wearables and The Hybronaut. *Intelligent Agent, 8*(1).

Berglin, L.; Ellwanger, M.; Hallnäs, L.; Worbin, L. & Zetterblom, M. (2005). Smart Textiles – What for and Why? *The Nordic Textile Journal*, *2005*, 47-49.

Breslau, N.; Roth, T.; Rosenthal, L. & Andreski, P. (1996). Sleep disturbance and psychiatric disorders: a longitudinal epidemiological study of young adults. *Biol Psychiatry, 39*(6), 411-418.

Chambel S. (2005). Ruído e o Ambiente. Ideias e Ambiente. Retrieved from http://www.ideiasambientais.com.pt/ruido_ambiente.html.

Flood, K. (2012). Experience Vera Zaichi Wang's Electroluminescent Fashion Colletion Alpha Lyrae. Retrieved from http://thecreatorsproject.vice.com/.

Hardoy, M. C.; Carta, M. G.; Marci, A. R.; Fiona, C.; Cadeddu, M.; Kovess, V.; Dell'Osso, L. & Carpiniello, B. (2005). Exposure to aircraft noise and risk of psychiatric disorders: the Elmas survey. *Social Psychiatry and Psychiatric Epidemiology*, *40*, 24-26.

Hume, K.; Brink, M., & Basner, M. (2012). Effects of environmental noise on sleep. *Noise & Sleep*, *14*(61), 297-302.

Iossifova, M. & Kim, Y. (2004). HearWear: The Fashion of Environmental Noise Display. *SIGGRAPH 2004: The 31st International Conference on Computer Graphics and Interactive Techniques*

Kluisenaar, Y.; Janssen, S. ; van Lenthe, F.; Miedema, H. & Mackenback, J. (2009). Long-term road traffic noise exposure is associated with an increase in morning tiredness. *Journal of the Accoustic Society of America*, *126*(2), 623-633.

Kirsten, T.; Cottet, D.; Grzyb, J. & Thörster, G. (2005). Wearable electronic systems – Electronic Textiles. In T. Xyoming (Ed.), *Wearable Electronics and Photonics* (pp. 177-197). London: Woodhead Publishing Limited.

Mazé, R. & Redström, M. (2010). Methods (and Madness). In M. Redström; J. Redström & R. Maz'e (Eds.), *IT+Textiles, The Interactive Institute* (pp. 30-45)

Miedema H. (2007). Annoyance Caused by Environmental Noise: Elements for Evidence-Based Noise Policies. *Journal of Social Issues*, *63*(1), 41-57.

Pauvonić, K.; Jakolievć, B. & Belojević, G. (2009). Predictors of noise annoyance in noisy and quiet urban streets. *Science of the Total Environment*, 407, 3707-3711.

Poh, M.; Kim, K.; Goessling, A.; Swenson, N. & Rosalind, P. (2009). Heartphones: Sensor Earphones and Mobile Application for Non-obstrusive Health Monitoring. *International Symposium on Wearable Computers*, 153-154.

Profita, H.; Roseway, A. & Czerwinski, M. (2015). Lightwear: An Exploration in Wearable Light Therapy. *Proceedings of the 9th International Conference on Tangible. Embedded and Embodied Interaction*, 321-328

Rheingold H. (2000). Tools for thought: the history and future of mind. *Cambridge: MIT Press*.

Rocha, K.; Pérez, K.; Rodríguez-Sanz, M.; Obiols J. & Borrel, C. (2012). Perception of environmental problems and common mental disorders, *Social Psychiatry and Psychiatric Epidemiology, 47*(10), 1675-1684. Doi: 10.1007/s00127-012-0474-0

Russolo L. (1967). The Art of Noises. *Something Else Press*, p.4

World Health Organization. (2011). Burden of Disease from Environmental Noise. Copenhagen.

Schifferstein, H. & Hekkert, P. (2008). Product Experience. *San Diego, CA: Elsevier*, p. 525

Seymour, S. (2009). Fashionable Technologies: The Intersection of Design. Fashion. Science and Technology. *Wien: Springer-Verlag*.

Sysna, K.; Aasvang, G.; Aamodt, G.; Oftedal; B. & Krog, N. (2014). Road traffic noise, sleep and mental health. *Environmental Research, 131*, 17-24.

van Ligtenberg C. L., Wanink A. (1982). *Basics of Audiology,* Philips. Retrieved from http://www.web.uwa.edu.au/__data/assets/pdf_file/0005/786650/booklet1.pdf.