SENSORY AUGMENTATION BY MEANS OF WEARABLE TECHNOLOGY: SUPPORTING INTERCULTURAL ADAPTATION THROUGH LANGUAGE LEARNING

IDE MASTER THESIS 2018

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TU Delft

NOKIA Bell Labs

RESPONSIBLE DESIGN FOR OUR FUTURE

"As designers, we must become more aware of the impact we cause in a complex world we do not fully understand."

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The work described in this thesis was carried out at the Department of **Industrial Design Engineering** from **Delft University of Technology,** The Netherlands.

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NOKIA Bell Labs

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ABSTRACT

It is known that the distinctive relationship of the Millennial generation with technology has brought two icons of the current lifestyle, mobile phones and online social networks, which it is often considered as a badge of generational identity. The accelerated rise of smart devices has enabled modern society to reach amazing levels of productivity in regular lives. On the other hand, technology has contributed to increase the “absent presence effect”, which is described as an individual is physically present but is absorbed by a technologically mediated world of elsewhere. This phenomenon has affected the quality of interpersonal relationships and the ability of individuals to accurately read verbal and non-verbal codes. In a higher multicultural context, as a consequence of the process of globalization these verbal and non-verbal communication coding systems are learned and passed on as part of the cultural experience, therefore, a cultural-specific knowledge (knowledge of intracultural communication) is required regarding the different verbal and non-verbal communication codes from a particular culture in order to understand and respond accurately to different the social interactions presented during the socialization process among different cultures.

This research proposes wearable technology as the preferred tool of communication for the human being, with the potential of improving human intercultural adaptation. Although wearable technology has the potential to assist all the dimensions of intercultural adjustment (verbal and non- verbal communication elements) however, for the purpose of this study, it has been decided to focus on one of these dimensions, direct communication (language barrier). Language is considered as the most relevant mediator that allows the human being to relate and understand each other. Hence, its importance as an initial approach to wearable technology assistance in intercultural adaptation.

The design proposal exposed in the present document aims to show the advantages that wearable technology can offer through the implementation of sensory augmentation principles, to improve and encourage an individual in his language learning process. In addition to the integration of augmented reality systems as a provider of a motivating, entertaining, and engaging learning environment. Thus, allowing the individual to be involved in a rich real-time support environment as he performs his daily activities (learning through direct experience).

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INTRODUCTION

Nokia is identified as a pioneer in the sector of telecommunication technologies by laying the foundations of communication mobility, which has shaped the lifestyle of millions of people. In line with the above, it is also a fact that mobile devices have taken an unprecedented protagonist role while impacting human communication, becoming obtrusive. Nevertheless, new technologies need to adapt and evolve according to the current and forthcoming demands of the human being, especially with the phenomenon of globalization, which has triggered and promoted higher intercultural exchange across the world. Therefore, it requires proper intercultural communication processes that allow accurate reflections about diversity and relationship among individuals from different cultural backgrounds. Additionally, Bell Labs envisions the future of wearable technology as the communication tool of choice of the human being. It considers that the application of computational social science, big data, computer vision, social media, and culture analytics (among other disciplines), it will promote the development of human-centered technologies. The earlier approach can trigger a paradigm change in the implementation of the wearable technology, which it is often based more on their technical capabilities rather on the impact or consequences in human behavior.

The present document is a joint effort with Delft University of Technology and Nokia Bell Labs, both known for their design-based research. This partnership has the aim of creating a design proposal that explores the advantages of wearable technology as a medium for improving human intercultural adaptation. This research will present how the intersection of technology with the evolution of human communication and interaction needs can trigger a higher potential for adoption and acceptance of the wearable technology.

This report guides the reader the process followed to achieve the earlier mentioned goal, with a strong research-based development that explores the impact of technology on human communication, intercultural adaption, the possibilities of wearable technology and augmented reality as an emerging technology. Elements which will lead to the structuration of a concept design, which will be tested and improved through a series experiential prototypes. Upon completion, an elaborated final design proposal is developed and presented, which will be evaluated for further recommendations that could be implemented in later on. Leading to the identification of future research areas that can be developed more extensively in forthcoming projects.

1.0 ABOUT NOKIA.

This chapter aims to provide a brief overview and introduction to Nokia history and breakthroughs, its current main divisions, Nokia Technologies, and Nokia Bell Labs, nevertheless, it is not the intention of the present document to provide detailed information about its customer segments, brand comparison, and competitors, on the other hand, if it has emerged further interest, this material can be found in more depth in the document "Nokia: Innovation and Possibilities" published by the company in 2016.

NOKIA'S ORIGINS

Nokia is a Finnish company known for its telecommunication technologies, which beginnings date back to 1865 as a ground wood pulp mill, emerging as Nokia Corporation until 1967. However, the setting of the birth of its telecommunications business started in 1960 , which eventually will Nokia to get more involved in producing telecommunications devices, network equipment and digital switches for the telephone exchange during the 1970's (Mohammed Azlan bin Mohamed Iqbal & Borhanuddin, 2016).

Later on, Nokia acquired Telefenno from the Finnish government, changing its name to Nokia Telecommunications in 1992 and allowing breakthroughs in telecommunication technologies with the development of the Global System for Mobile Communications (GSM), the dominant technology in the mobile telecommunication industry in the 1990's.

Nokia is considered as the world's largest mobile phone manufacturer until 2012, in a combined effort with Siemens Network in 2007 to lead the global telecommunications infrastructure to focus on mobile broadband technology and services (Mohammed Azlan bin Mohamed Iqbal & Borhanuddin, 2016).

In January 2016, the acquisition of Alcatel Lucent, including its integrated business division, Bell Laboratories, giving rise to Nokia Bell Labs. This transaction is considered as part of Nokia strategy to become a leader in smart products, innovative services for mobile and telecommunications (Nokia: Innovation and Possibilities, 2016).

1.1 NOKIA TECHNOLOGIES & NOKIA BELL LABS.

Nokia a global leader in the technologies that connect people and things powered by the innovation of Bell Labs and Nokia Technologies. While Nokia Bell Labs serves as the research arm and innovation driver, Nokia Technologies focuses on advanced technology development. As a result, Nokia Technologies is able to build new ideas through its technology incubation program developed in Bell Labs (Nokia: Innovation and Possibilities, 2016).

Bell Labs aims to produce disruptive innovations for the next phase of human existence by conducting breakthrough and game-changing research on emerging technologies that will contribute solving the main concerns affecting the Information and Communications Technology industry. Constantly working on short and mid-term research projects with the promise of significant market impact when directly incorporated into Nokia products, thus, providing solutions with value for customers. It is considered as a leading research organization on the fields of Information Technology and Communications. (Nokia: Innovation and Possibilities, 2016).

Nokia Technologies it is focused on the development of advanced consumer and professional technology products in digital health and digital media, as well as the Nokia brand for mobile devices

It pursues new business opportunities building on the innovation supported by Bell Labs, developing and licensing cutting-edge technological breakthroughs, and creating brand partnerships in order to promote the value of the Nokia name in consumer devices.

Bell Labs supplements and complements Nokia Technologies innovation capacity efforts, setting the global standard in research to find the solutions of problems in information and communication technology with the potential to fundamentally change the way people communicate with each other and the world around them.

1.2 NOKIA'S VISION & MISSION.

Nokia has proposed itself the mission of enabling people to connect with one another and to information regardless of time and place (van der Linden et al., 2007). In addition, it is acknowledged that the Social Value of Nokia is about making people feel close to each other, a proof of this, is its well-known brand slogan is Connecting People (Roto et al., 2008). Said slogan, is representing what is considered as an increasingly important value in contemporary societies, connectedness (Poveda & Svensson 2012).

Nokia became a largely recognized brand due to the fact it was able to understand that mobile communications tools (handsets) serve as an extension a of the identity of an individual, in this respect, they promoted the approach on mobile phones as a fashion accessories (Alcacer et al., 2010). Nokia has focused on designing technology in the service of people, driven by its vision of expanding the human possibilities of technology of the connected world by deploying self-managing technology that works invisibly in the background, while adapting in order to anticipate the needs of the individuals (Nokia: Innovation and Possibilities, 2016).

Figure 1.1 Representative Image for Nokia's Slogan

1.3 NOKIA DESIGN PHILOSOPHY.

Due to the fact that Industrial Design discipline is an area of interest for this research, it is considered important to explore Nokia Design Philosophy around the development of its commercial products. A good understanding of the design drives behind Nokia product design will lead to an effective implementation of the brand values for a future development concept.

Product design has a key role as a persistent and non-arbitrary reminder of the core values of any brand (Karjalainen & Snelders, 2010), thus, Nokia is not an exception, where bold, innovative lifestyle-orientated product design, has become a substantial part of the rise of Nokia, driven by the exploration of new applications of available resources and capabilities (Ravasi & Lojacono, 2005).

It is suggested that Nokia works with semantic translation to determine its core values, semantic meaning in product design is constructed through a triadic interaction or relationship (Møller, n.d, Pierce Edition Project, 1998). Based on the above, and considering its Scandinavian design roots, Nokia is a company whose design values are built on friendliness, comfort, functionality, and human-centeredness; earlier phones of Nokia have been proof of that, where general curves of the phone were used to express user friendliness (Møller, n.d.).

Through the pass of the years, it is wise to say that Nokia has gained expertise and maturity a in the field of product design by addressing individual needs and lifestyles, therefore, emphasizing principles such as personalization, simplicity and style (Ravasi & Lojacono, 2005). Nokia considers design innovation as its core competence, thus it has the need for a flexible design philosophy (Karjalainen & Snelders, 2009), in order to adapt to of the users.

Figure 1.2 New Nokia 3310

1.4 NOKIA'S OUTLOOK IN WEARABLE TECHNOLOGY.

In June 2016, Nokia acquired Withings, the French health-tech company which focused on the development of consumer electronics, including smartwatches, fitness trackers, connected thermometers and baby monitors. Withings, now folded into Nokia Technologies and its Research Development Department, allowed Nokia to set its entrance to the wearable technology market (Tech Times, 2017), and bringing it back into consumer devices, with a focus on the growing IoT (Intelligence, 2016). An example of that, it is the smartwatch called Steel HR, a comprehensive activity tracker reporting right to a smartphone.

Withings and Nokia Technologies has formed the basis of the digital health business sector of Nokia (Best, 2017). The advances in health technology are driving interest in wearables, most commonly used for fitness-tracking purposes, however, showing great potential for widespread adoption in the healthcare sector (Intelligence, 2016). Nokia through its Digital Health division aims to reinvent health care by transforming the relationship people have with their well-being, by unlocking the potential of connected health devices. Providing the tools people need to take control of their own health (Nokia, 2017).

Figure 1.3 Nokia Steel HR

Simultaneously, Nokia Bell Labs has a long and distinguished history of supporting the creation and production of new art by leveraging its in-house technological skill and innovation, The Experiments in Art and Technology Lab, which fosters meaningful exchange between fields and exploring the human condition at the beginning of the electronic era. Nokia Bell Labs, has the interest to expand the possibilities of artistic expression and technical innovation for the future of wearable items. The collaboration announced in May 2017 aims to develop a sentient garment that engages emerging technologies, including Augmented Reality (AR), Virtual Reality (VR), Internet of Things (IoT), haptics and augmented intelligence (Bell-labs.com, 2017).

On the other hand, Domhnaill Hernon (Innovation Incubation Head of The Experiments in Art and Technology project at Nokia Bell Labs), expressed in The Electronic Engineering Times magazine through the article "Wearables Need Fresh Design Style", the mission of Nokia Bell Labs to invent the future and solve the greatest human need challenges that could arise in the time frame of five up to ten years, by applying "future back thinking" to predict the intersection of technology with the evolution of human communication/interaction needs.

Furthermore, he points out that wearable market has failed to explode because wearables today do not solve real human needs, technology should enable people to fulfil towards self-actualization and transcendence rather than focus on physiological and safety needs. Hernon believes that properly designed wearables have the potential to positively disrupt how the technology today for the betterment of humanity, therefore, develop human-centric technologies.

"CURRENT WEARABLE TECHNOLOGY FALLS FAR SHORT OF ITS POTENTIAL BECAUSE OF A SILOED APPROACH TO DESIGN, A LACK OF INTERDISCIPLINARY R&D AND A GENERAL INABILITY OF PRODUCT DESIGNERS TO SOLVE REAL HUMAN NEEDS."

- Domhnaill Hernon -

Head of The Experiments in Art and Technology

Nokia Bell Labs

Figure 1.4 Nokia Headquarters in Espoo, Finland.

1.5 CONCLUSIONS.

This chapter presented a general overview of Nokia, including its Design Philosophy and its perspective regarding the wearable technology. The study of this information allowed to identify what are the core values of the brand that drives their product design, which are friendliness, comfort, functionality, and human-centeredness. As is well-known, an expected outcome of this research is to develop a future concept design, therefore these elements should be implemented in the final proposal wherever possible.

It exists the interest from Nokia to explore wearable technology, as its strategy would suggest, it has two fronts; on one hand, with the acquisition of Withings enabled the exploration and introduction of Nokia to the wearable market by developing consumer products mainly focused on the healthcare sector (Digital Health). On the other hand, Nokia Bell Labs has shown interest in the wearable sector in a broader scope through its Experiments in Art and Technology Lab, which aims to expand the possibilities of artistic expression and technical innovation for the future of wearable items.

As mentioned earlier, Bell Labs is the innovation incubation program of Nokia, whose discoveries are often implemented on Nokia Technologies, therefore, it is possible to envision that in the future the range of wearable products will increase.

Furthermore, Bell Labs has opted for the study of the diversification of wearable technology, by focusing on computational social science, which includes big data, computer vision, and culture analytics to understand human behavior. Therefore, it aims to predict how future wearable technology will be implemented as the communication tool of choice of the human being.

2.0 EXPLORING WEARABLE TECHNOLOGY.

Wearable technology is a term that refers to garments or accessories that are created or enhanced using electronics (King, 2011). Wearable Technology aims to serve users by providing them with information or entertainment (Buenaflor & Kim, 2013) and due to their proximity to the body, it can be applied to monitoring information about the user or his/her surroundings (Svanberg, 2013).

WEARABLE'S ORIGINS

The distinction between wearable technology and wearable computers is blurry, wearable computers are considered as part of the larger classification of wearable technology, therefore, it is a term used to describe different forms of body-mounted technology, which includes wearable computers, smart clothing, and functional clothing (Dunne, 2004), see **Figure 2.1**. For the purpose of this research, when referring to Wearable Technology, it is considered as the electronic technologies or computers incorporated into items of clothing and accessories which can be worn comfortably on the body (Tehrani & Michael, 2014).

It is suggested that the first form of wearable technology was the wrist watch, which has been said it was invented as early as the late 1500's (Childers, 1999). The watch was a technology designed to provide a specific service, thus, the desire for continuous service access has pervaded in the development of wearable devices (Dunne, 2004). On the other hand, it is true that wearable technology has promoted a new type of human–computer interaction with the development of information and communication technology, its attributes of mobility and connectivity allow access to online information conveniently when moving, nevertheless, at the same time it has raised several social and cultural barriers (Lee et al., 2016; Billinghurst et al., 1999; Dvorak, 2008).

Although it has been decided to address the definition of Wearable Technology proposed by Tehrani & Michael in 2014 (described above), it is important to approach the broad scope that wearable technology offers in order to understand its different areas, which includes wearable computers, smart clothing, and functional clothing. Therefore, **Figure 2.2** is focused in a brief description of each field.

Nevertheless, Wearable Technology could be considered as the intersection of the fields of dominant computing and functional clothing design (Dunne, 2004).

Figure 2.3 Wearable Device Example

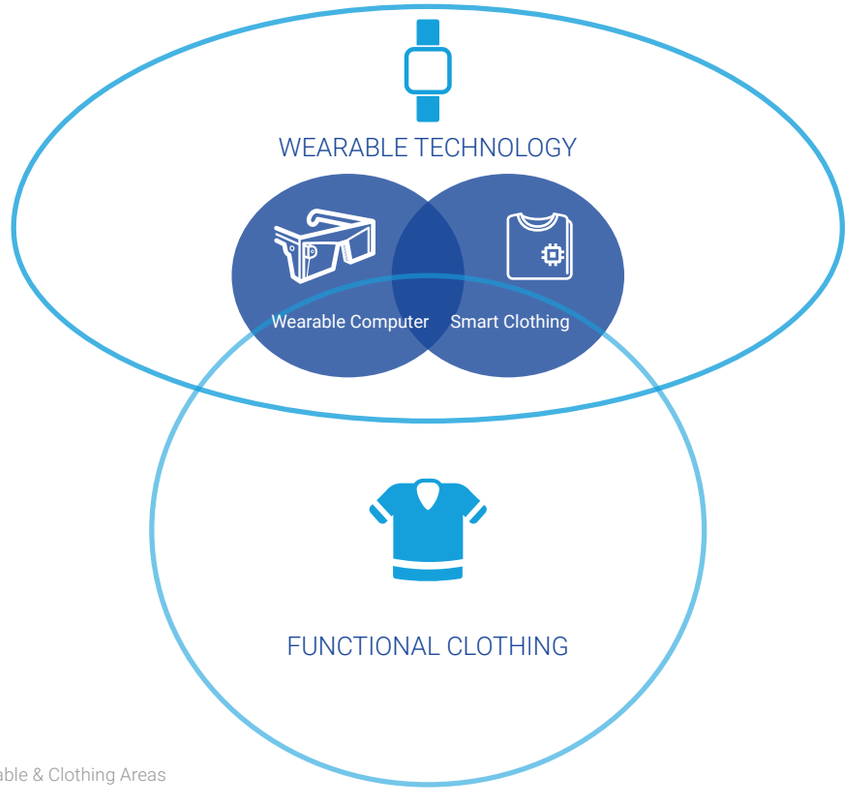


Figure 2.1 Wearable & Clothing Areas

WEARABLE COMPUTERS

Are considered as electronics housed within a fashion accessory such as a bracelet or a watch, this enables consumers to carry out tasks in a relatively unobtrusive way, leading to increased levels of productivity or enjoyment. (Page, 2015; Rackspace, 2013).

SMART CLOTHING

To this group belongs smart textiles that are using either the physical properties of the material, or electronics woven into the fabric, allowing to measure and/or react to stimuli from the user or environment (Page, 2015; Hertleer et al., 2012).

FUNCTIONAL CLOTHING

It addresses the ability of clothing to assist the natural mechanisms of the body to regulate temperature, manage moisture transport, protect from environmental hazards, and resist impact and abrasion by using passive technologies: performance fabrics (Dunne, 2004).

Figure 2.2 Wearable Technology & Clothing Areas

2.1 CLASSIFICATION AND APPLICATION OF WEARABLE TECHNOLOGY.

The 21st century has been the entrance to the advanced stage of development for wearable devices, its complexity has driven their design according to the needs of users and market, therefore, it is expected that in the following years wearable devices will enter into a period of prosperity (Jiang et al., 2015). In addition, the number of wearable devices will approach 130 million by 2018 according to Juniper Research (Mobile Smart Wearable Device Shipments, n.d.), although it should be considered that wearable market is currently dominated by smart watches and fitness trackers, thus, its user-base consists predominantly of early adopters in technology and those involved in the quantified-self movement (Öste, 2015), however, it does not mean that developers are not looking at the whole human body as an opportunity for connectedness (The Wearable Future, 2014).

It is considered that there are two standards for classifying wearable devices (G. Chen, 2014). One standard is based on product form, which consists of head-mounted, hand-worn, and foot-worn elements. On the other hand, the second standard is based on product functions, including healthy living, information consulting, and somatosensory control. However, it is important to keep in mind that wearable devices show more features as they continue evolving, such as diversity and concealment (D. Y. Chen, 2000).

Based on the classification proposed by G. Chen (2014), the research will focus on market segmentation of wearable technology in terms of product function, due to the fact that this study it is considered as application driven project in the wearable field. As consequence, it is considered as suitable to suggest the market segmentation developed by Beecham Research, Ltd., in collaboration with Wearable Technologies AG, whose complete study can be found in the document "Wearable Technologies: Towards Function with Style". Said article provides a market segmentation divided in eight sectors, matched with their respective applications and functions (**Figure 2.4**).

Based on **Figure 2.4**, it is possible to suggest that the area of interest for this research lies in the areas of communication and lifestyle, due to the fact they fits the best to the vision and mission of Nokia (Chapter 1.2). The mentioned areas involve interactions through social media and multimedia elements, as a matter of fact, it has been estimated that entertainment, media and communications companies have the largest opportunity for growth in the wearable technology market in order to create new genres of communication and entertainment (The Wearable Future, 2014). Additionally, Nokia current divisions (Nokia Technologies & Nokia Bell Labs), are currently exploring wearable applications in the wellness sector with the Steel HR and the glamour sector through collaborations with fashion tech designers. Hence, the present document offers the opportunity to explore the possibilities that the combined areas of Communication and Lifestyle can provide in wearable technology applications.

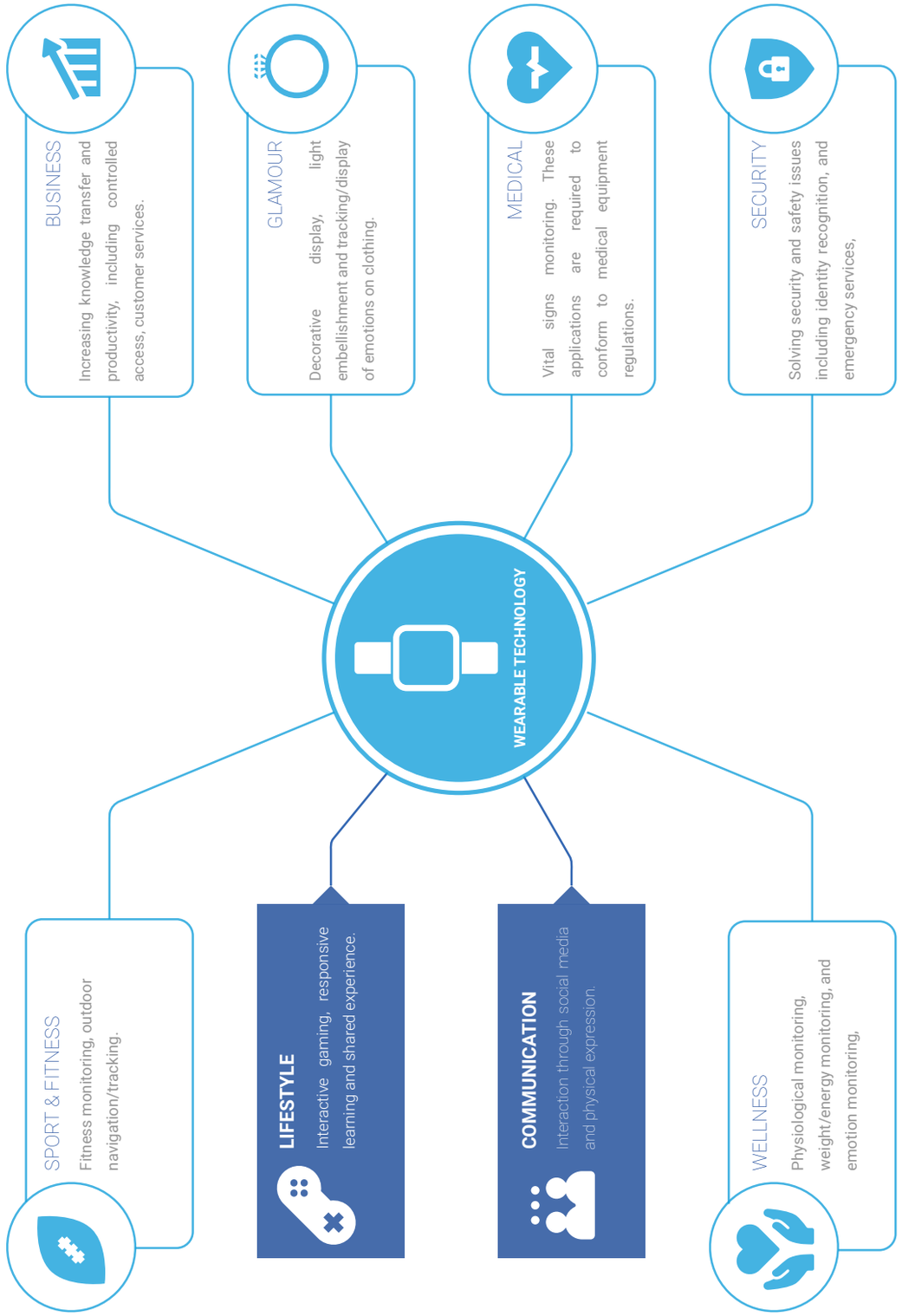


Figure 2.4 Wearable Technology Market Segmentation based on Beecham Research.

2.1.1 Human Socialization as the Next Phase of Wearable Technology.

In recent years wearable technology has begun to support networked social interaction, applying functionalities such as messaging, calendars, email, and other social coordination and connection tools (Pizza et al., 2016). This is evident with the development of applications such as Snapchat Micro, a messaging app released specifically for the Galaxy Gear Smart Watch which allows users to send snaps directly from this device (Isbister et al., 2017). Although smartphones have brought social media to the daily basis of human beings, wearable technology has the potential to bring social media even closer to the everyday living, by offering social information with even further prompt means, especially for straightforward notifications.

It is expected that wearable technology will create a new humongous means of data capturing, seamlessly sharing it with social media, nevertheless it is crucial to keep in mind that Social Media applications will work different from platform to platform, therefore, it will be crucial to anticipate accordingly the future demands of the users in order to succeed in the field (Kumar, 2016). On that basis, wearable technology can offer new possibilities for online social interactions, on the other hand, there is evidence that wearable technology has become seen as disruptive in colloquial interactions (Levy, 2014), therefore, upcoming challenges arise in the usage of wearable technology as a medium and promotor of offline interactions as well.

Specialists in the subject consider that the next phase of development for Wearable Technology is the so called “The Social Age of Wearable Tech”, enhancing the ability of human body to communicate, express, and empathize with others (Cosco, 2016; Isbister et al., 2017). However, wearable technology has not yet started to support actively face to face interactions (Lundgren et al., 2015), hence, the essence of wearable technology should not lie in its digital characteristics, but rather in the relationships with the world enabled, through its usage. (Tamminen & Holmgren, 2016).

2.2 THE CHALLENGES OF WEARABLE TECHNOLOGY.

Despite the efforts of major technology companies such as Google or Samsung in the exploration and demonstration of the potential of wearable technology through the pass of the years (The Wearable Future, 2014), as yet there are physical, cultural and design barriers that do not allow wearable technology be extended as it could be expected. Wearable technology introduces new social concerns, as it can mediate the ways in which an individual is perceived by others, interacts with others, and manages his/her surroundings (Dunne, 2004).

This research has identified and proposed the following challenges that should be overcome in the wearable technology field for the purpose of envision a new paradigm shifting, which are described in more detail on the following sub-themes.

Figure 2.5 Google Glass.

2.2.1 Improving Aesthetics: Gadget Accessory V.S. Fashion Accessory.

Aesthetics is considered a key part of the brand strategy for companies, providing a competitive advantage, consumers are subject to sensory experiences (visual, auditory, olfactory, tactile), which can impact on their initial decision, providing a pre-reflective judgment of a product (Simonson & Schmitt, 1997). Although an aesthetic experience is a subjective construct between artefact and viewer, the concept of taste is becoming increasingly relevant in the field of Human Computer Interaction field, where Wearable Technology is one of its domains (Wright et al., 2008, Boehner et al., 2008).

A wearable device, no matter how much aesthetic advances it represents if its visual perception still remains as a tech accessory rather than a fashion accessory (Friedman, 2017). This could be the consequence of current wearable technology seems to prioritize the technology aspect more than the wearable element, by trying to miniaturize as much as possible its technology (processors and internal components) in a wearable item. Which it often results in aesthetic sacrifices for functionality (Eadicicco, 2014).

It has been suggested to move from terms such as 'wearable computing' and 'user' and replace them with "jewelry" and "wearer" to highlight their constant and intimate relationship (Wright et al., 2008).

Technology allows self-expression and digital jewelry could be seen as a different approach that could offer an aesthetically appealing design which forces the technology to subtly blend or even disappears (Miner et al., 2001).

On the other hand it is believed that the aesthetics of wearable devices does not always fit the changing fashion trends consumption (Kindred, 2005). However, the potential of using fashion thinking in designing wearable devices will eventually allow consumers to experience these devices in similar ways as their clothes and accessories (Juhlin et al., 2016).

2.2.2 Added Value: Extending Functionalities.

Wearable devices functionalities are chiefly turned to the monitoring, documentation, and augmentation of individual lives, assisting people in specialized professional and personal activities (Smart Wearables: Reflection and Orientation Paper, 2016). However, wearable market has failed to explode because the options of today do not solve real human needs, current devices offer limited utility which eventually will fail (Amed, 2016).

The term "wearable" tends to be mentioned as only the restrictive definition, which is fitness tracking devices that are accessorily used to maintain individual health status worn on a wrist, (Lee et al., 2016).

The benefit of wearing the device must outweigh its inconvenience, improving practicality and adding new measurement features will not be enough to boost long-term user engagement, therefore, a wearable device must aim both, provide and help improve the data (UCLA Center for Digital Behavior, 2014).

Donald Norman, pioneer in applying human cognition considers that wearable technology has mainly focused on core technology development, ignoring the extensions of mind and body through technology, which could be recognized as an inherent objective of wearable technology. In addition, it is suggested that wearable technology should enable people to reach higher into Maslow's hierarchy of needs--towards self-actualization and transcendence--rather than focus on physiological and safety needs at the bottom (EETimes, 2017).

Wearable technologies hold a strong value-expressive component for the users (Eadicicco, 2014), additionally, an opportunity arises for researchers and developers to focus on the exploration of wearable applications and services that can provide the best value from a user perspective, thus, developing a human-centric technological approach, which will allow a positive disruption on how technology is used today for the betterment of humanity (EETimes, 2017).

2.2.3 Social Acceptance: Reaching Not Only Early Adopters

Consumers perceive the vast potential of the emerging wearable technology, which shows promising contribution in augmenting human capabilities (Buenaflor & Kim, 2013), however, the opinion of the consumer remains skeptical, due to the fact that wearable devices lack from a meaningful purpose in their lifestyle (The Wearable Future, 2014). The perception of the user about a new technology can significantly affect its acceptance, and any negative perception of the device presents a barrier to its adoption (Bergmann & McGregor, 2011), as consequence, intended users who actually have adopted wearable technology are still limited (Buenaflor & Kim, 2013).

Consumers expect Wearable Technology products to not drastically change their image, current wearable devices are considered as obtrusive and socially isolating, (Miner et al., 2001). Wearable devices are primarily perceived through visual and somatosensory (sensations of the body) processes, the Somatosensory perception has more relevance on the experience of the wearer, particularly the ones regarding physical and body comfort, in addition, the body and a wearable accessory as isolated elements may have discrete properties, nevertheless, both are modified as they are brought together. Therefore, social acceptance will depend on the normalcy of the user appearance (Dunne et al., 2014, DeLong, 1998).

Wearable technology has failed to give utmost consideration to its consumers in the design and development aspects, leading to its low acceptance (Buenaflor & Kim, 2013), on the other hand, there is a real interest and high expectation from consumers to recognize companies and developers using human-centered design to unlock the potential of wearable technology for disruptive innovation (The Wearable Future, 2014).

2.2.4 Privacy and Security Risks: Setting the Boundaries of Shared Information.

Wearable Technology could be considered as networked devices that can collect data, track activities, and customize experiences to users (Evans, 2014), however, alongside with the functionalities that Wearable Technology can offer, concerns about security have raised, although wireless-devices provide the flexibility of connecting everywhere, it also makes them more susceptible to security breaches (Wei, 2014), the limited bandwidth and processing power of Wearable Technology provides less security compared to other computing devices (Al-Muhtadi, Mickunas & Campbell, 2001). In addition, at present, most of the wearables are not standalone devices, as they required to be supported by a smartphone when secure authentication is required, this complexity of communication creates security vulnerabilities (Ching & Singh, 2016).

Contrary to expectation, concern over personal data sharing is not perceived as a key issue for the users of wearables, as a matter of fact, users believe in the value of sharing their data with friends and family, due to the fact that is part of their motivation to achieve the goals that wearables help them to aim for, people rely on effective social support for the achievement of personal goals (Fitzsimons & Finkel, 2015; Wearable Technology and the Internet of Things, 2016).

Furthermore, results have shown that users of wearables are more likely to share their data with wearables manufacturers rather other areas (e.g. healthcare, internet firms), wearable manufacturers are seen as trustworthy due to the perception of being earnest when protecting data (Wearable Technology and the Internet of Things, 2016). Nonetheless, it does not mean that users are unaware of the risks involved, therefore, the willingness of taking them goes hand in hand with their perception of the received value, a good risk and reward structure can provide a lot of additional entertainment value (Williams et al., 2011).

On the other hand, features and functionalities of wearable devices that allow capturing images or recording video without the notice of their target can affect third-party privacy, which can eventually lead to negative perception about this matter, as a matter of fact, there is evidence that some public spaces have banned the use of wearable devices due to privacy problem (Ching & Singh, 2016).

Privacy and security indeed are worthy of attention, however, premature regulations, especially the ones applied on evolving technologies such as Wearable Technology could mean a rigid supervision, and as a consequence, this will lead to reducing the potential and the benefits of Wearable Technology (Diallo, 2013). Hence, it is suggested that the better alternative to measuring objectively the future regulations for wearable technology is to deal with the concerns creatively as they develop, by using a combination of educational efforts, technological empowerment tools, social norms, industry best practices, and self-regulation, transparency, and targeted enforcement of existing legal standards (especially torts), as needed (Castro, 2013; Thierer, 2015).

2.2.5 Behavioral Change: Addressing the Social Conventions of Wearable Technology.

Social conventions demonstrate a common consensus of how individuals should act in public (and into some extension, privately) situations by defining the accepted rules of social interaction (Becker & Mark, 1998). Not following these conventions could lead to disruption in the normal flow of social interaction, and as consequence, even been labeled as rude, antisocial and/or dangerous. Nevertheless, the set of conventions in a culture is not stationary, it changes as the society develops in an attempt to systematize new patterns of social interaction.

On several occasions, technology can determine new patterns of interaction or behavior that eventually has the potential to become established as new or modified. Therefore, it is possible to assume that it could be expected that social conventions governing human to human communication to be affected by the adoption of wearable technology among the general population, much as they did when the telephone became widely used (Dvorak, 2008; De Sol Pool, 1983).

Wearable Technology in order to manage transparently the communication of the user, it should take into account and learn from the negative social implications of current tools of communication (e.g. mobile phones), which violates many social conventions: e.g. able to hear private conversations in public spaces (Dvorak, 2008). For example, it is not the call itself that annoys people, it is rather the attitude that those using their cell phones adopt. A face to face social interaction is no longer relevant and is replaced by a social context consisting a third-remote party. Wearable technology could exacerbate the “absent presence effect”, which is described as an individual is physically present but is absorbed by a technologically mediated world of elsewhere (Gergen, 2002).

As wearable computing technology pervades in the daily lives of individuals, it must be asked how it influences social behavior, current applications emphasize intellectual and sensory capabilities over interpersonal interactions and social competence, if this practice in wearable technology continues it might lead to inhibiting social interaction (Kortuem & Segall, 2003). On the other hand, it is possible to forecast that wearable technology eventually will overcome the negative social implications that arise from the current state regarding its voluminosity on devices, however, others implications are inherent to the wearable technology paradigm. The latent possibility of giving more attention to the device and the information it presents will entail wearable users have less time and attention to offer people nearby. This behavior can negatively influence outsiders' views of wearable technology and their use (Kortuem & Segall, 2003).

Wearable technology opens the opportunity to encourage designers to apply fashion thinking approach on wearable devices, which eventually will lead to a positive paradigm shifting about how wearable technology is perceived by the society.

A wearable device should be used as a medium of self-expression and communication for the user. In addition, wearable technology could be considered promotes personal empowerment through its capacities to equip the individual with a personalized, customizable information space. However, wearable technology should be careful when addressing the current social conventions for social interactions, it should avoid the "absence present effect".

2.2.6 Conclusions.

Based on the above, wearable technology has the potential to attract a bigger scale of potential consumers as long as it has something valuable to offer, this means that the aim of wearable technology should be focused on solving needs related to self-actualization and transcendence (EETimes, 2017). As mentioned earlier, it is not enough to provide measurement data to the user, wearable technology needs to promote pro-active relationship with the user, extending its potential as the preferred communication tool of the user when interacting with the world around him, enabling a more intimate connection with the device.

As mentioned earlier, there is the willingness to accept and adopt wearable technology, nevertheless, current options are considered as obtrusive and socially isolating (Miner et al., 2001).

Figure 2.7 Wearable Device

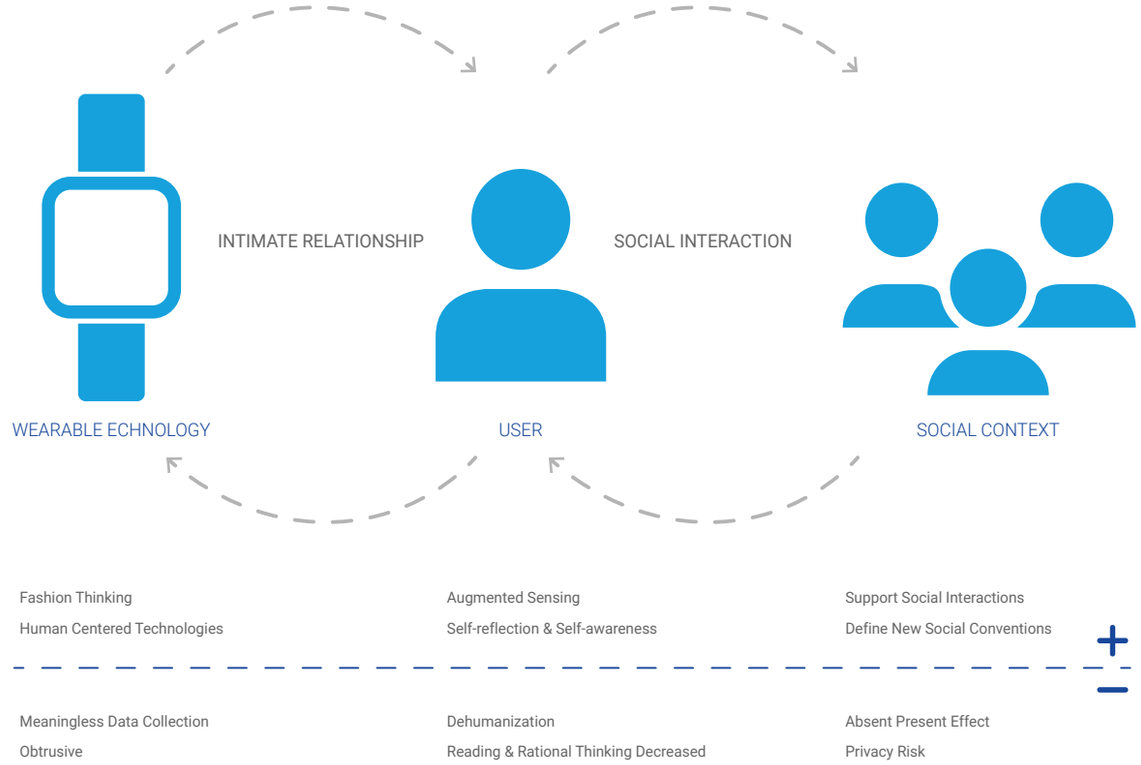


Figure 2.6 General Outlook For Wearable Technology

2.3 ENVISIONING THE FUTURE OF WEARABLE TECHNOLOGY: UNLOCKING THE FULL POTENTIAL OF WEARABLES.

The world of the Twenty-First Century is driven by connectivity, and Wearable Technology has a role to play on it (Fashion, Smart Textiles, Wearables and Disappearables, 2016). On that basis, it represents an exciting stage for Wearable Technology with the potential to rethink and possibly to re-define the current relationship with technologies. It opens new options on how technology can positively impact the way people live, work and socialize.

Based on the report "The Future of Wearable Tech: Key Trends Driving The Form And Function Of Personal Devices", a research conducted in 2014 by PSFK Labs (an innovation consulting firm), in partnership with iQ by Intel (a tech culture magazine), have summarized the trends related to Wearable Technology categorizing them under three major areas (**Figure 2.8)**. This will serve as a guideline for the present document to identify opportunities areas that are aligned to the purpose of this research in later stages (Design Vision).

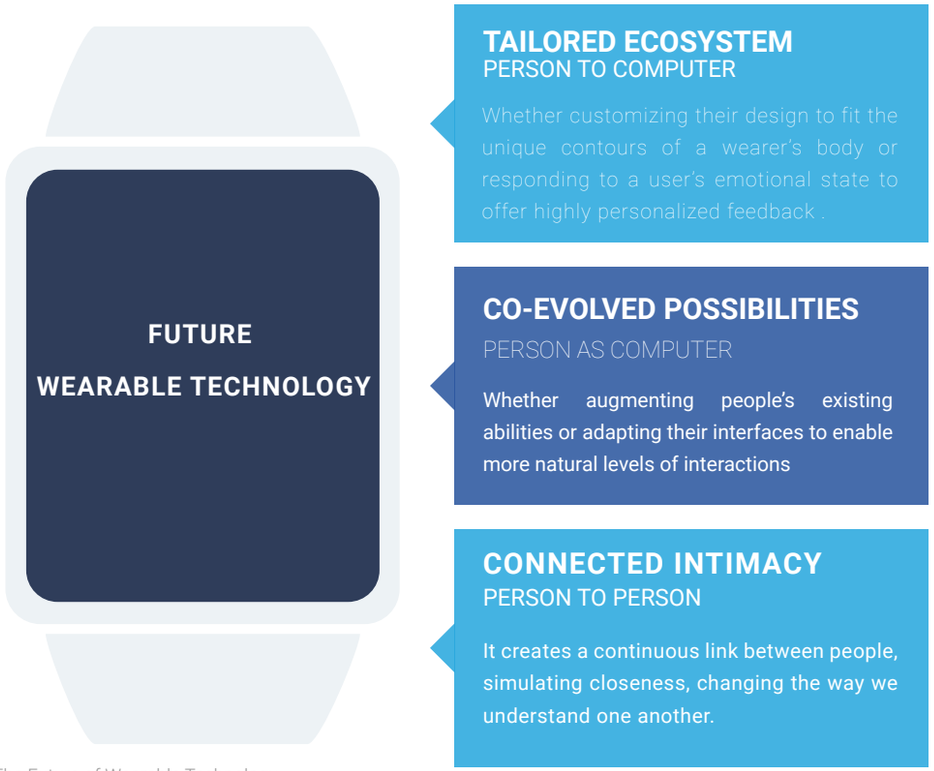
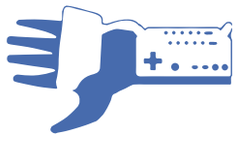


Figure 2.8 The Future of Wearable Technology



1ST GENERATION

The sensor is attached to an apparel.

2ND GENERATION

Embed sensors in the garment.

3RD GENERATION

The garment is the sensor, thus, representing "The Next Generation of Wearable Technology.

Figure 2.9 Wearable Technology Generations

The three areas showed on **Figure 2.8** set the stage for a future context of Wearable Technology, nevertheless, when considering the desired approach of Nokia to positively disrupt how the technology in order to provide an accurate intersection of technology with the evolution of human communication/interaction needs (Hernon, 2017), it is is possible to suggest that the efforts should be focused in the area of Co-evolved Possibilities.

On the other hand, technical factors have contributed in the hesitant uptake of wearables, which includes, the limited functionality, the low level of comfort and body conformability, short battery life, limited connectivity, lacking interoperability, concern on data security and production costs (Smart Wearables: Reflection and Orientation Paper, 2016; Park, Chung & Jayaraman, 2014).

Furthermore, it has been identified three generations of Wearable Technology from a technical point of view (Fashion, Smart Textiles, Wearables and Disappearables, 2016), which are as shown in **Figure 2.9**. Accordingly, research and development efforts are essential for unlocking the full potential of wearable technology, and as consequence bringing the "Next Generation of Wearable Technology" available for everyone.

2.3.1 The Experts Opinion.

Additionally, this research conducted a series of interviews in collaboration with experts from the different area yet related to the impact and development of Wearable Technology. Their most relevant thoughts and opinions are cited below:

KASPAR JANSEN

Professor of Emerging Materials

Delft University of Technology

He is a professional in the field of polymer material properties and processing. His current research focuses on the implementation of smart and interactive materials in product design and wearable technology.

""There is a difference between smart textiles and wearable technology, for me wearable technology I associate it with smartwatches, are objects, rings, watches and bands with sensors integrated which can monitor the behavior of your body"

"[Wearable device]... should look catchy, the design is important, it should be almost invisible"

"If you are Face-to-Face, Why you should use a wearable device? I cannot see any advantage for wearable technology in this setting, but might be helpful for people who are handicapped, for example someone who is blind or deaf, then the wearable will help with the communication...."

"Wearables at the beginning can help to reduce this problem [absent presence effect] because it might be special that you have a wearable device and get an interaction if both people have the same kind of wearable... it might represent an invitation to connect.... but if everybody has this kind of things it is not special anymore, like the cellphones, now everyone has one it is not special anymore..."

MARINA TOETERS

Design and Research in Fashion Technology

Utrecht School of the Arts

She operates on the cutting edge of fashion technology and fashion design. She stimulates collaboration between the fashion industry and technicians for a relevant fashion system and supportive garments for everyday use.

"Fashion Technology entails textile and garments, while wearable technology refers to electronics... I perceive Fashion Technology term as a broader concept"

"Garments is the first thing that you see, it is your image... Garments have a huge identity and communication value"

"It is not about seamless integration of Technology, is more about integration [of technology] in Society.... Group identity and individual identity is something that is totally ignored in wearable tech"

"Wearable Technology is focusing on the tech-geeks, very masculine.... You can find cheap- end and high-end products on the market.... Wearable Tech should be [available] for the everyday people"

"One of the main challenges for Wearable Technology is to provide good feedback loops. Augmented sensing, technology is taking a lot of information from our body, but we are not getting anything back from it [technology].... The focus should be in the activation part, how to get the information back... Sensing-Activating around a human person"

"[For emotion sensing] I quite skeptical, a lot of endeavors are needed. It is so complex and we are not that good yet.... [Negative] emotions is something that you do not want to show"

"Technical limitation is a boring discussion, you can make such tinny things now that hardly affects the fabric"

"Fashion Technology innovation in a broader sense should be about feeling good about what you wear and showing that out, taking care of you, well made and communicating the right thing"

NATALIA ROMERO HERRERA

Design Contextualization and Communication

Delft University of Technology

She applies her Computer Science background in the design and development of working prototypes to evaluate in the field technologies designed for awareness and social connectedness

" Wearable Technology is associated with personal technologies, they are technologies that are appropriated on the daily basis of human beings, something that you wear... I like to use the term appropriated, due to the fact that [wearables] are something that you customize according to your needs"

"Personal Informatics is a term that is often applied in Wearable Technology, it refers to the data automation in user behavior, through wearables the information is presented in a readable way to promote auto-reflection"

"Currently wearable technologies offer benefits in a long-term, there is an opportunity to provide also short-term benefits, how to give more direct benefit in a short-term"

"I am trying to find what is the role wearable technology, what is the suitable amount assistance that wearable technology should provide to the users, how passively the user should act when using a wearable, I think wearable technology should alert the users to avoid bad habits, if this is accomplished, then wearable technology is successful "

"Technology should give us back the power to be active, be owners of what we are doing"

" [In terms of interpersonal relationships] ... Wearable technology is suitable to promote information sharing among peers, people who are in the same situation or need to overcome similar barriers as you, however, privacy is an issue, although might you feel empathy with these people you still don't know them"

"Social wearable technology has the potential to promote auto-reflection in ourselves, but most important, it will help us to understand what we are doing, understand our impact in our surroundings, which is an even a higher level of transcendence that just behavioral change"

"Wearable Technology has the potential to trigger a social interaction, but at the same time it should allow to provide the opportunity to discover social layers, we need to explore those layers as part of the development of our social skills, and social skills mean feeling uncomfortable until we feel comfortable with the situation, is part of the experience"

"Wearable technology should help you to get out from your comfort zone and empower you to do something in a different way as you usually do"

"Wearable technology should be aware what information should be shared and whatnot, alongside with when to do it, how to do it and why to do it.... Wearable technology should strive to make the invisible, visible"

"[Wearable] technology should ask itself what we need to know about a person and why we need to know about it... Our interpersonal privacy refers to what we would like to communicate and what we want to keep as a private"

NYNKE TROMP
Social Design & Behavioural Change
Delft University of Technology

She is intrigued by how products can change behavior without people being aware of it. In her view, this implicit influence does not only imply a serious responsibility for designers, it also offers a powerful means to support desired behavioral change.

"Wearable Technology enriches the perception of knowledge that you have in your surroundings, of yourself and other people"

"[Wearable technology barriers are]... Yet another device, yet another stream of information... mistrust, what happens to my data? Stigma..."

"Social conventions are still in development with communication devices, you can literally start a conversation with someone is not there, which is kind of disruptive... It is hard to anticipate what social conventions wearable technology will change without knowing what exactly is going to do"

"What I think will be the sort of money of the future is attention... and every device requires maybe some attention, and in that sense it disrupts the social relationships because there is a decrease attention for each other [people]"

"What I think there is a lot of development research for the sensitivity towards each other... I can imagine that could really enhance your group, work or your collective gathering..."

"The idea of the interpretation of emotions of others... [Before that] maybe you even should start to understand your own. It is difficult, [because] you will enhance something that you normally would not perceive [through wearable technology]... It could be very disturbing"

"...It is also how people use [emotions] to be interpreted and with who, you don't want to be noticed by a stranger, you also want to cover up for your emotions, you might want to be approached differently from how you feeling"

"The solution should be more focused in self-awareness, self-learning and understanding yourself better and regulate your emotions better, rather than understand more about the other"

2.3.2 Conclusions.

Generally speaking, the points addressed by the experts seem to be consistent with the main challenges discussed earlier in Chapter 2.2, most of the experts can see the potential of the application of wearable technology in terms of promoting social interactions (e.g. collective playing), nevertheless, some of them consider that the true value of wearable technology might fall to in the creation of self-awareness to understand the impact of the human behavior with his/her surroundings.

Technology has a role to play in the development of future applications, at this moment, it could be said that their implementation is based more on their technical capabilities rather in the impact or consequences in human behavior. However, developers are starting to realize of this, therefore, they are changing their mindset of how technology could truly have a positive impact on the life of individuals. The latent possibility of applying technologies able to read not only at physiological but also psychological level the human being, it opens the opportunity to understand in depth the human being and his relationship with his environment.

Furthermore, trends have shown that one of the main areas for future applications on Wearable Technology is the one related to co-evolved possibilities, which has a strong focus in the development of human-centric technologies.

Based on the above, it could be assumed that developers have seen the potential of Wearable Technology in this area, however, it does not seem to be clear so far now how it should be applied in order to achieve the best benefits possible. On the other hand, there is an open debate regarding the efficiency of technology as a medium to connect people on a deeper level (emotionally), there is still skepticism regarding its potential in this task. Thus, developing technology more emotionally intelligent could emphasize barriers regarding privacy and social conventions that are especially relevant in this area, due to the fact that people probably need first to be prepared to assimilate the potential fact of being openly observed and analyzed in an aspect considered as private. In that sense, the developers will require providing the necessary mechanisms to control and regulate such sensitive information.

2.4 CONCLUSIONS.

This chapter has explored the current state of the art of wearable technology, the challenges/ opportunities that need to be addressed in order to overcome the social barriers, thus, integrate seamlessly wearable technology into the lifestyle of the human being. In general, society has shown willingness and interest in adopting Wearable Technology, however, on one hand, it should not represent a burden for the user and the risk involved when sharing data/information should not surpass the benefit that comes from the wearable.

Ideally, the security protocols will evolve alongside with the implementation of wearable technology. On the other side, wearable technology should provide users with a valuable benefit, meaning, it should be thought of the impact on the life of the user caused by the information provided from wearable technology, aiming to fulfill needs towards self-actualization and transcendence, creating an intimate relationship with the device for better understanding.

While it is true that technology has served as a medium for human interactions, it should not affect the communication of human connectedness, therefore, with the risk of becoming an obstacle for the interpersonal relationships. Thus, wearable technology has to be channeled in a way that facilitates and supports social competences.

Special attention should be addressed to the “absent presence effect”, it has been suggested that wearable technology has the potential to exacerbate it. Technological dependence should not be promoted, instead, it should be used as a medium of support, without the intention of reducing the self-reliance, thus promoting a pro-active relationship between the wearer and the wearable.

On that basis, and as mentioned earlier, the development of wearable Technology should be approached using human-centric technologies, designers and developers need to understand the ways in which humans interact with one another and the world around them. Both factors are highly dynamic and culturally influenced, and the consideration of both is essential to successful design and major social acceptance. If these challenges are successfully overcome, the possibilities of assimilating naturally wearable technology will increase.

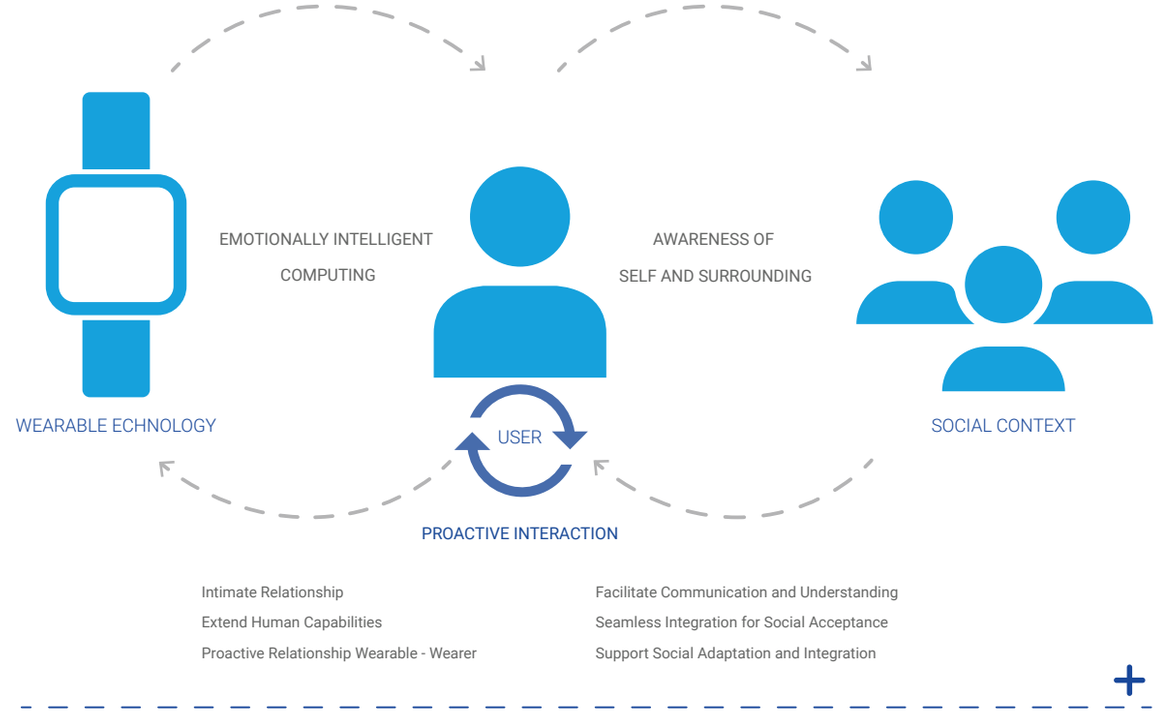


Figure 2.11 Next Phase For Wearable Technology: The Social Age

3.0 UNDERSTANDING THE IMPACT OF TECHNOLOGY IN HUMAN COMMUNICATION.

This chapter unfolds in the importance and interference of technology on human communication, which has shaped a large part of the current lifestyle of the human being. It is important to understand its capacities, possibilities, and the new challenges that are needed to be overcome for a successful interpersonal communication. Starting with a brief of introduction to the so-called Millennial generation.

THE MILLENNIAL KIND

With the phenomenon of globalization, it is possible to assume that European Millennials are similar to the U.S. Millennials, nevertheless, some differences exist due to cultural and geographical contexts in which they developed. The European culture and attitudes remain (e.g. widespread travel, multilingualism, work-life balance, multiculturalism), thus, continuously influencing social norms and behaviors, and as consequence distinguishing European Millennials (Corvi et al., 2007). Moreover, The Millennials, often called The Connected or Net Generation, are unafraid of new technologies (Reynolds et al., 2008; Tyler, 2007; Wesner & Miller, 2008), as a result, are the ones excited about the use of technology and are the spreading word when it comes to new technologies and devices (Azaroff, 2006; Glass, 2007; Prensky et al., 2007).

On the other hand, in order to have a better understanding of Millennial generation, it has been suggested that attention should be given to their key behaviors and preferences, which are the ones that are different in kind or degree from previous generations at the same age and which are likely to become part of their lifelong culture; being more specific, those associated with learning, education, and communication (Sweeney, 2006). These general behaviors are proposed by Sweeney in his article “Millennial behaviors and demographics”, which are briefly described in **Figure 3.3.**

Millennials belong to a generation that has been greatly shaped by the technological advances present during their childhood and college, and it continues doing it in their career, and into the workplace (Gibson & Sodeman, 2014). In that sense, the development of information technology and the associated new digital communities and networks have an extensive impact on the communication behavior (Bertoncini & Schmalz, 2013), therefore, Millennials are not exempted from this phenomena.

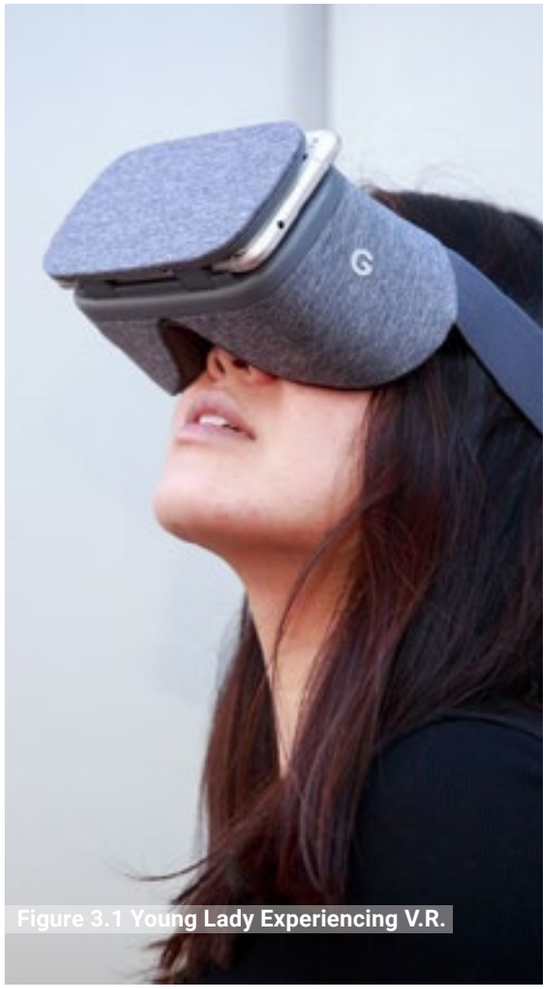


Figure 3.1 Young Lady Experiencing V.R.

*”...Contrary to popular belief, most Millennials prefer to **COMMUNICATE IN-PERSON** and over the phone because it allows them to have the most **MEANINGFUL** conversations”*

Kelly Conway
Mattersight CEO

Figure 3.2 riends Sharing a Moment

LEARNERS

Millennials strongly prefer learning by doing. They almost never read the directions; love to learn by doing, by interacting.

FLEXIBILITY / CONVENIENCE

Millennials prefer to keep their time and commitments flexible longer in order to take advantage of better options.

PERSONALIZATION AND CUSTOMIZATION

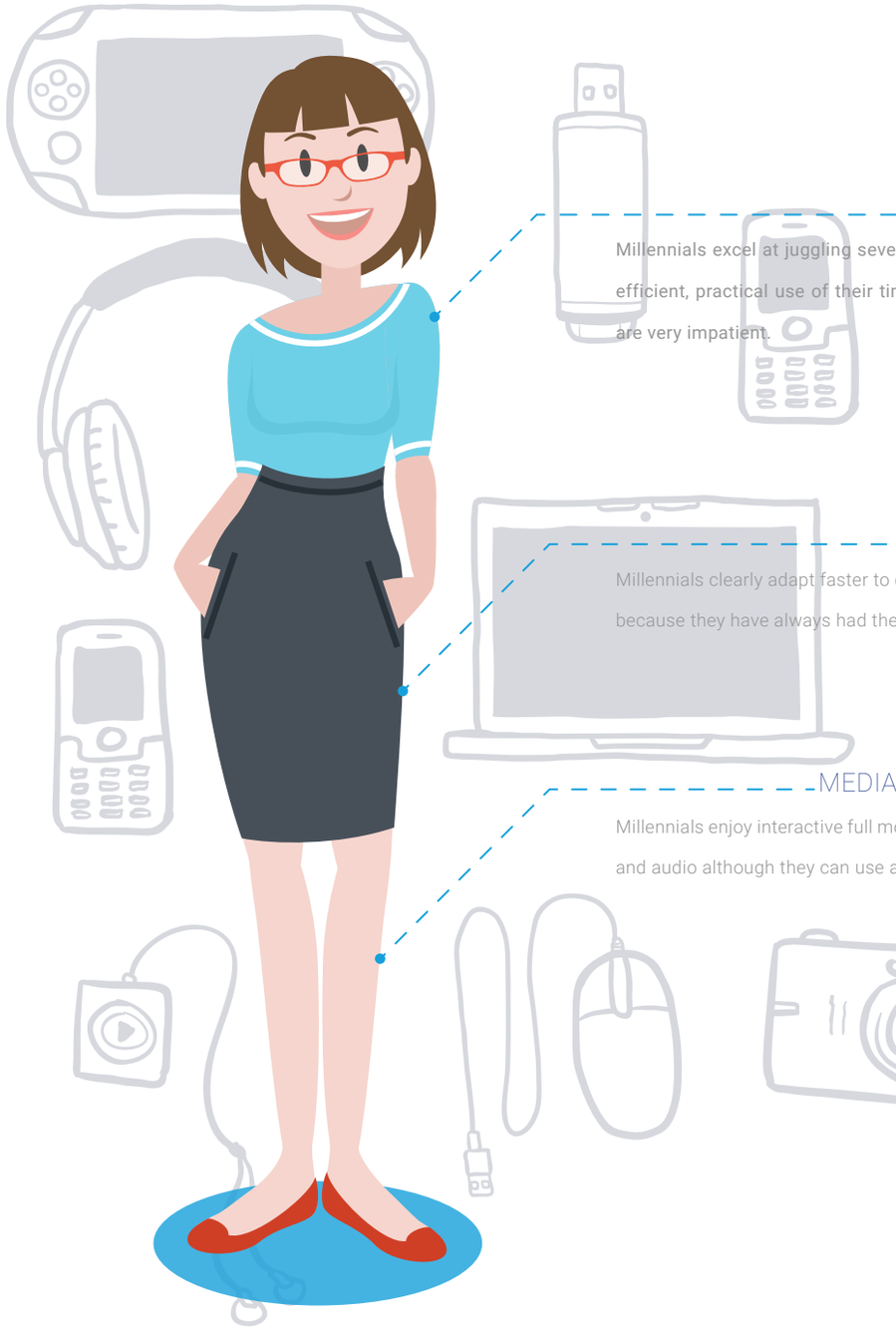
Millennials expect from the products and services to have as much personalization and customization features as possible to meet their changing needs, interests and tastes.

PRACTICAL RESULTS ORIENTED

Millennials are interested in processes and services that work and speed their interactions.

IMPATIENCE

Millennials expect their services instantly when they are ready, requiring almost constant feedback to know how they are progressing.



MULTITASKERS

Millennials excel at juggling several tasks at once since this an efficient, practical use of their time and, as already noted, they are very impatient.

DIGITAL NATIVES

Millennials clearly adapt faster to computer and internet services because they have always had them.

MEDIA/ FORMAT AGNOSTIC

Millennials enjoy interactive full motion multimedia, color images, and audio although they can use any media, even text.

Figure 3.3 Milllenials Behaviors based on Sweeney 2006

3.1 TECHNOLOGY, A TOOL FOR SELF-EXPRESSION AND COMMUNICATION.

The distinctive relationship of Millennials with technology has brought two icons of the millennial lifestyle, mobile phones and online social networks, which grew up alongside the generation, thus, it is considered as a badge of generational identity (Hershatter & Epstein, 2010;). These innovations provide more than a bottomless source of information and entertainment and new ecosystems for their social lives (Keeter & Taylor, 2010). On that basis, Millennials have a full range of media available in an extremely technological environment, from mobile phones, instant messaging, computers, and internet, among others (Cheng, 1999; Corvi et al., 2007). Millennials are considered as the first generation using digital forms of media over than the traditional media, which has made to call them “Digital Natives”, not only using digital media for entertainment but also for accessing and sharing information, socializing and conversing with friends (Tanyel, Stuart & Griffin, 2013). Furthermore, this technological range of possibilities has fundamentally changed how people think and act. It has supported individuals in the expression of their opinions about politics, society and religion, additionally, it contributed to their attitude towards intercultural relations, breaking down preconceptions and prejudices, increasing the possibilities to bridge cultural gaps (Corvi et al., 2007).

Individuals are conscious about the advantages and disadvantages of using technology as means of communication, however, generally speaking, society perceives that new technology makes people closer to each other rather than more isolated (Keeter & Taylor, 2010).The application of technology has recognized and even enhanced the abilities of the user when addressing the everyday social needs, moreover, it has served as a medium of self-expression for individuals (Miner et al., 2001). The use of technology has transformed the role of the human body in the process of communication, innovations such as the telegraph, the telephone, and e-mail, have allowed humans not have to be physically together to interact (Campbell, 2008). Mobility, immediate access, and the freedom to communicate at any time and place are significant advantages of mobile communication tools (Leung & Wei 2000), with the potential to powerful impact on interpersonal communication and cultural norms (Nurullah, 2009).

Technology has the potential to define new patterns of interaction or behavior that eventually become established as new or modified conventions. Thus, social conventions governing human to human communication can be affected by the adoption of Wearable Technology among the general population, much as they did when the telephone became widely used (De Sol Pool, 1983; Dvorak, 2008). In that sense, it represents an opportunity for Wearable Technology to promote a paradigm shifting on how technology can be used in human communication.

Figure 3.4 Millennials Using Technology as Medium of Communication

Figure 3.5 Impact of Technology in Human Comunication

3.2 TECHNOLOGY IMPACT IN HUMAN COMMUNICATION.

As people have an easier access to mediated mass technological communication, they become less dependent on interpersonal interactions (Williams, 2003). Human potential flourish through close, supportive and interpersonal communication, a lack of communication or misunderstanding in communication has a direct impact on the well-being of a person (Venter, 2016). Communication is the foundation of all human relationship (Searle et al., 2009). Its presence in social settings has influenced interpersonal relationship, enabling the opportunity for people to connect more easily regardless the distance (Przybylski & Weinstein, 2012).

Technology affects the understanding and the consciousness of oneself and the surroundings during communication, due to the fact that individuals tend to lose their sense of presence when engaging with electronic media (Meyrowitz, 1986). Although multitasking ability of the human being allows engagement in multiple activities, and therefore, be involved on some level within their participation unit in an indirect or direct communication interaction (Humphreys, 2005), it is possible to suggest that the level of commitment affects the quality of communication. Technology interference is leading to a decrease in reading and critical thinking (Wolpert, 2009), which affects the ability to understand the information codes (verbal and non-verbal) fr0m an individual during a social interaction (Keltner & Haidt, 2001).

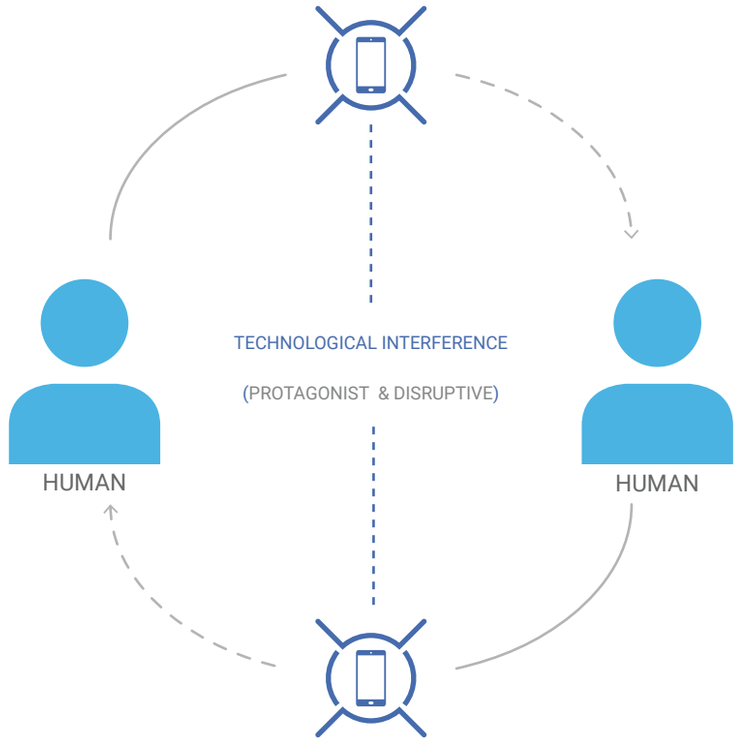


Figure 3.6 Basic Diagram of Technological Interference in Human Communication

3.3 VERBAL & NON VERBAL COMMUNICATION IN A INTERCULTURAL SETTING

Leaving aside for a moment the role of technology in communication, it is important to address what are the major communication challenges present in an interpersonal relationship. As mentioned earlier, interpersonal relationships are socially constructed entities that are created, maintained and altered through communication (Sigman, 1995). Additionally, the millennials, who have developed intercultural sensitivity, and open-mindedness, have promoted intercultural friendships (Corvi et al., 2007; Gareis, 2012). An intercultural friendship is considered as a type of friendship which involve individuals who belong to a different cultural background, which is perceived as voluntary and rewarding as a normal friendship (Peng, 2011). However, it is not without challenges and obstacles that arise from cultural differences (Li, 2010). Cultural-specific knowledge involves coding systems (verbal and non-verbal communication elements) that people learn and pass on as part of the cultural experience (Porter & Samovar, 1994). Verbal and non-verbal communication codes differ from culture to culture, hence the importance of being aware of such differences in order to understand and respond accurately to different the social interactions presented during the socialization process among different cultures (Kim, 2001).

Based on the model of "Stumbling Blocks in Intercultural Communication" proposed by LaRay M. Barna (1994), verbal codes are referred as the existence of language difference between individuals, while, non-verbal elements deals with features of human communication that are not part of the verbal language, which conveys personal and cultural identity (Hargie, 2010).

It is believed that in the near future cultural boundaries will be less visible, the world will not be fragmented into cultures and societies, instead, it will be subjected to contact and cultural hybridization, thus, it will become one immense region, where interaction and cultural exchange persist even more (Hofstede, 1980). To that effect, it is believed that proper and effective intercultural communication processes are needed to be developed in order to promote accurate reflections about diversity, and therefore, support better and mutual understanding of the verbal and non-verbal-codes present among individuals from different cultural backgrounds.

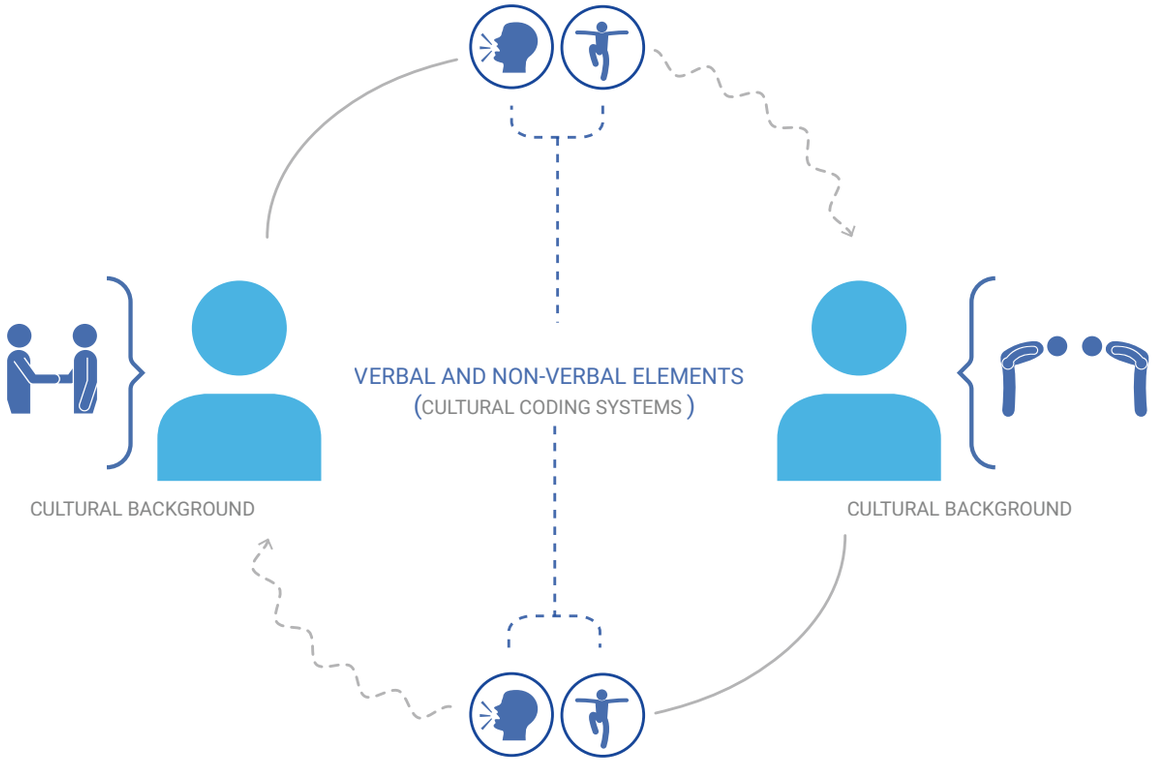


Figure 3.7 Coding Systems as part of Cultural-specific Knowledge

3.4 THE RELEVANCE OF NON-VERBAL COMMUNICATION

Non-verbal communication adds an extra layer of communication, which are often seen as a set of signals that go beyond a given verbal message (Thompson, 1996). Non-verbal communication during a social setting is considered as relevant, due to the fact that it has been claimed that 60% of human communication is non-verbal (Hall, 1959). Non-verbal communication deals with features of human communication that are not part of the verbal language. It serves as the replacement of verbal communication in situations where it might be impossible or inappropriate to engage a verbal conversation, it complements verbal communication, and as consequence, it enhances the overall message; it regulates the conversation by supporting the mark of speech turns; it expresses emotions and interpersonal attitudes; it functions as a negotiator of interpersonal relationships in respect of dominance, control, and liking; it conveys personal and cultural identity and contextualize the interaction by generating a particular social setting (Hargie, 2010). A tentative classification of the major components of nonverbal communication is presented in **Figure 3.8** based on Darn, 2005.

Nevertheless, non-verbal communication can be very ambiguous, therefore, an individual needs a certain level of interpersonal skills in order to acquire the ability to send and receive non-verbal signals appropriately (Thompson, 1996). In that respect, an individual should not presume that can read accurately the inner state of another person on account of the non-verbal cues that he/she has displayed during the communication process. The odds of being assertive or equivocal are equally present, for that matter, it is proposed that individuals should recognize an entire group or cluster of non-verbal cues that suggest the similar state of mind rather than seize upon one gesture or cue in isolation (Eunson, 2005).

On the other hand, it is important to acknowledge that in some respects, it is a false dichotomy to separate verbal and non-verbal communication, an effective communication occurs when the two aspects are in harmony (Jones & LeBaron 2002),

HAPTICS

It is referred to the physical touch, what is an acceptable level or amount of touching, and what is culturally normal or acceptable touching. Touch is necessary for human social development, and it can be welcoming, threatening, or persuasive.

KINESICS

This includes body posture and the motions the body engages in. It outlines the use of gestures, head movements and posture, eye contact, and facial expressions as nonverbal communication.

VOCALICS

It is the study of paralanguage, which includes the vocal qualities that go along with verbal messages, such as pitch, volume, rate, vocal quality, and verbal fillers (Anderson, 1987).Pitch helps convey meaning, regulate conversational flow, and communicate the intensity of a message.

PROXEMICS

It refers to the study of how space and distance influence communication. In general, space influences how people communicate and behave. It is a spatial separation in relation to the social and physical environment.

CHRONEMICS

It refers to the study of how time affects communication. How an individual uses the time, his/her punctuality in arriving or departing, the routine of a person provides extra information about his/her cultural background and personality.

PHYSICAL APPEARANCE

This involves everything from the manner of how an individual dress, to the personal grooming habits he/she engages in. Personal presentation involves two components: physical characteristics and the artifacts with which a person adorn and surround himself/herself.

Figure 3.8 Major Components of Nonverbal Communication

3.5 A TESTIMONY OF THE MILLENIALS: ATTITUDE TOWARDS TECHNOLOGICAL IMPACT IN THEIR INTERPERSONAL RELATIONSHIPS

A series of interviews were conducted as a testimony of their beliefs and perceptions regarding this subject. The most relevant insights are presented in the following pages, while a general conclusion is represented in a scheme which can be seen in **Figur 3.9**.

FACE-TO-FACE INTERACTION HOLDS A HIGHER VALUE THEN ONLINE INTERACTION

"...An offline friendship is more meaningful to me, you can have extra information when you are interacting with someone... It is more candid and deeper..."

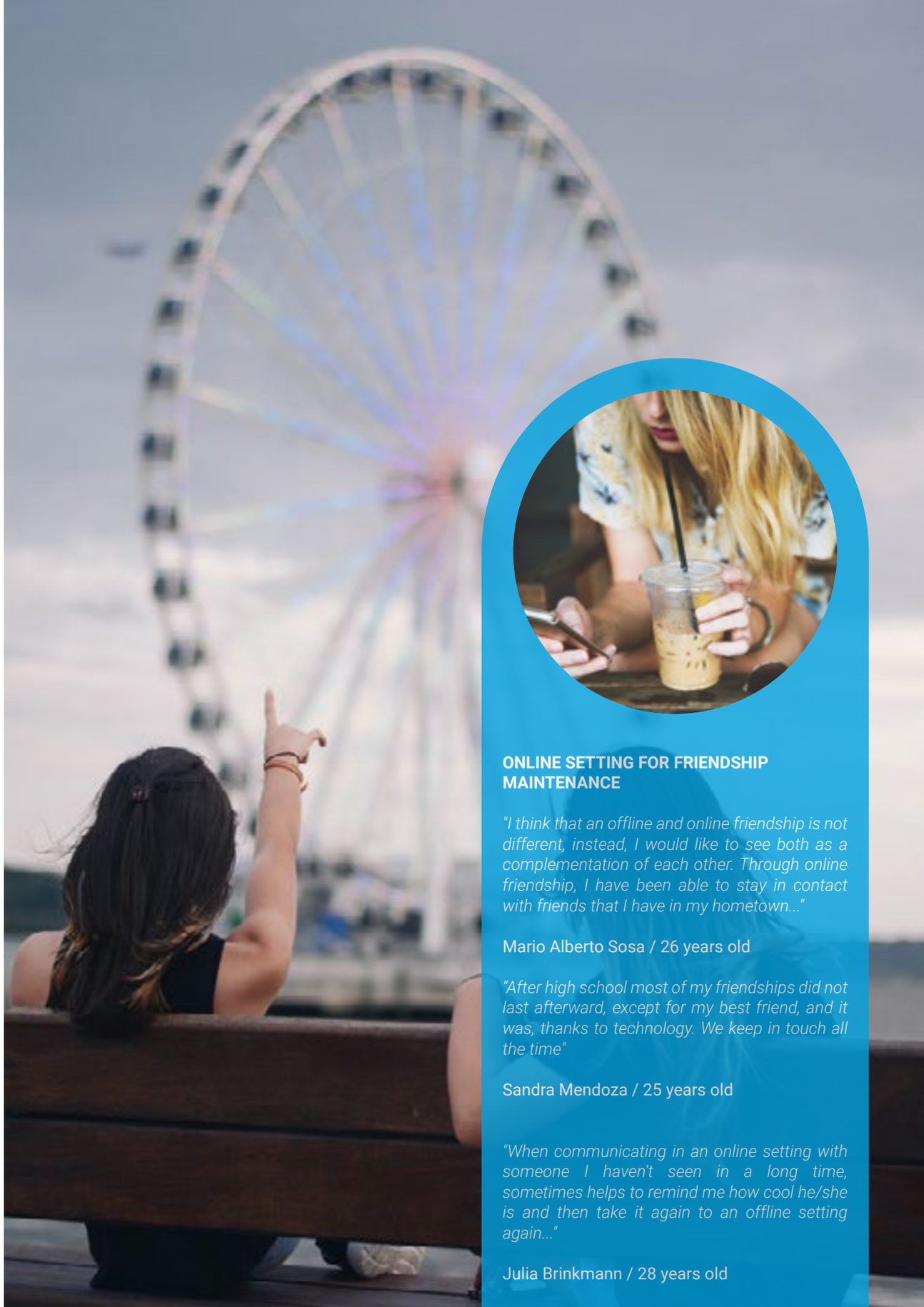
Gray Dawdy/ 27 years old

"With an offline friendship you are sharing a moment, you are Face-to-Face you can see a direct answer/reaction... Having the expression of the person is the best thing that you can have, experiences are built better in an offline setting"

Sandra Mendoza / 25 years old

"[Face-to-Face setting] it is more physical, it involves sport activities, it involves adventures I would say... It is just human interaction"

Lorenz Bauer/ 27 years old



ONLINE SETTING FOR FRIENDSHIP MAINTENANCE

"I think that an offline and online friendship is not different, instead, I would like to see both as a complementation of each other. Through online friendship, I have been able to stay in contact with friends that I have in my hometown..."

Mario Alberto Sosa / 26 years old

"After high school most of my friendships did not last afterward, except for my best friend, and it was, thanks to technology. We keep in touch all the time"

Sandra Mendoza / 25 years old

"When communicating in an online setting with someone I haven't seen in a long time, sometimes helps to remind me how cool he/she is and then take it again to an offline setting again..."

Julia Brinkmann / 28 years old

VULNERABILITY LEADS TO A FRIENDSHIP CONNECTEDNESS

"...When I move to the Netherlands, I started to be more open [about myself] because I saw the value on that ... then you can deeply connect with someone"

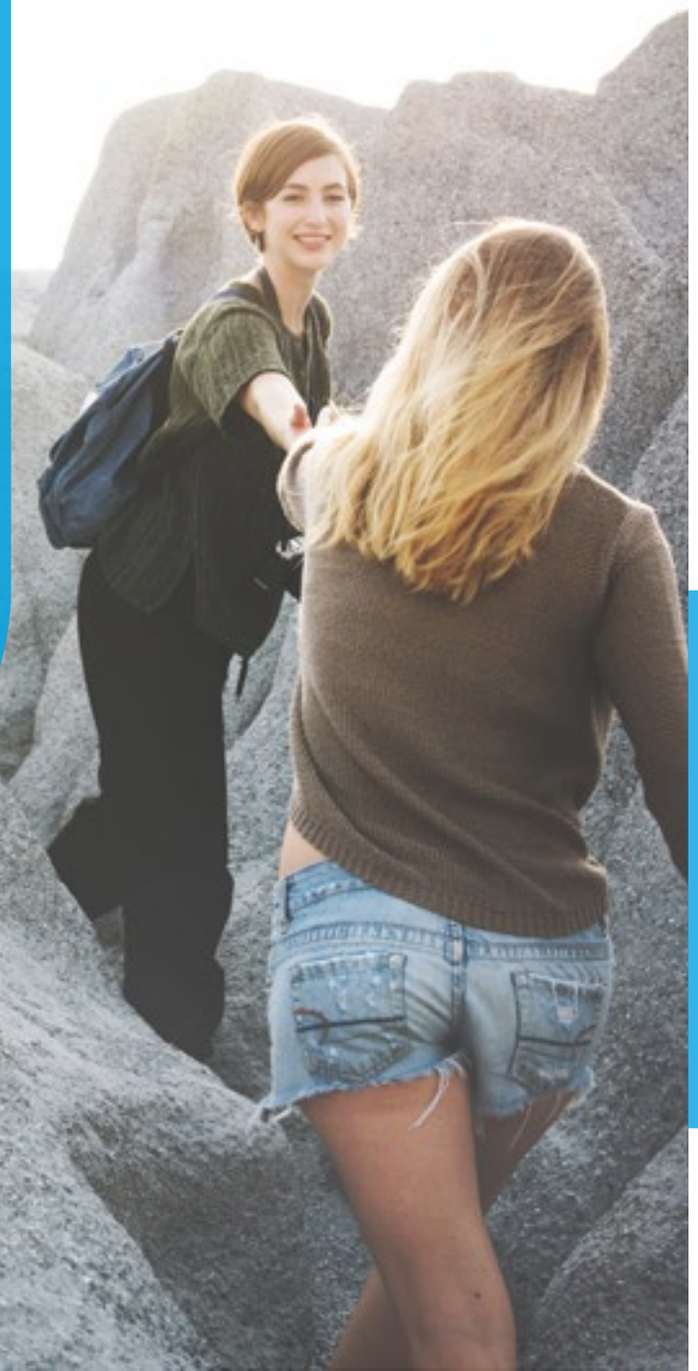
Gray Dawdy/ 27 years old

"...if you want to become better friends, you need to make yourself vulnerable, because you need to get personal, and you don't want to do that with someone you don't trust"

Lukas Riedel / 27 years old

"Someone who you feel totally yourself when you hang out with. Someone you can talk about your fears..."

Lorenz Bauer/ 27 years old



COMMON INTERESTS MIGHT TRIGGER A FRIENDSHIP

"I like to hang out with people who likes the same kind of things, on that level it is easier to meet people"

Gray Dawdy/ 27 years old

".. If I don't see that the other person is interested in what I am interested in, I will not make the effort to befriend him"

Lukas Riedel / 27 years old

"...After graduation, most of my new friends are related to my job/profession... design"

Lorenz Bauer/ 27 years old

INTERCULTURAL ADAPTATION IS NOT AN EASY PROCESS

"....I was not interested to find new people in any student committee or association, which are common in Dutch universities. It simply does not go with me, perhaps I felt that I was too old for that..."

Julia Brinkmann / 28 years old

"During the first interactions I had with my fellow [Dutch] female classmates, they misunderstood my friendliness with flirting behavior... It was embarrassing..."

Mario Alberto Sosa / 26 years old

"[We] as Latin Americans we tend to be touchy, while in Europe is not that way unless they are drunk... It has been hard to adapt myself because human touch is so natural for me..."

Eloisa Zayola / 29 years old .

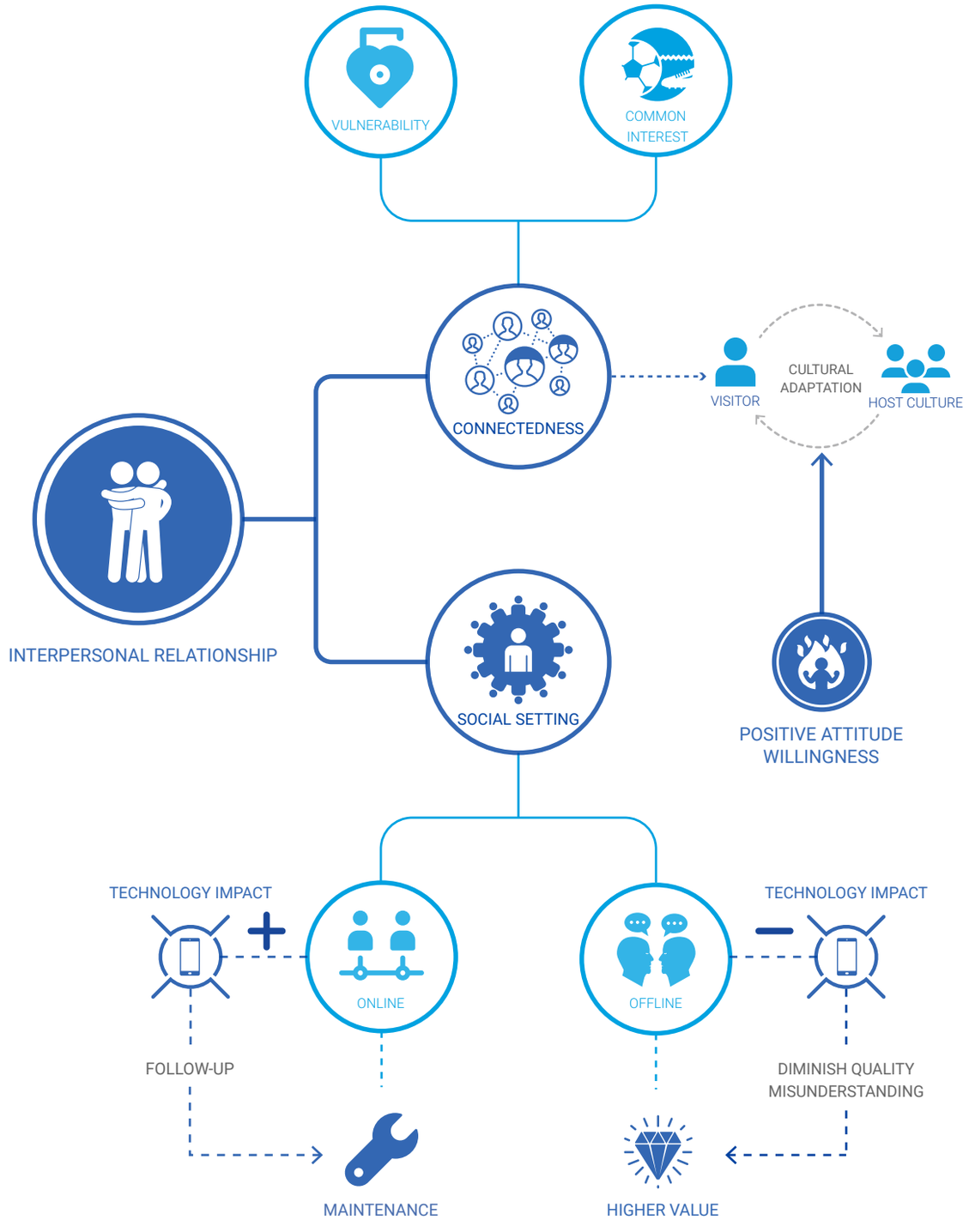


Figure 3.9 Graphical Representation of the Interviews Conclusions

3.6 CONCLUSIONS.

This chapter explored the impact of technology on communication. On one hand, it has contributed to the millennial generation to express more openly about their thoughts and opinions, in other words, it has highly promoted self-expression. Additionally, the advantages of mobility have enabled for this generation to be referred as the “Always Connected”, allowing them to reach a higher number people regardless the distance. On the other hand, the penetration of technology in the lives of so-called Millennials has affected the quality of their interpersonal communication, by decreasing the ability for reading and critical thinking, which is required for the good understanding of informational codes (verbal and non-verbal).

TECHNOLOGY IMPACT

On the other hand, cultural boundaries will be less visible due to a higher persistence of cultural exchange, entailing the necessity of promoting consciousness regarding cultural-specific knowledge. Verbal and non-verbal communication codes differ from culture to culture, hence the importance of being aware of such differences in order to understand and respond accurately to different the social interactions. Proper intercultural communication processes are needed to be developed with the purpose of promoting accurate reflections about diversity among individuals from different cultural backgrounds. There is an imperative need for technology to adapt and evolve according to the new demands for intercultural communication, opening an opportunity for (wearable) technology to set new courses for information technologies.

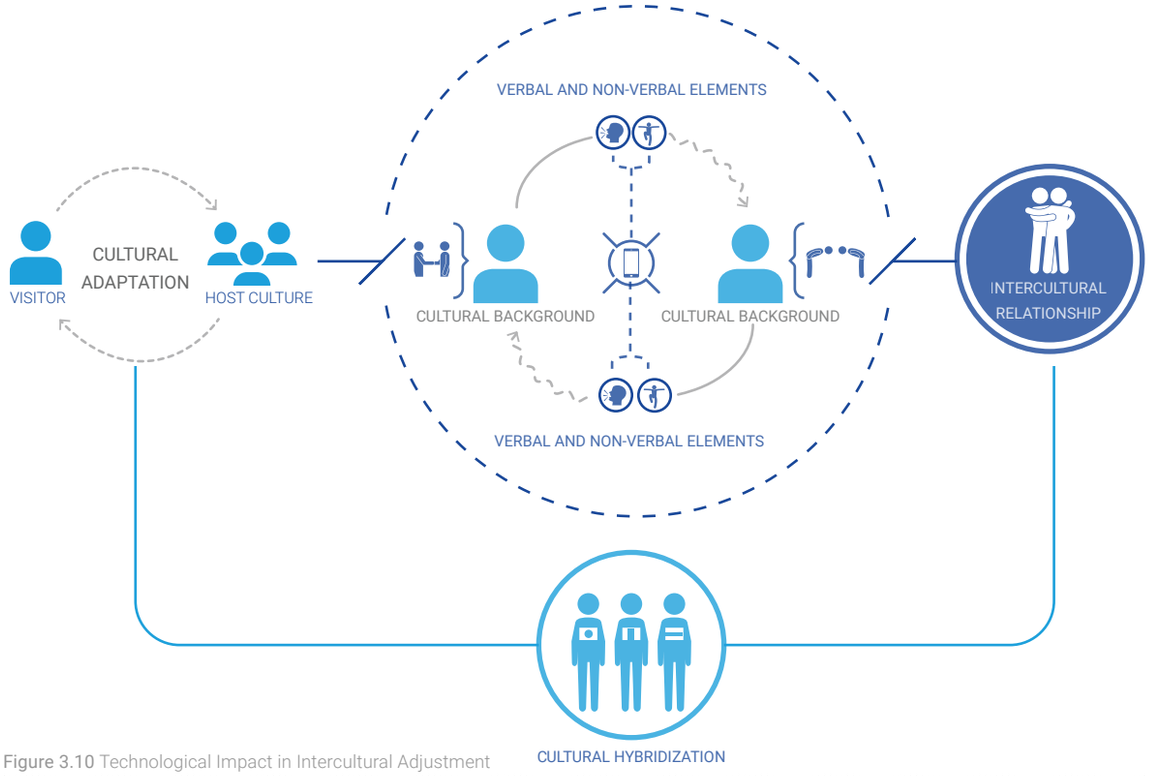


Figure 3.10 Technological Impact in Intercultural Adjustment

4.0 TOWARDS THE FUTURE OF WEARABLE TECHNOLOGY.

This chapter will focus on the construction of a design vision, which eventually it will become the support for the future concept development. However, as a preamble, this section delves the elements changed of mindset towards the application of technology, fashion thinking, intercultural sensitivity, and affective computing, which have been identified in this research as key elements in the pursuit of the construction of a successful interpersonal relationship in a possible future context.

4.1 TECHNOLOGICAL ADAPTATION FOR CONNECTING PEOPLE

As mentioned earlier, the social Value of Nokia is about making people feel close to each other, a proof of this is its well-known brand slogan is “Connecting People” (Roto et al., 2008), which has been the main design driver for the company since its beginnings, using technology for the benefit of the humankind. Nokia has been a pioneer in the sector of telecommunication technologies by laying the foundations of communication mobility, which has shaped the lifestyle of millions of people. However, it is important to be aware that the world has changed (and it and will continue), therefore, the new technologies need to adapt and evolve according to the current and new demands of the human being.

Although it has been recognized that simultaneously, technology has affected positively and negatively how individuals communicate each other, there is not a clear stance against or in favor of it. However, mobile devices have taken an unprecedented protagonist role while impacting human communication, becoming obtrusive. This research believes that the solution does not lay in removing technology from the current lifestyle of the human being, instead, it purposes a change of mindset towards how technology is implemented in human communication. Wearable technology has the potential to provide a self-managing technology that works invisibly in the background while adapting in order to anticipate the needs of the individual (Nokia: Innovation and Possibilities, 2016). And as consequence, creating new ways to connect people, through a seamless integration with technology (**Figure 4.1**).

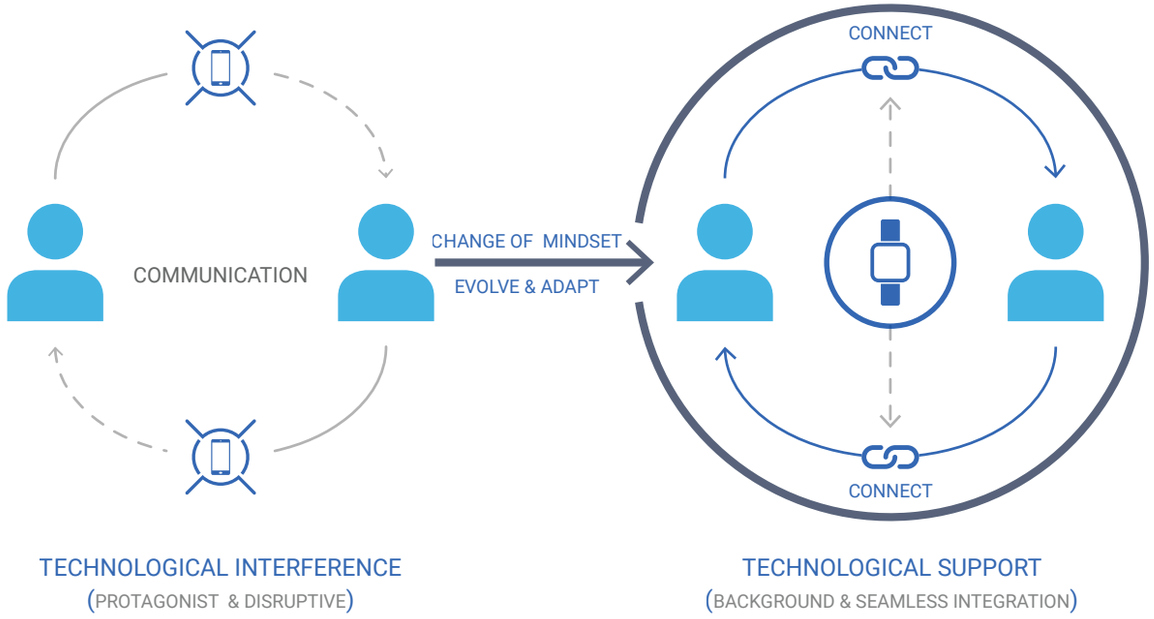


Figure 4.1 Connecting People through Technological Support

Figure 4.2 Friendly Spontaneous Gathering

4.2 THE NECESSITY OF INTERCULTURAL SENSITIVITY

The phenomenon of globalization has triggered and promoted intercultural exchange across the world, therefore, is more common for individuals to be involved in interpersonal relationships (Corvi et al., 2007). This means that cultural boundaries might become less visible, the world will not be fragmented into cultures and societies, instead, it will be subjected to contact and cultural hybridization, becoming one immense region, where interaction and cultural exchange persist even more (Hofstede, 1980).

However, it does not mean that this process will not face challenges, which are needed to be overcome for such hybridization. This will require proper intercultural communication processes that allow accurate reflections about diversity and relationship among individuals from different cultural backgrounds. In that sense, integration, adaption, and culture-specific information will be considered as relevant components for a successful intercultural adjustment. This study believes that a successful intercultural adjustment will be achieved through cultural sensitivity, which represents the willingness and interest of an individual to learn the customs and practices of a host culture in order to be enriched as a human being (Bennett, 1993).

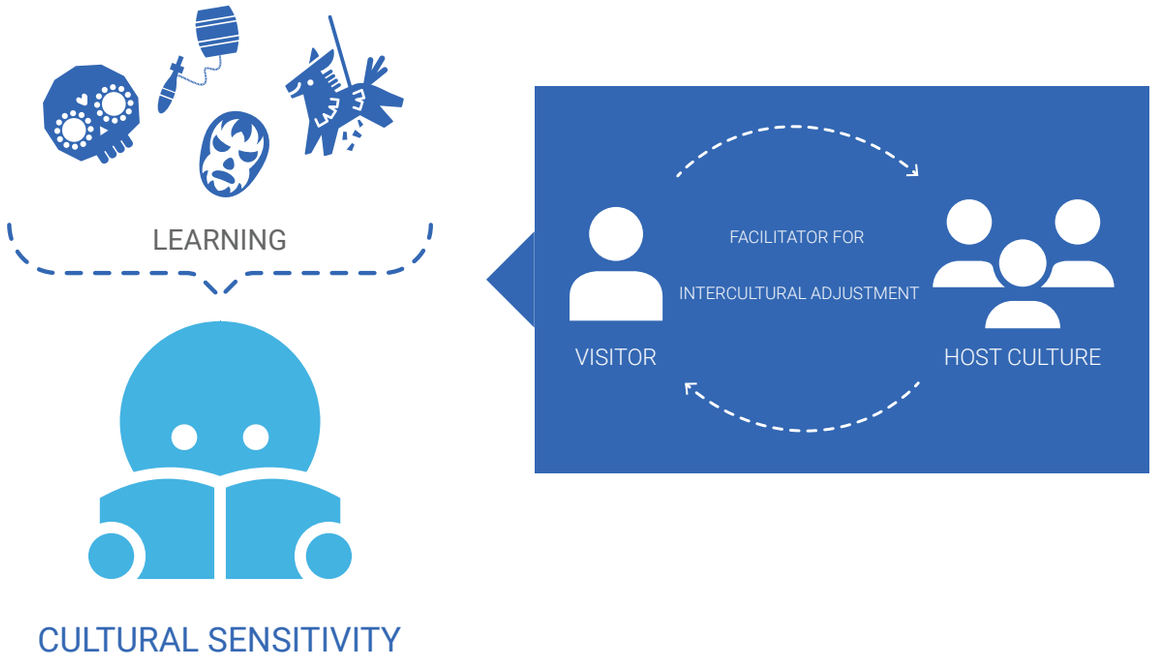


Figure 4.3 Cultural Sensitivity for Successful Intercultural Adjustment

Figure 4.2 Intercultural Friendship promotes Diversity and Enrichment

Although it has been suggested that personality features are relevant to an expatriate individual success (Parker & McEvoy, 1993), it should be considered that in order to encourage the learning of a host culture it might be necessary to enhance the learning experience itself. Thus, the possibilities for the involvement of an individual in the learning process could be fostered. The ability to understand the culture of oneself and another one will promote a better understanding, reduce miscommunication and establish a well-grounded intercultural relationship.

4.3 PARADIGM SHIFTING IN WEARABLE TECHNOLOGY DESIGN.

As seen earlier (Chapter 2.2.1), current wearable devices design tends to be presented as a technological accessory, which affects the perception of (potential) users towards wearable technology (Friedman, 2017). Designers should remember that during the creating process, regardless the nature of the product at issue, it should be thought according to the needs and desires of the user. Thus, wearable devices should not be an exception, especially when addressing the fact that it holds a strong value-expressive component for the users (Eadicicco, 2014). A wearable device becomes an extension of the self-expression of a human being, even with the potential to become a statement of the identity of an individual.

Hence, the wearable technology might be benefited from the application of fashion thinking, allowing the possibility to experience these devices in similar ways as clothes and accessories (Juhlin et al., 2016). On the other hand, it is necessary to be cautious to not fall into in the superficiality that fashion trend in occasions it represents, which can lead to meaningless products. With this in mind, and recalling one of the Commandments for Good Design proposed by Dieter Rams, the aesthetic value for future wearable technology should lay on its integral design, where its beauty and usefulness converge in order to positively impact the well-being of an individual.

Additionally, this research believes if wearable devices evolve to fashion accessories, it might be possible to reduce the gap for its social acceptance, and therefore, its broader dissemination..

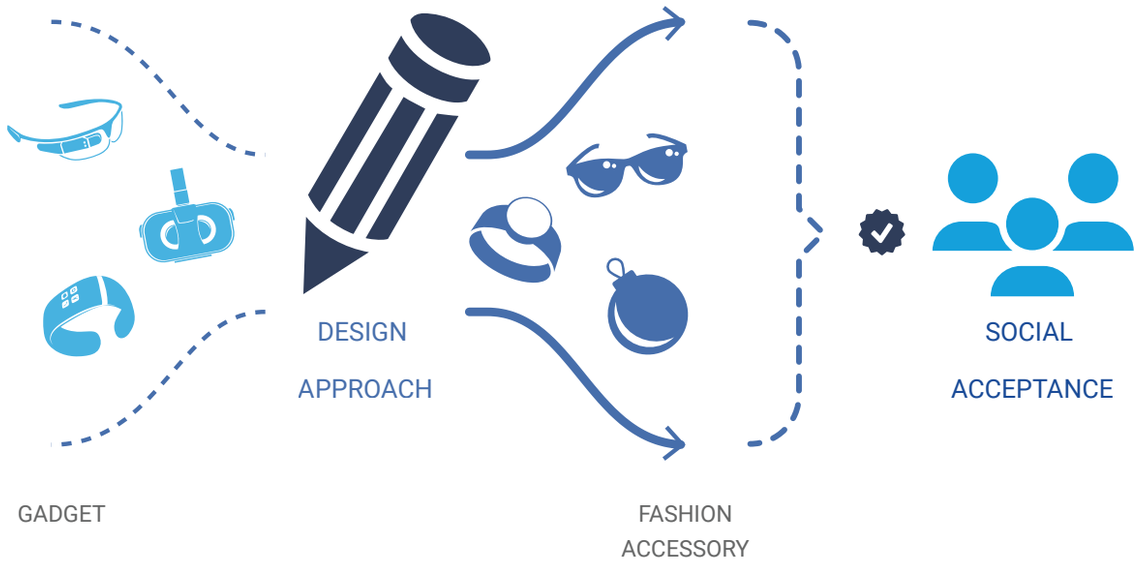


Figure 4.4 Fashion Thinking as Design Appraoch for Wearable Technology

Figure 4.5 Spectacles: Fashionable Smartglasses

4.4 THE INTEGRATION OF INTELLIGENT AFFECTIVE COMPUTING IN WEARABLE TECHNOLOGY.

Affective Computing refers to the ability of a computer could capture, process and reproduce human emotions (Picard, 1997). Emotion recognition pretends to identify the types of emotions based on signals, which can be seen as a pattern recognition task. Additionally, it requires quantitative measurement of the emotion, which is often related to the matter of value estimation based on trained model (Dai et al., 2015). Building an emotionally intelligent system requires overcoming the challenging automatic recognition of the affective state from an individual, on account of that the emotion of a person is assessed from different sources of information, which includes, causal information context and individual traits, as well as the information of recognizable bodily reactions of the individual (Zimmermann et al., 2003). Technology has the potential to bridge the gap between what is felt inwardly and displayed outwardly. However, owing to the fact that individuals have different reasons to keep their emotions as a private matter, it is important to consider how such technology can be designed so that it recognizes human needs for control over the display of emotions and behaviors (Picard, 2009).

On the other hand, it is important to keep in mind that one of the motivations of affective computing is to facilitate computers the better understanding of human needs by empowering an effective adaption to the particular desires of the user, rather than create an idealized user, who has been recognized to be strongly influenced by emotion even if there is no emotion at all (Picard, 2003).

Regardless the challenges that are needed to be overcome for the implementation and further development of emotional systems, it has been identified the imperative need that such systems must connect on an emotional level with their users (Norman, 2004), which eventually will allow the better understanding of oneself, and hence, comprehend his environment and others as well.

Current emotion-aware applications sense emotion by the relationship between the emotion of the user and the behavioral pattern of the mobile phone device (LiKamWa et al., 2013), nevertheless, the interpretation and accuracy of the emotion recognition is either limited by the small scale data collected by mobile devices or it is dependent on an intensive manual labor of labeling processes, consequently, it limits the provision of a sufficient emotion-oriented care (Chen et al., 2015).

By contrast, one of the most distinguished features of wearable devices, as opposed to the simply portable computers, is the fact that they can be in physical contact with the individual in a long-term intimate way, having the potential to learn to recognize physical and physiological patterns, especially those related to affective states and physiological sensing. An affective wearable device can be defined as a tool equipped with physiological sensors and pattern recognition that can perceive and respond to the affective state of the wearer (Dabek, Healey & Picard, 1998).

Furthermore, affective wearables represent a perfect opportunity to implement computational methods to bear on testing emotion theories (Picard & Healey, 1997), and as a consequence, using wearable technology as an important technique for the development of human-centric technologies (Bonato, 2005). Thus, these two elements can merge together as one through seamless integration, where the wearable becomes an extension of the human capabilities (**Figure 5.5**).

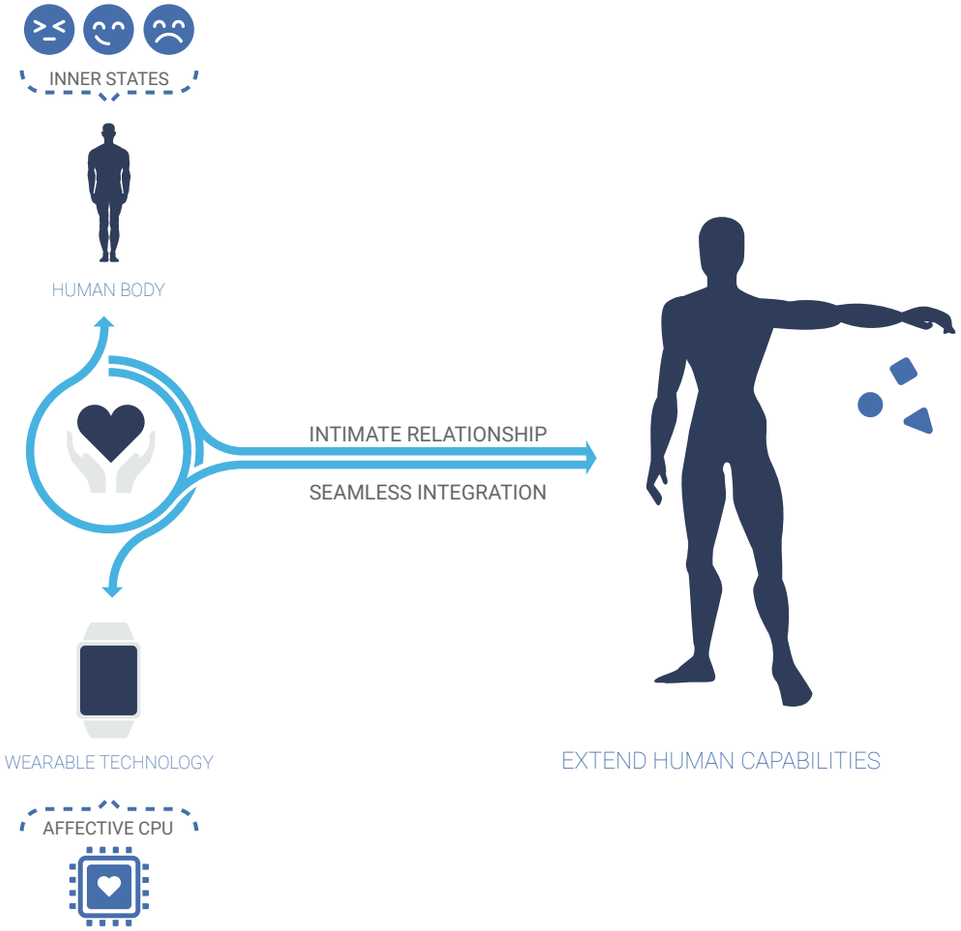


Figure 4.6 Seamless Integration of Wearable Technology

4.5 THE PROSPECTIVE CONTEXT FACTORS FOR A FORTHCOMING SOCIAL WEARABLE TECHNOLOGY.

It is believed that in a future context individuals will continue to value friendship as an essential experience for the human being. Additionally, it is assumed that intercultural relationships will persist even more in the future, due to the "nature" of the millennials (Corvi et al., 2007), in this respect, it might possible to entail that the future generations will suffer a process of cultural hybridization (Hofstede, 1980).

Wearable Technology has the potential to offer new models and practices that might contribute the human being at a personal level in the construction of qualitative social connections, by assisting the individual in the self-reflection, the self-awareness, and the consciousness of his/ her environment. With the support of the application of affective computing principles, it is possible to promote a deeper and intimate relationship with technology, which will allow a better understanding between the wearer and the wearable, and therefore, enhance the capabilities of the individual accordingly. Technology should provide assistance during the building of an interpersonal relationship regardless cultural background, with the intention to bridge the gap of miscommunication between individuals.

Based on, it is possible to envision the involved factors that might support the role of a Forthcoming Wearable Technology, as follow (See **Figure 4.6**):

CONNECTING PEOPLE

Nokia aims to provide self-managing technology that works invisibly in the background, while adapting in order to anticipate the needs of the individuals (Nokia: Innovation and Possibilities, 2016). Thus, creating new ways to connect people, through a seamless integration with technology.

FASHION DESIGN THINKING APPROACH

The terms "wearable computing' and 'user' should be replaced with "jewelry" and "wearer" to highlight their constant and intimate relationship (Wright et al., 2008). Technology should subtly blend within the user (Miner et al., 2001). Fashion thinking in designing wearable devices will allow consumers to experience these devices in similar ways as their clothes and accessories (Juhlin et al., 2016).

AFFECTIVE COMPUTING

When Integrated into Wearable Technology, it facilitates to the computers the better understanding of human needs by empowering an effective adaption to the particular desires of the user all (Picard, 2003), creating a long-term intimate way (Dabek, Healey & Picard, 1998). And as a consequence extending human capabilities and promoting the development of human-centric technologies.

CULTURAL HYBRIDIZATION

Cultural boundaries will be less visible, the world will not be fragmented into cultures and societies, instead, it will be subjected to contact and cultural hybridization, thus, it will become one immense region, where interaction and cultural exchange persist even more (Hofstede, 1980). To that effect, it is believed that a proper intercultural communication processes will promote accurate reflections about diversity and relationship among individuals from different cultural backgrounds.

INTERCULTURAL SENSIVITY

It should be encouraged on individuals to actively participate in learning about different cultures. Successful intercultural adjustment will be achieved through cultural sensitivity, which represents the willingness and interest of an individual to learn the customs and practices of a host culture in order to be enriched as a human being (Bennett, 1993).

Additionally, it is assumed that the acceptance of Wearable Technology will increase in a future scenario by reaching a major maturity (development) to overcome the challenges earlier cited during **Chapter 2.2**. Through this project, an opportunity it is open for Nokia to be positioned as a leading innovation company in the development of future wearable devices with a strong focus on the human-centered technologies and the transcendence of human being.

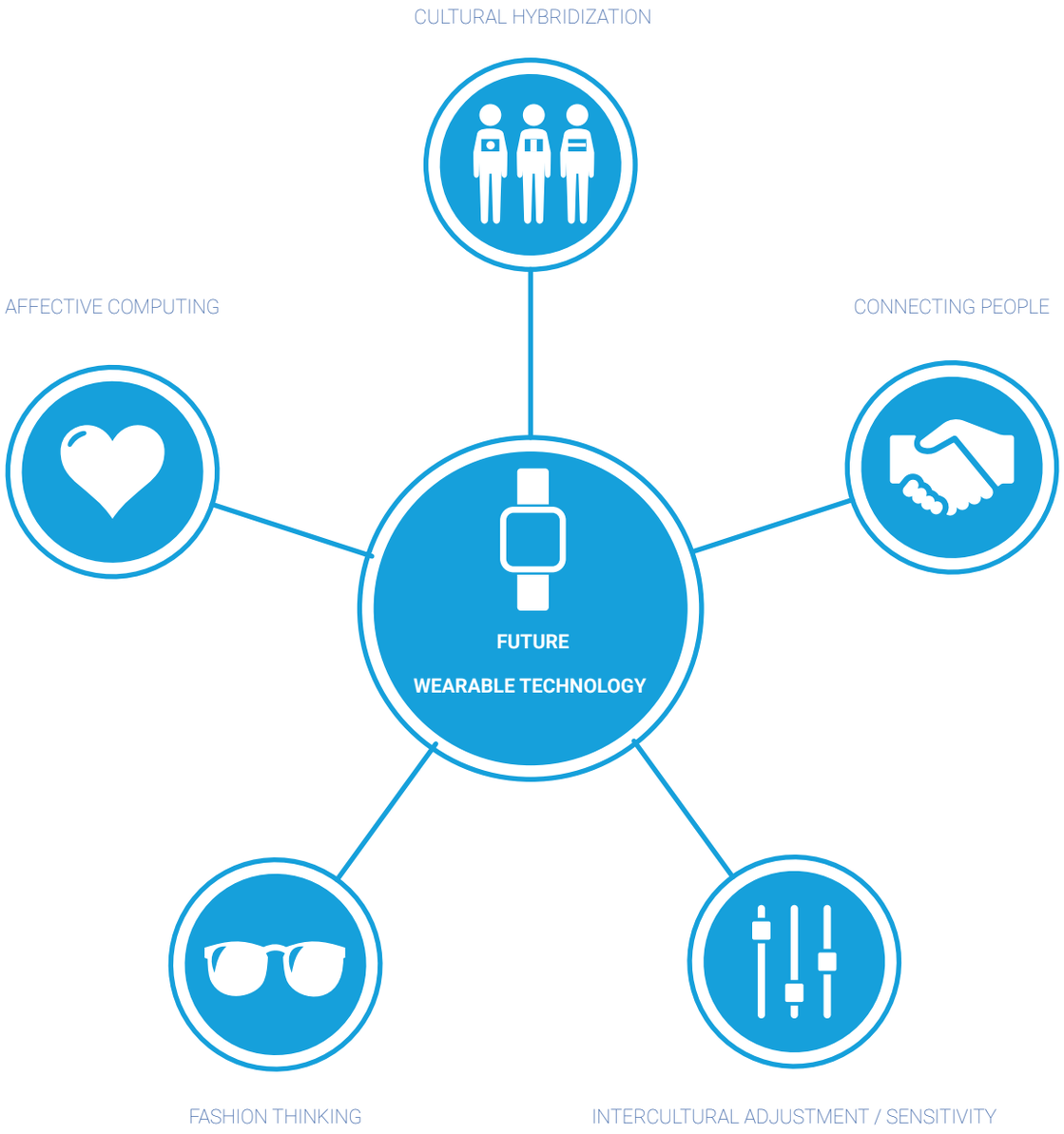


Figure 4.7 Future Context Factors of Wearable Technology

4.6 AN OUTLOOK OF WEARABLE TECHNOLOGY ASSISTANCE FOR A SUCCESSFUL INTERCULTURAL RELATIONSHIP

Previously (**Chapter 3.3** and **Chapter 3.4**), it was addressed the relevance of the verbal and non-verbal communication elements involved in an intercultural interaction, where the accurate interpretation of such elements are needed for a successful communication. Hence the need for a communicative competence, intercultural sensitivity, and open-mindedness from the individuals involved in the construction of such relationship. Cultural sensitivity on an individual plays a key factor for his successful cultural exchange and integration, it encourages the active learning of another culture (Matsumoto et al., 2001). In that sense, it increases the possibilities of promoting new intercultural communication mechanisms for the accurate reflections about diversity among individuals from different cultural backgrounds.

Aligned with the above, the adaptation of technologies must be defined on the basis of the evolving communication needs of the human being. The adoption of wearable technology might offer a higher possibility to bring the benefits a self-managing technology that works invisibly in the background while adapting in order to anticipate the needs of the individuals.

It holds the potential to learn to recognize physical and physiological patterns of a person, resulting in the development of an intimate relationship with the device. This approach will allow the promotion of human-centric technologies capable of extending human capabilities.

This study proposes that the wearable technology could be considered as a valuable support mechanism for an effective intercultural communication, assisting individuals in the better understanding of the verbal and non-verbal communication coding systems. Wearable technological assistance is proposed as a medium for the promotion of cultural sensitivity with the intention of creating self-awareness and thoughtfulness about cultural background diversity. The role of wearable technology should lie in the second plane of the human communication process, with the aim of giving back the individuals the meaning of true human connectedness and not reducing their self-reliance.

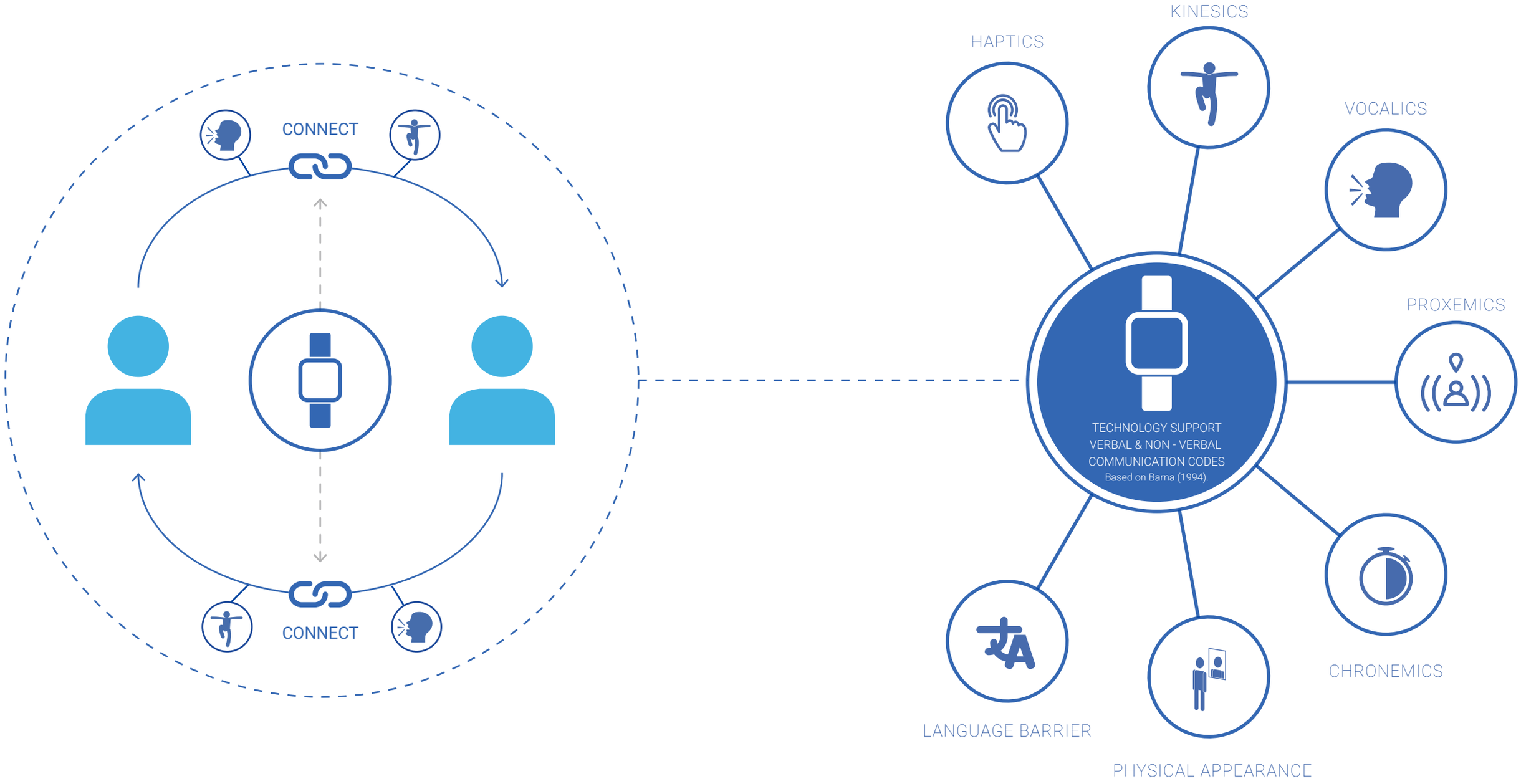


Figure 4.8 Technological Assistance for a Successful Intercultural Relationship

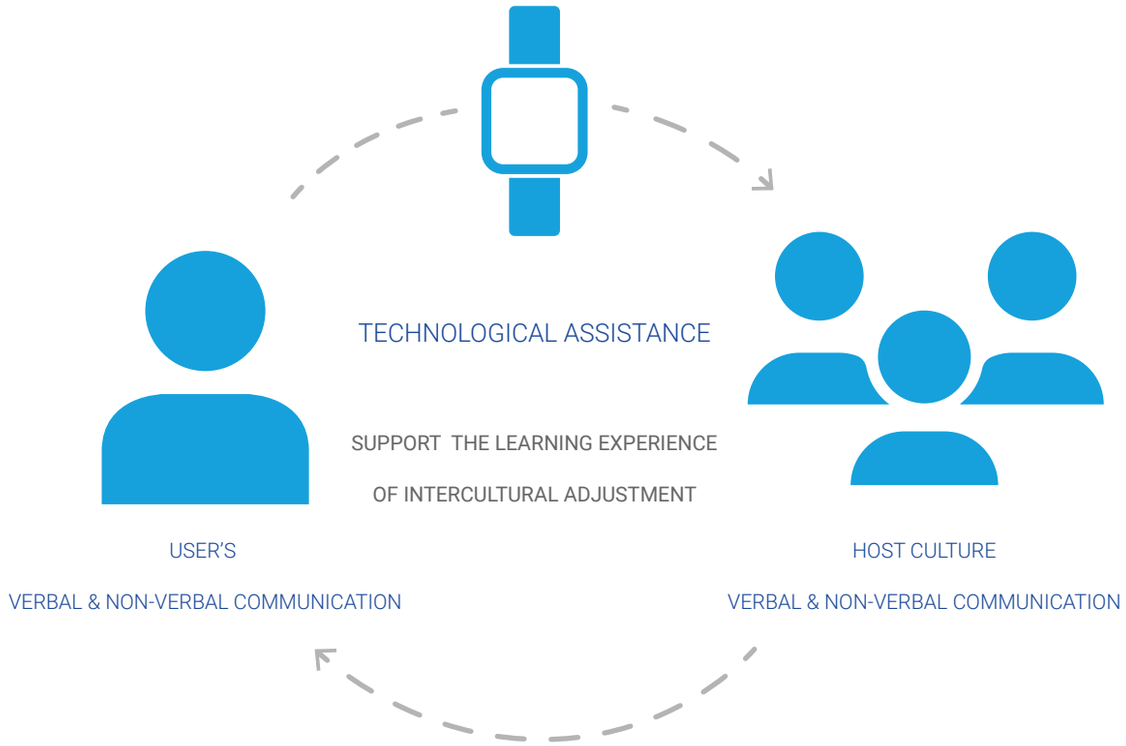
4.7 DESIGN VISION: A FORTHCOMING WEARABLE TECHNOLOGY.

Nokia is focused on the development of advanced consumer and professional technology products, who has acknowledged the importance of making people feel close to each other. Nokia considers that communications tools should serve as an extension of the identity of an individual, therefore, it aims to predict the intersection of technology with the evolution of human communication/ interaction needs. Although Wearable Technology offers the possibility to create self-awareness on an individual, it should not forget its impact on the society and the surroundings.

Technology has extended the possibilities to reach a higher number people regardless the distance and time at the expense of the decrease in the rational and critical thinking, in addition to the escalation of fictitious interpersonal relationships through the use of digital communication, and as consequence, compromising the quality of interpersonal communication. Nevertheless, technology has become a part of the human nature, therefore, instead of removing it from the lifestyle of the people, it is proposed a change of mindset where technology has the potential and the capability to assists individuals in the construction of interpersonal relationships.

As mentioned earlier, wearable technology with the integration of the principles of affective computing can offer new models and practices that might contribute to the development of human-centric technologies, by assisting and extending the abilities and capacities of the individual, simultaneously, offer the possibility to create self-reflection, self-awareness, and surroundings consciousness.

With the assistance of technology, it is believed that the capacity intercultural adjustment can be improved on individuals. As previously mentioned, through intercultural sensitivity it is possible to facilitate the learning about different cultures, and therefore, reduce the gap of verbal and non-verbal communication codes. Technology is proposed only as a medium of support without the intention of reducing the self-reliance of an individual. It aims to provide self-reflection to the user on how his/her behavior or attitudes are contributing or affecting an interpersonal communication within an intercultural setting.



> *Design a wearable device that supports the learning experience of intercultural adjustment in order to promote an effective intercultural relationship.*
>
> - Guillermo Márquez -

Figure 4.9 Design Vision: A Forthcoming Social Wearable Technology

5.0 EXTENDING THE HUMAN CAPABILITIES THROUGH WEARABLE TECHNOLOGY.

This project is thought as a future solution yet feasible, therefore, it is considered within the domain of a concept design. The key technological functionalities of a future concept proposal will be explored within this chapter, which might be still under development process, yet with the potential to be implemented in the near future. This Chapter will unfold in the development and synthesis process in order to converge in a final direction for further concept development.

5.1 FRAMING THE DESIGN SPACE OPPORTUNITY: THE VALUE OF LEARNING A FOREIGN LANGUAGE.

The design vision has supported the elements and the factors that are needed to consider for the implementation of wearable technology, allowing to explore its capacities and applications that might complement and enhance the current human capabilities. Based on the earlier research, at a theoretical level, wearable technology has the potential to assist all the dimensions of the learning experience for intercultural adjustment, which includes verbal and non- verbal communication elements (**Figure 4.7**). However, although other dimensions should not be discarded, this research has chosen language barrier as the focus of this study, due to the fact it is considered as the main channel for direct communication.

As mentioned previously, language difference is considered as one of the barriers to intercultural communication (Barna, 1994), however, before proceeding any further, it is important to define the what it is perceived as a second language, which is considered a language studied in a setting where that language is the main form of everyday communication and where abundant input exists in that language (Rebecca & Oxford, 2003). Language is considered as the most relevant mediator that allows the human being to relate and understand each other (Imberti, 2007).

In particular, language barrier in overseas travel has been studied as a barrier for intercultural communication between visitors and hosts (Edgell & Haenisch, 1995; Cohen, 2004), which has been identified as one of the obstacles for the approach to the learning about the local/host culture (Gmelch,1997).

According to the Developmental Model of Intercultural Sensitivity proposed by Bennett (1993), it is believed that intercultural sensitivity involves personal and cognitive growth and the development of a mindset capable of understanding from within and from without both, the own culture of an individual and the culture of another one (Bennett, 2003).

It is suggested that an individual who has intercultural sensitivity will foster the attitudes, knowledge, and behavior that facilitate his/her successful intercultural communication and adjustment in an unfamiliar cultural setting (Kim, 2001, 2005). This study assumes that supporting the language learning of the host culture, an individual will be more apt for adaptation/ integration within the host culture (Jackson, 2011).

Figure 5.1 Evidence of Intercultural Sensitivity

Figure 5.2 Philips Vibe for the Suppor of Emotional Awareness

5.2 EXTENDING HUMAN CAPABILITIES THROUGH SENSORY AUGMENTATION OF WEARABLE TECHNOLOGY.

It is known that human cognitive capacity is finite, and as consequence, when attending a task the cognitive resources available for other tasks is reduced (Setz et al., 2010). Hence the vital importance of enabling intelligent systems to augment the human ability to process information, and minimize the interfering factors that demand mental effort (Kim & Dey, 2016). Human Augmentics (HA) refers to the technologies that expand the capabilities, and characteristics of humans. It is suggested that Human Augmentics is a driving force in the non-biological evolution of humans (Kenyon & Leigh, 2011). Augmenting the senses of an individual with computational support allows the improvement of the information perceived and the tasks performed.

Nevertheless, it is important to consider that the impact of such augmentation might range according to the user context, thus, affecting the quality of the user experience (Kim & Dey, 2016). An individual is often seen as a being almost inseparable from her/his smartphone, thus, wearable technology has the potential of being the future medium for the development of augmentics devices, enhancing human capability to visually, aurally, cognitively and physically interact with his/her surroundings beyond what he/she would naturally be capable of (Kenyon & Leigh, 2011).

Sensory Augmentation has been explored in the following two areas: On one hand, supporting individuals with sensory deficits to restore the ability to perceive a certain defective sensory modality by using the existing capabilities of a functional human sensory system, Sensory Substitution. On the other hand, sensory augmentation has the potential to extend the ability of the body to sense aspects of the environment that are not normally perceivable, Sensory Extension (Kaczmarek, 1995).

For the purpose of this study, it is considered that sensory augmentation should be approached from the sensory extension aspect, due to the fact that learning a second/foreign language represents to extend an existing capability that does not present a sensory deficit. It is suggested that the development of systems for augmenting human sensory capability is increasingly becoming more wearable and (Internet-) connected, thus, promoting the potential of extending the cognition and attention abilities of an individual (Kim & Dey, 2016).

As consequence, through the implementation of sensory extension principles in wearable devices, it might be possible to support the learning process of a second language

5.3 SENSORY PREFERENCES AS A LEARNING STYLE WHEN LEARNING A FOREIGN LANGUAGE.

A language learning style is one of the main factors that assist to determine how an individual learn a second or foreign language. Learning styles are considered as the general approaches (e.g. global or analytic, auditory or visual) that an individual uses in the process of gaining/ learning a new language or learning any other skill (Rebecca & Oxford, 2003). The four dimensions of learning styles which are strongly associated with the process of learning a second language are sensory preferences, personality types, desired degree of generality, and biological differences (Graham, 1993). Nevertheless, although it is important to keep in mind that learning styles are not dichotomous (black or white, present or absent) due to the fact that they generally operate on a continuum or on multiple, intersecting continua (Rebecca & Oxford, 2003), this study will focus on the learning style that involves sensory preferences. The earlier is mainly based on the evidence of the capability of wearable technology to enhance the cognition and attention abilities of an individual during a task performance (Kim & Dey, 2016), where learning a second language is not the exception.

Sensory preferences are referred to the physical and perceptual learning channels with which an individual is the most comfortable when engaging a learning experience (Rebecca & Oxford, 2003).

It is proposed that sensory preferences can be divided in four main areas: visual (through images, color and form), auditory (by hearing and sound), kinesthetic (movement-oriented), and tactile (touch-oriented). **Figure 5.3.**

VISUAL LEARNING

Visual learners prefer seeing what they are learning. Pictures, images, graphs, and colors help them understand ideas and mentally organize information (Gilakjani & Ahmadi, 2011).

AUDITORY LEARNING

Auditory learners prefer spoken messages. Some auditory learners need to hear their own voice to process the information, but others process information through listening to other speakers. They can attend aurally to details, translate the spoken word easily into the written word (Gilakjani & Ahmadi, 2011).

KINESTHETIC LEARNING

Kinesthetic learners prefer to sense and be aware of the position and movement of the provided information during the learning experience. It is suggested that kinesthetic learning gravitates towards active sensory-motor learning (Gilakjani & Ahmadi, 2011).

TACTILE LEARNING

Kinesthetic learners to some extent, tactile learners assimilate better the information through tactile experience (touch). It is believed that tactile/kinesthetic learners acquire better knowledge through an active “hands-on” approach. Thus, favoring the interaction with the physical world (Gilakjani & Ahmadi, 2011).

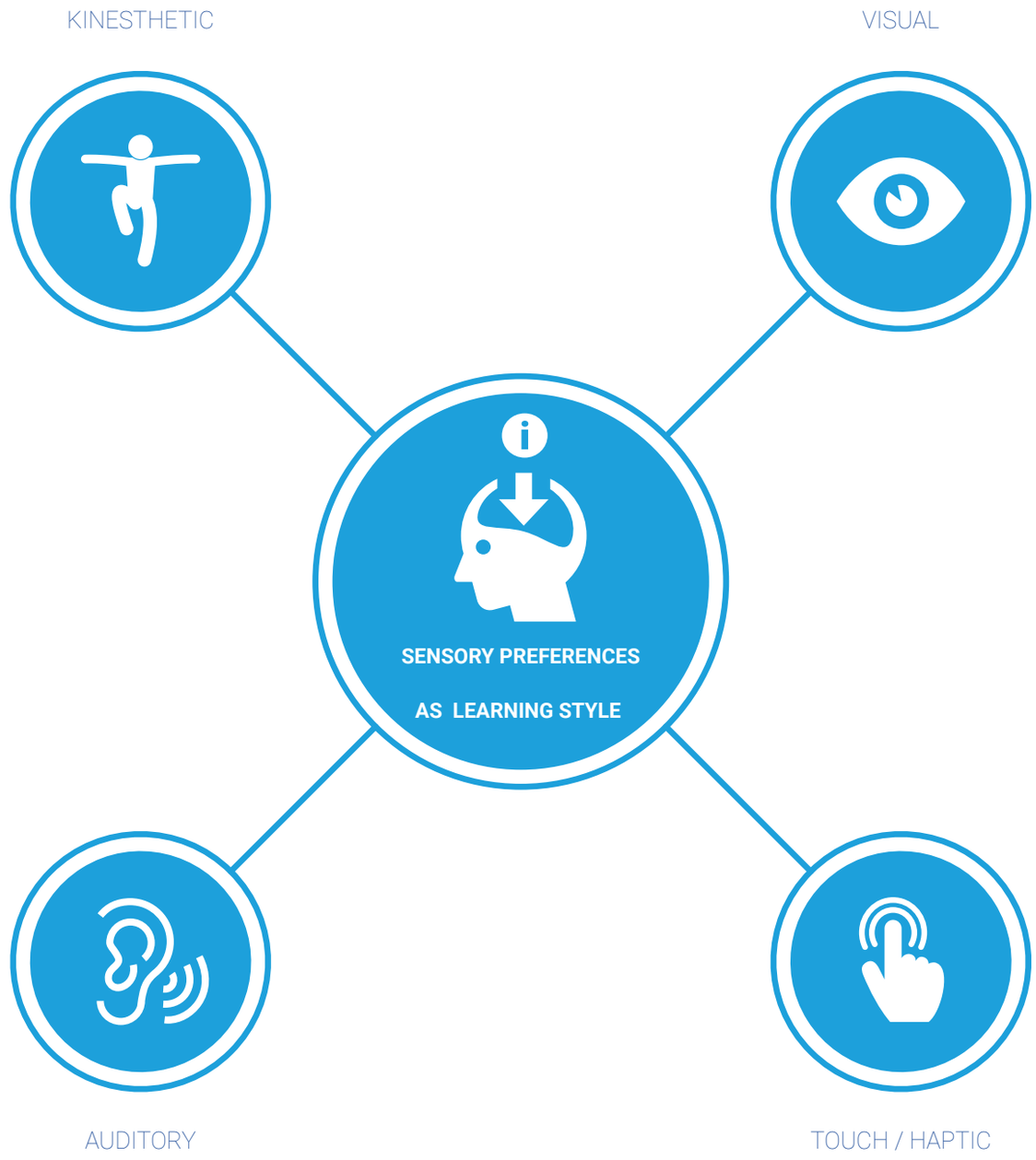


Figure 5.3 Sensory Preferences as Learning Style

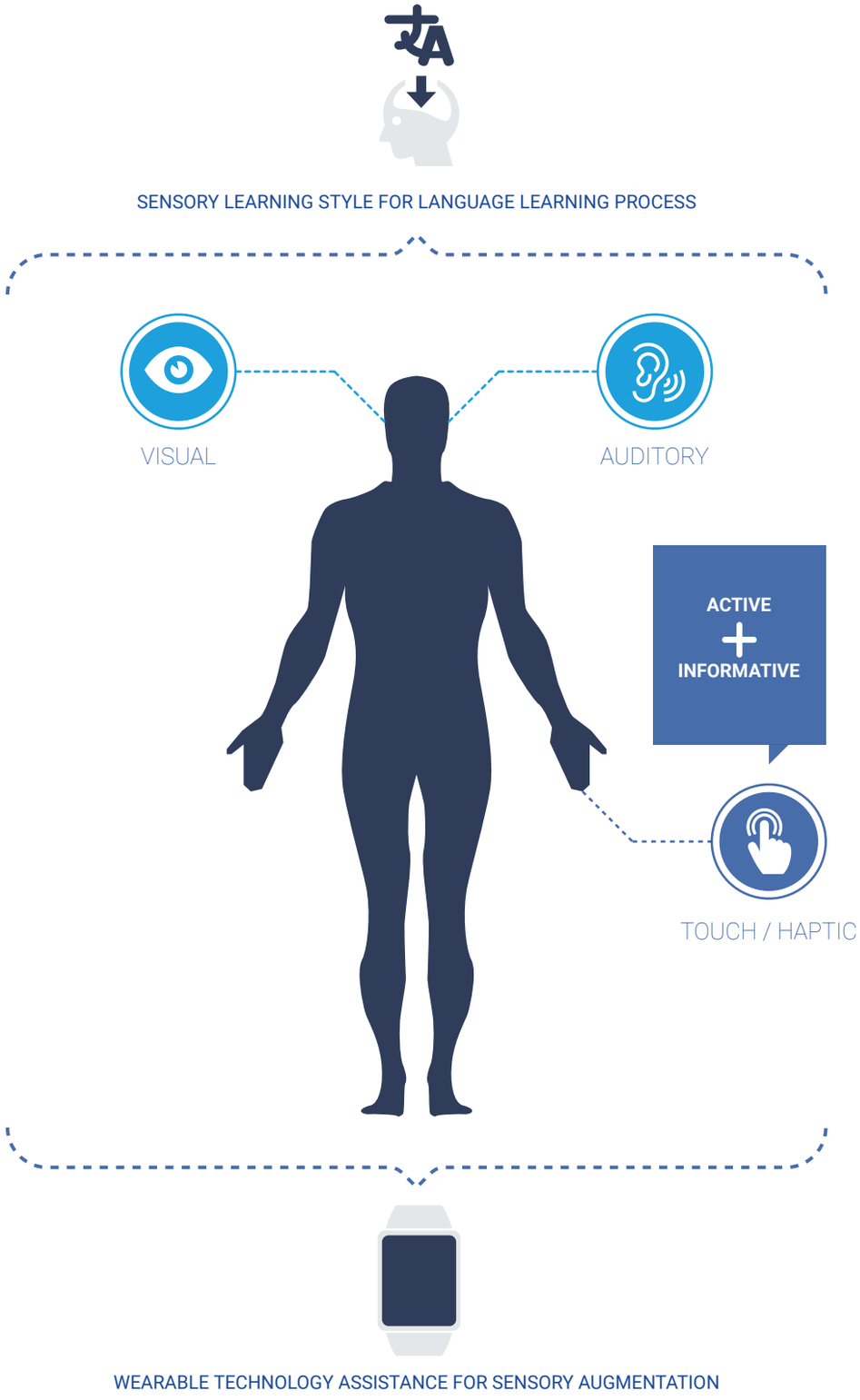


Figure 5.4 Enhancing sensory Learning through Wearable Technology

EXTENDING HUMAN CAPABILITIES

Regardless which sensory preference an individual might choose for his/her learning experience, one of the most significant factors for its success is oneself responsibility for his/her own learning process (Gilakjani & Ahmadi, 2011). A human being interacts with her/his surroundings through five sensory channels-sight, sound, taste, smell, and touch, which act as sensory input modalities for the process of learning (Felder & Henriques, 1995), therefore, it has been suggested that a multisensory approach, also recognized as VAKT (Visual-Auditory Kinesthetic- Tactile) promotes a better learning process due to the fact that the best practice to acquire a new concept is using the four modalities (Moustafa, 1999).

Nevertheless, since the five human senses are seeing, hearing, touching, tasting, and smelling, this study proposes that “kinesthetic” does not properly belong on a list of sensory input modalities. Based on the above, there is a discrepancy among experts to establish which sense(s) are the most important for the learning process, in addition to the personal preferences of an individual for her/his own learning styles (Felder & Henriques, 1995).On the other hand, it is known that an individual extract and retain more information from visual presentations than from written or spoken prose (Dale, 1969), furthermore, in the context of learning a second/ foreign language it has been proved that visual and audio input has a reinforcing effect on the retention of new vocabulary of the target language (Felder & Henriques, 1995).

However, this study suggests that another promising sensory channel for this particular learning process might be the human sense of touch, which is an active, informative, and useful perceptual system that leads to the foundation for the development of a wide range of concepts (Klatzky & Lederman, 2002). Additionally, touch provides extra information about the object not only “sensations”, whereas the eye remains fixed on outer surfaces (Kennedy, Gabias, & Heller, 1992).

Despite the acknowledgment that haptic and visual modalities operate together in the process of information of the perceived world and memory, much of the multimodality approach has the tendency to overlook the haptic sense, giving priority to auditory and visual modalities (Minogue & Jones, 2006). Based on the above, it is possible to suggest that wearable technology has the potential to devise ways of augmenting visual, audio and touch inputs with the purpose of enhancing the language learning experience (Kenyon & Leigh, 2011), and therefore, extending human capabilities by providing the opportunity of acquiring a second/ foreign language in a further holistic experience (**Figure 5.4**).

Figure 5.5 Exploratory Actions as part of the Learning Process

5.3.1 Active Learning Experience for Language Learning.

Kinesthetic Learning and Tactile Learning are learning styles that are used as means of language learning. These styles overlap each other due to the fact that they involve active sensory-motor learning (Gilakjani & Ahmadi, 2011). Learning by doing denotes learning from experiences resulting directly from oneself actions, as contrasted with learning from observing the performance of another person. Additionally, it is known that encouraging exploratory actions lead learners to discover the principles of a concept that is needed to be understood (Reese, 2011).

This study considers that learning a language might be beneficial through a “direct experience”, which involves mental contact with mental phenomena by introspection; but in the current context, it means sensory contact with the results of doing (Robinson, 1930). The proposed strategy called Total Physical Response (TPR), which uses physical interaction to teach a language (Asher 1966, 1969, 2000), offers a different strategy for language learning, that might benefit language learners who prefer sensory learning as means of second language acquisition (Oxford, 1990). Wearable technology opens the opportunity of providing an alternative for an active and effective experiential process, where the integration of technologies contribute to speed learning and hold the engagement of the learners.

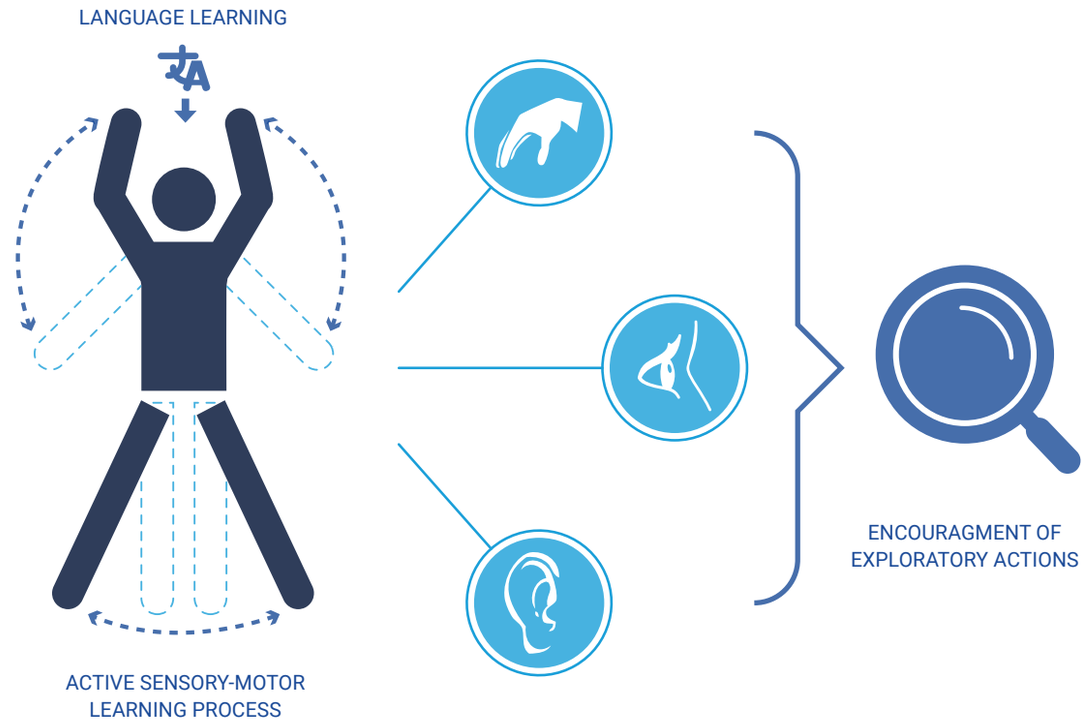


Figure 5.6 Exploratory Actions as means of Active Learning

5.4 AUGMENTED REALITY: A LEARNING ENVIRONMENT FOR ACTIVE LEARNERS

Augmented Reality and Virtual Reality are terms that are considered related (Milgram et al., 1995), it should be valid to define these concepts separately. On one hand, virtual reality refers to the use of computer graphics systems in combination with display and interface devices that allows implementing the effect of immersion in the interactive 3D computer-generated environment. While on the other hand, augmented reality involves the incorporation of virtual computer graphics objects into a real three-dimensional scene, or alternatively, the inclusion of real-world elements into a virtual environment (Pan et al., 2006).

It is important to mention that the term Augmented Reality and Mixed Reality are currently being used interchangeably due to the fact that the distinction between both terms has not been clarified enough yet, however, it is considered that the term Mixed Reality seems to be fading out in favor of Augmented Reality at least in the realm of the consumer/ general public (Foundry.com, 2018). Additionally, it has been proposed three characteristics that are part of the essence of an augmented reality interface, which are as follow: the combination of the real and the virtual, real-time interactivity and it is registered in three dimensions (Azuma, 1997).

Regardless the characteristics and differences that are present between Virtual Reality and Augmented Reality, they are recognized as technological breakthroughs that hold the potential to facilitate learning. It is believed that these technologies in education have the latent opportunity to enrich the teaching and learning processes (Pan et al., 2006).

Augmented Reality offers the possibility to provide both powerful contextual, on-site learning experiences and serendipitous exploration and discovery of the connected nature of information in the real world (Johnson, et al., 2010). According to Lee (2012), Augmented Reality will have an impact on the future of learning and training experience in the following aspects (**Figure 5.6**):

INTERACTIVE EDUCATION

Provide educational environments more productive, pleasurable, and interactive. Not only by engaging the learner through interactive scenarios but also providing to each individual with her/his own unique discovery path, which includes a rich content from computer-generated three-dimensional environments and models.

Figure 5.7 Individual Wearing a Virtual Reality Headset

EFFICIENCY AND EFFECTIVENESS

Efficiency in learning and training processes by providing information at the right time and right place, with the assistance of computer-generated three-dimensional imagery.

EFFORTLESS LEARNING PROCESS

Simplicity and ease for learning and training experiences, learners might accept more easily knowledge and skills with the support of three-dimensional simulations. Enabling the learning and training processes to a much more straightforward and succinct to approach.

CONTEXTUAL INFORMATION

Augmented Reality can improve the extent and quality of information, by producing and delivering rich, constructive, and gainful content. For instance, geotag information for historical and cultural heritages could be connected as well as annotation regarding complex physical objects and artifacts could be supported by the implementation of AR tools.

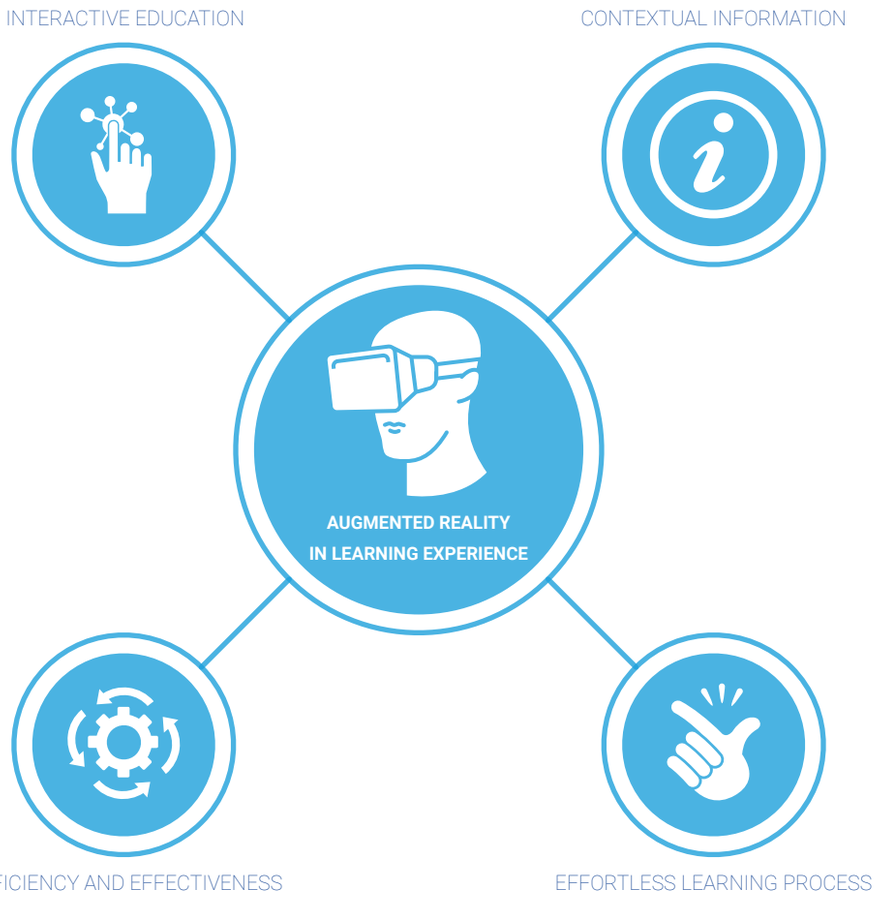


Figure 5.8 The Impact of Augmented Reality in the Learning Experience.

Figure 5.9 Virtual Reality Headsets

Augmented Reality Systems offer a motivating, entertaining, and engaging environments, conducive for an enjoyable learning experience (Lee, 2012). Based on the above, this could trigger the promotion of active learners, who are considered as individuals who have a natural tendency towards active experimentation (Kolb, 1984). This also is aligned with the fact that the application of any technology should be thought on the basis of extending the mind and body capabilities of the human being. The integration of Augmented Reality Systems into wearable technology has the potential to take further the sensorial experiences while connecting digital and physical world at the same time.

In the context of learning a second/foreign language, it has been suggested that augmented reality, which involves mixed media, will offer the opportunity to an individual of being involved in a rich real-time support environment as she/he continues with her/his daily activities (Godwin-Jones, 2016). This study proposes that the implementation of augmented reality systems will enrich the learning experience of the user, by making it more interactive through a multi-sensory experience, while at the same time providing access to knowledge more efficiently (right time and right place). It provides a motivating learning environment that could trigger a higher engagement from the user.

5.5 A COLLABORATIVE WEARABLE TECHONOLOGY: SPEECH-BASED NATURAL USER INTERFACE.

Improvements in computer technology have promoted the development of remarkably interactive user interfaces. A Natural User Interface allows an individual to interact with computers in the way she/he interacts with the world by using both sensory inputs and outputs (eg. touch, speech, and gesture), leading to a more natural and human communication with technological devices. Natural User Interfaces aim to provide a seamless user-experience where the technology is invisible, providing a natural integration (Kaushik & Jain, 2014).

It is believed that Speech-Based Natural User Interface is one of the main representations of the evolution of technology (Hempel et al., 2016; Sim, 2017), proof of the above, is the presence of the most common and extensively used Intelligent Personal Assistants on the market that includes Alexa, Siri, Cortana and Google Assistant, which are considered as Speech-based Natural User Interfaces (López, Quesada & Guerrero, 2017). Speech-Based Natural User Interface is recognized as a technology that belongs to “Calm Technology”, which are the technologies that lead to true calm and comfort. It represents the ability to use appropriate means to engage the focal and peripheral attention of an individual, a how it moves back and forth between both (Weiser, & Brown, 2001).

Figure 5.10 Google Assistant

Extending on the above, peripheral attention refers what an individual attunes to without attending to explicitly, while focal attention represents the concentration that individual directs to a certain stimulus while disregarding the rest (Juola, 2016). On the other hand, when trying to define the character of such interface, it has been proposed that an Intelligent Personal Assistant might play two main roles through a natural user interface system (Lieberman & Selker, 2003), which are described as follows:

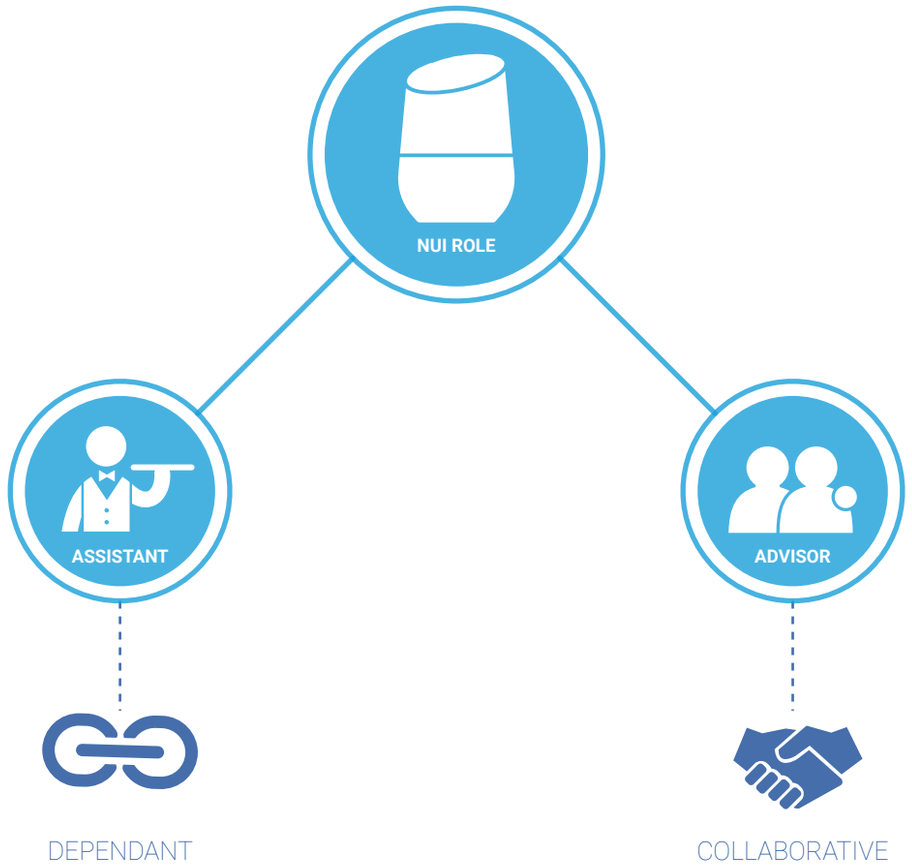


Figure 5.11 The Roles of a Natural User Interface

ASSISTANT

It is based on the premise that the NUI is considered as a butler or a servant, promoting a dependency relationship with the NUI agent. The individual is prevented from having to do an activity or task.

ADVISOR

the NUI acts as teacher or tutor, where it allows to the individual to perform her/his own activities by just providing her/him with suggestions to achieve more effectively her/his goals. Advisory NUI agents have proven to improve user performance.

Figure 5.12 Amazon Echo

EXTENDING HUMAN CAPABILITIES

Advances on intelligent machines and machine learning coupled with cheap sensors, ubiquitous telecommunications have promoted unprecedented automation of tasks, which were long thought as undoable by machines, increasingly taking over tasks once done by people. It is proposed to think less about human-machine interfaces and more about human-machine teamwork, where technology is designed based on human capabilities with the intention to take over the parts of a task that an individual is deficient at. Intelligent assistant systems should be thought as collaborators, not as replacements (Norman, 2017).

This study believes that the approach that should be taken into account for the development of the communication between the human being and the forthcoming wearable device must be founded from an advisor role perspective, through the application of a Speech-Based Natural User Interface system, creating a more natural form of communication between them. Which will allow the empowerment of the user to achieve her/his goals, a better understanding in the communication between the individual and the machine, and last but not least, a friendly human-machine collaborative relationship (**Figure 5.11**).

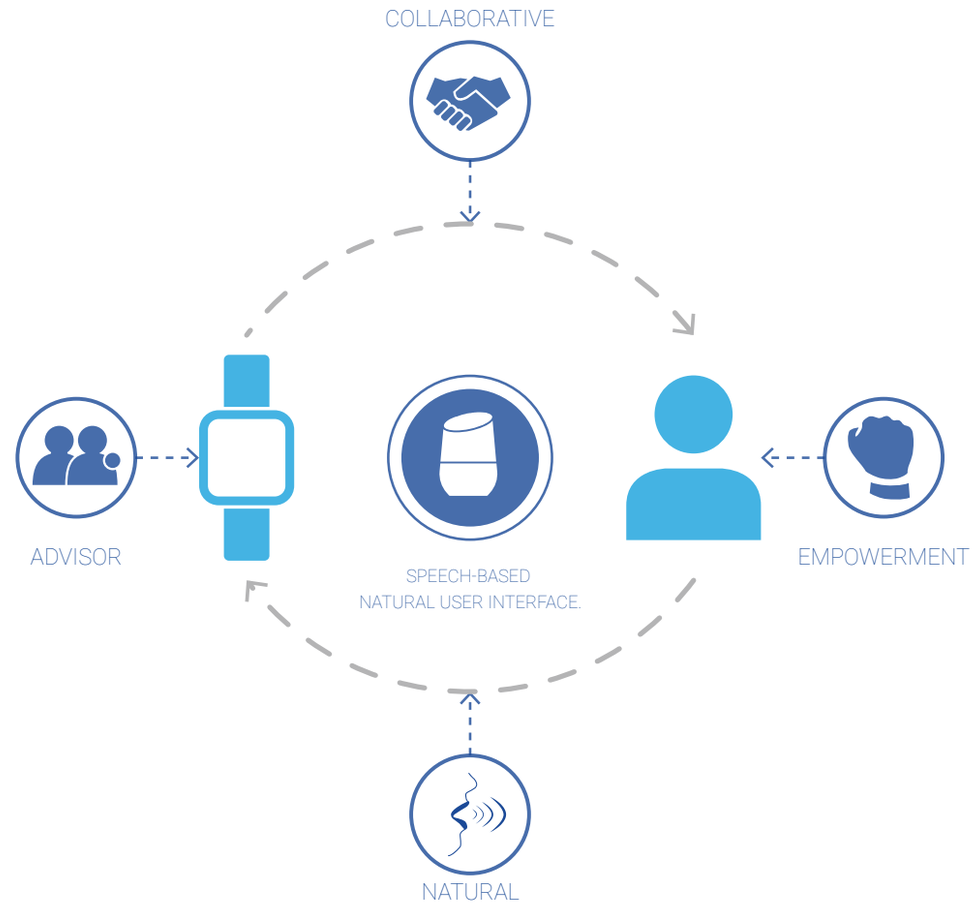


Figure 5.13 The Role of a Forthcoming Wearable Technology

5.6 ESTABLISHING A RELATIONSHIP: SETTING THE INTEARCTION VISION

In the context of learning a foreign/second language, it has been suggested that visual and auditory elements are the most common and effective stimuli used (Felder & Henriques, 1995), however, this study proposes to add an extra layer for the learning experience through haptic sensing, which has proven the potential to take even further the learning processes and experiences (Kennedy, Gabias, & Heller, 1992). Wearable technology has a role to play in it, however, it is suggested that a product provides meaning for people through its interaction (van Boeijen et al., 2014).

Therefore, the user interaction vision suggested will be based on a well-known slogan from "Papalote Museo del Niño", a Mexican museum for children, which is focused on learning through interactive expositions of science and technology. The slogan has the purpose to invite the kids to visit and discover the museum, which is as follows: "Toca, Juega, y Aprende". Translated into English, it means: "Touch, Play, and Learn". This research does not discard the value of playfulness, however, it prefers to approach this factor as an element of exploration. On that basis, the assistance of wearable technology aims to provide the three following aspects: TOUCH-EXPLORE-LEARN when earning a language, promoting a more proactive experience,. Not only in relation to the device and the individual but at the same time, the individual with his environment.

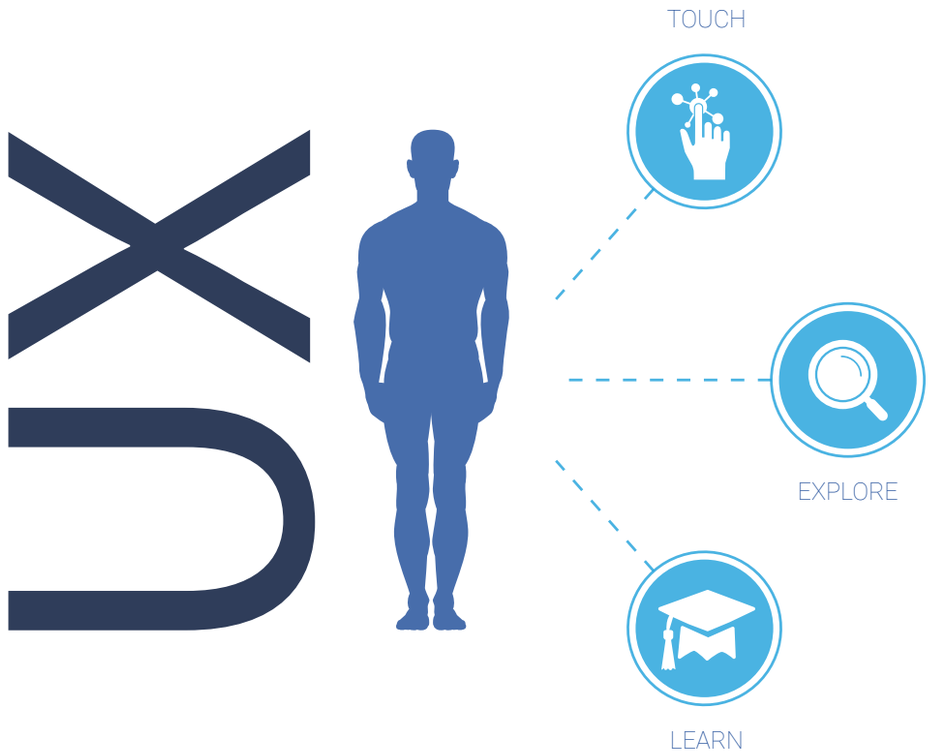


Figure 5.14 Providing a Meaningful Experience through Interaction

NOKIA Bell Labs

"TOUCH, EXPLORE AND LEARN a new way to grasp a language"

-INTERACTION VISION-

Figure 5.15 Exploring & Touching for Learning Experience

5.7 THE HUMAN-COMPUTER INTERACTION SYSTEM OF A FORTHCOMING WEARABLE.

It is important to define the involvement of the user with the computer, this is referred as an Interaction Design, which establishes the means of framing the relationship between a human being and the objects designed for them, and as consequence, defining the mechanisms that frame the activity of design (Dubberly, Haque & Pangaro, 2012). A good first approximation for understanding an interaction between a person and a dynamic system is to acknowledge the user turns her/his intention to action via an input device connected to a physical system, where this information as signals (output), that the user interprets and evaluates it according to her/his initial intention (Norman, 2013), see **Figure 5.**.

On that basis, it is possible to propose that the user interaction with any system is predicated on the function of three human factors (Verplank, 2003; Benyon, Turner P., & Turner, 2005), which are as follows:

INPUT EFFICACY

How and how well an individual sense what a system communicates to her/him?

PROCESSING MODEL

How and how well an individual understand and think about the communication, functionality, and behavior of the system.

OUTPUT EFFICACY

How and how well an individual communicate back to the system?

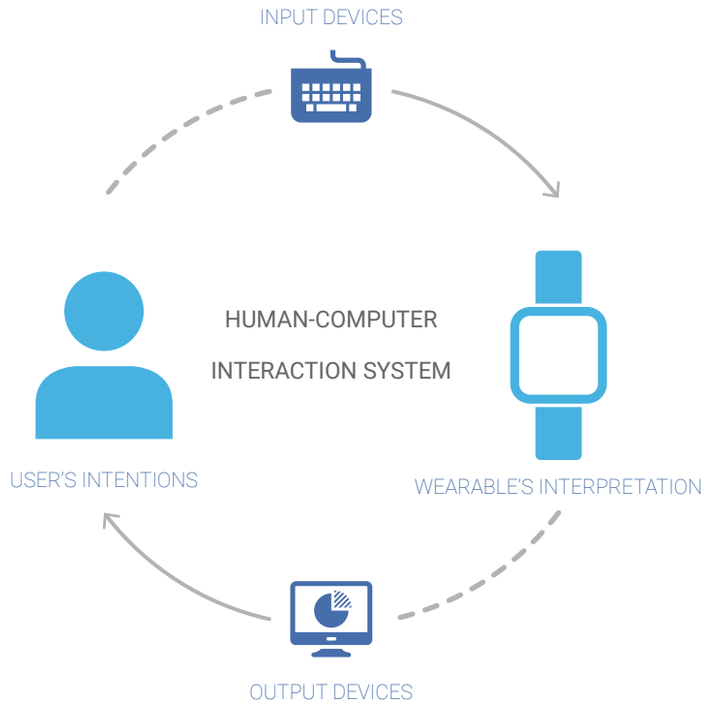


Figure 5.16 Basic Diagram of Human-Computer Interaction System

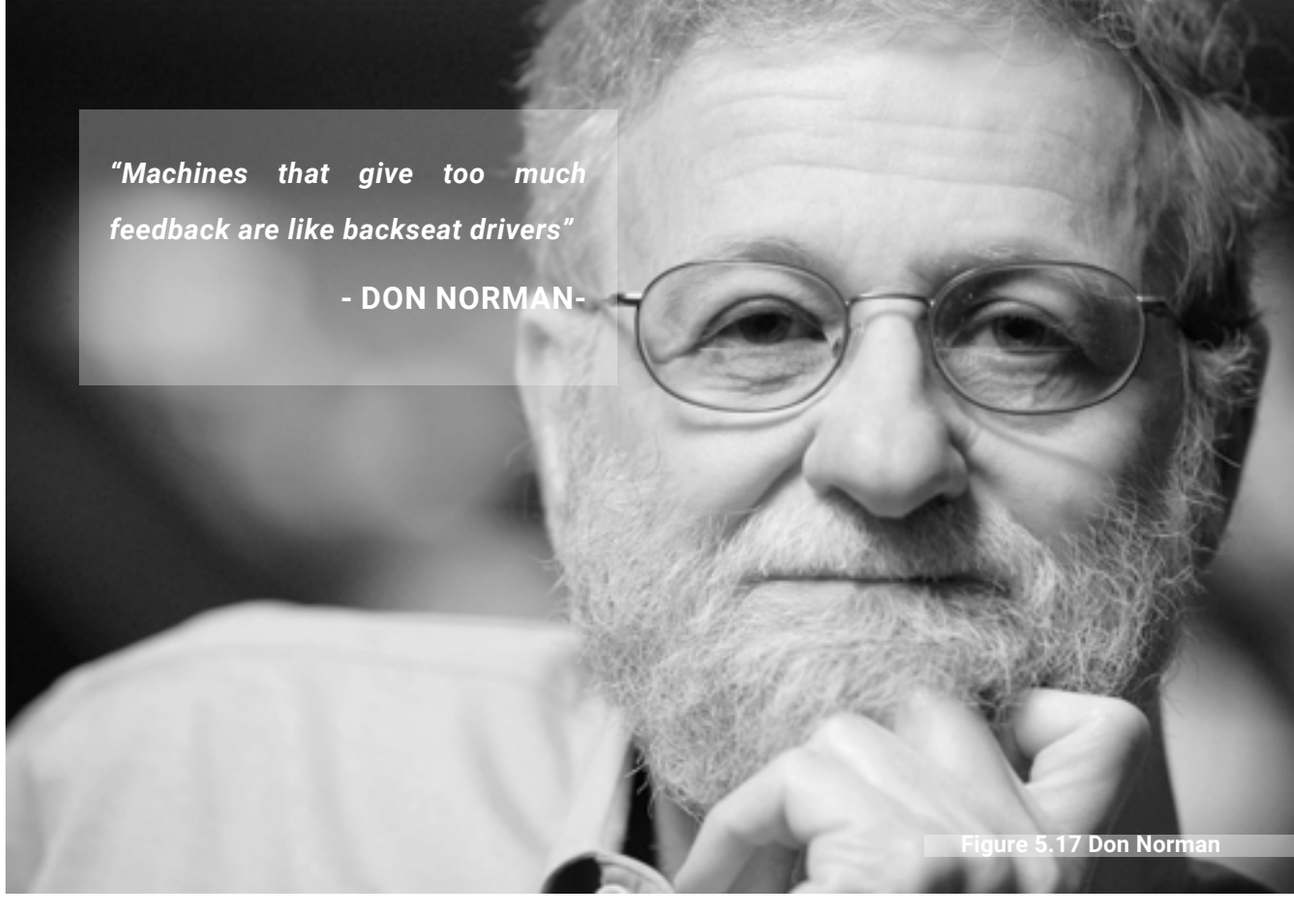


Figure 5.17 Don Norman

Aligned with the above, it is important to remind that a broad view of interaction design should include context and meaning (Buchanan, 1998), therefore, considering the goal of the individual based on the context of information (Dubberly, Haque & Pangaro, 2012). Hence the reason for this investigation to initially concentrated its efforts in an extensive research to understand the possibilities, challenges, and opportunities for wearable technology (**Chapter 2** and **Chapter 3**) in order to define a valuable purpose of the wearable technology for the human being (**Chapter 4**). On the other hand, **Chapter 5** has been exploring and focusing on the mediums that will support the individual in the pursuit of her/his objectives, by defining which human capabilities are needed to be extended to enhance his/her learning experience (**Chapter 5.2** and **Chapter 5.3**), the suitable technological environment that will promote active learners (**Chapter 5.4**), and finally, the role of the natural user interface that will support the individual in her/his learning process (**Chapter 5.5**). Thus, with the previous elements established, it is possible to suggest the functionalities (inputs and outputs) that the wearable technology should integrate. With the intention of settling a good communication and understanding between the individual and the computer (Human-Computer Interaction System), the proposed functionalities are described in **Figure 5.**.

INPUT

Based on the sensory preferences as the learning style for a second language (Chapter 5.3), and the principles that promote a natural user interface for a human-machine collaborative relationship (Chapter 5.5).

OUTPUT

The mediums proposed are found on the sensory preferences for the learning style of a second language (Chapter 5.3), and the factors that create a learning environment for active learners (Chapter 5.4).

SENSORY CHANNEL	TECHNOLOGY	COMPONENT	FUNCTION	JUSTIFICATION
	Eye tracking	Pupil Sensor & Camera	The sensor tracks the pupils of the wearer by measuring the distance between the centers of the two pupils, which indicates the depth of an object that a person is trying to focus on.	Its main purpose is to determine and assist the user in the location of an object of interest.
	Speech Recognition (Speech Deep Learning Model)	Activity Detector & Microphone	Linguistic information is processed to identify the personal aspects of the speaker (speech and emotion).	Its value is based on theIts value is based on the ability to be the medium to carry out a Speech-Based Natural User Interface with the device for a natural way of communication.
	Electromagnetic Sensing	Magnetic Field Sensor	With a magnetic field based haptic surface system, users can touch the surface of an object and detect the electromagnetic noise that the naked human senses are not able to notice.	It enables to register and recognize the objects that an individual merely touch with her/his hands, without interfering with the natural way that touch sensing gives information to the human being.
	Bone Conduction	Vibration Transducer	It decodes sound waves in order to convert them into vibrations.	It keeps the ears free in order to keep the individual aware of her/his surroundings when wearing them, and at the same time, it promotes a personal and private communication with the device.
	Augmented Reality System	Optical Head-mounted Display	OHUD allows the individual to have access to visual information in her/his normal field of view.	It allows the individual to have access to contextual information at the right time, without being obtrusive with his surroundings.

Figure 5.18 Inputs and Outputs for Future Wearable Device Concept

The functional capabilities for future concept design has been determined by presenting an overview of the Human-Computer Interaction System, integrating the physical product and the user with the involved interaction (inputs and outputs), in addition to the context and meaning assigned to the wearable technology, offering a valuable purpose for the human being. And as a consequence, it enables the designer to bring forward harmony between the user, the task(s), and the environment to enhance the system, with the flexibility to amend any of these elements in order to improve the relationship. With this in mind, it is possible to educate and train the user, the environment enriched, and adapt the tasks when needed (Benyon, 1993).

On that basis, it will be possible to maximize the potential of wearable technology according to the human needs, enhancing her/his learning experience. Thereby, promoting a human-centric technology approach (Hernon, 2017).With this multimodal approach, it is believed that the enhancement of the learning experience might be even higher. However, it is important to remind although the use multisensory channels for learning experiences have suggested a better performance (Minogue & Jones, 2006), when considering the principles of Human-Computer Interaction, the overload of feedback information (outputs) might result counterproductive during the interaction, having as a consequence, miscommunication and misinformation between the device and the user (Norman, 2017).

Hence the reason for not overwhelm the user with several channels of information, therefore, it is proposed to only retain visual and auditory as sensory channels for feedback. Additionally, the implementation of a Speech-Based Natural User obeys the fact that such interface does not abruptly get in the way of the focal and peripheral attention of an individual (Weiser, & Brown, 2001), enabling the possibility for the user to draw his focus within both realms according to his desires and needs. On the other hand, the implementation of augmented reality system in the learning experience increases the probabilities for the user to experience his learning process in a motivating, entertaining, and engaging environment, thus making it more enjoyable.

In that sense, the integration of the previously cited elements into wearable technology will trigger a more proactive relationship between the wearable and the user. As mentioned earlier (**Chapter 2.2.2**), wearable technology should aim for user engagement with the intention to not to only provide useful data for the user, but also with the purpose of improving this data The definition of inputs and outputs that are involved in the human-computer system allows supporting a more structured concept design(s), by setting the basis of the functional requirements and the desired relationship between the user and the wearable device (**Figure 5.17**). The outcome of this implementation will be further explored in the following chapter, through the presentation of concept proposals

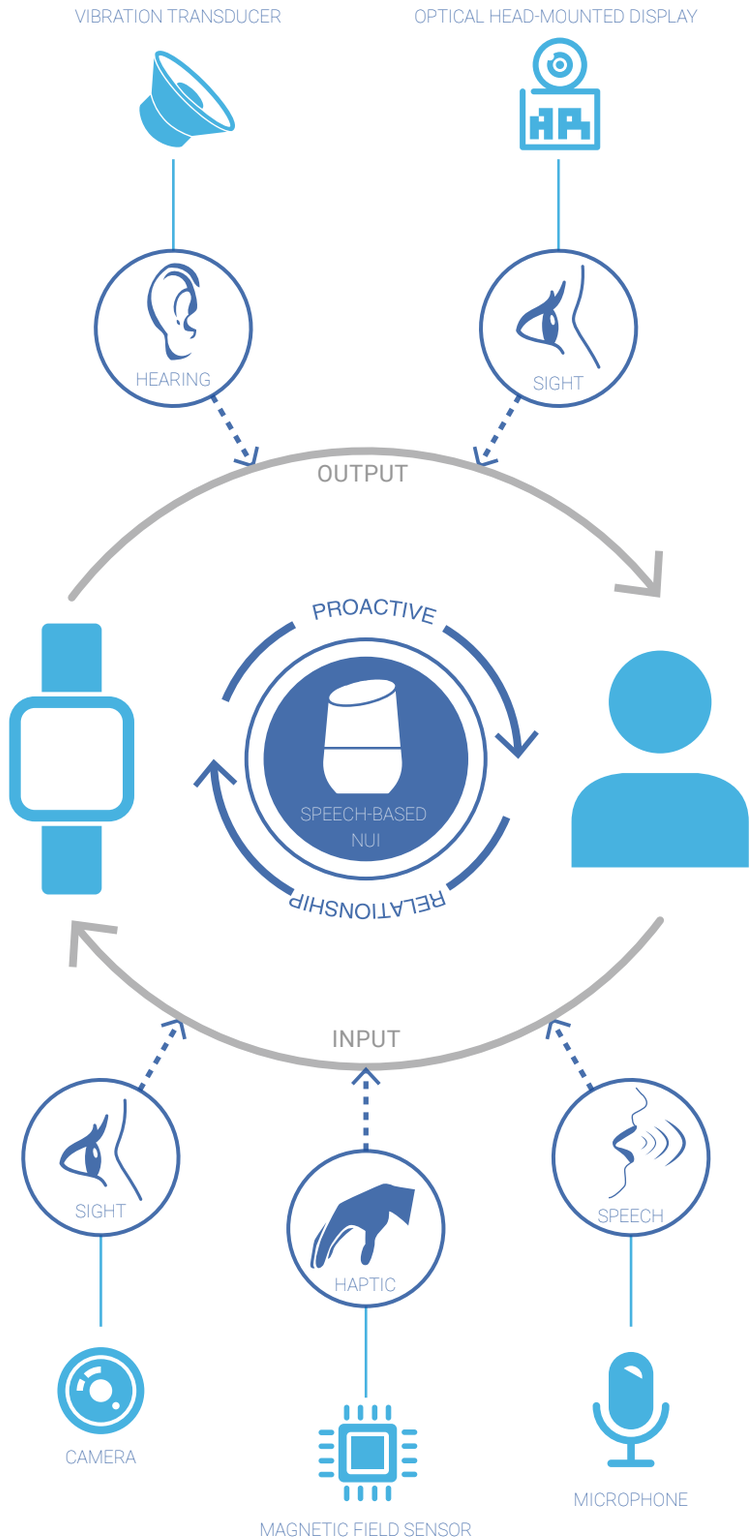


Figure 5.19 Basic Diagram of Inputs and Outputs for Future Concept Development

5.8 CONCEPT DEVELOPMENT.

Product design has been used as an instrument to achieve diverse business goals, which includes technology development. It is known that product design is often related to the tasks carried out for providing production documentation, however, when product design does not lead to a market launch, there should be a conceptual differentiation from the core meaning of product design (Keinonen, 2006). In that sense, for the purpose of this research, concept design utilizes the practices of product design, including creativity, user-centered design approach, research and model making in order to propose the fundamental outlining of a future product development.

Additionally, it is considered that the proposal being pursued through the present document can be interpreted as an emerging concept, which pursuits the identification of opportunities of a new technology or market and with the intention of unraveling future user needs (Keinonen, 2006). This concept is being developed to support at one stage, the strategic decision-making of Nokia by outlining the future beyond the range of product development and research activities, therefore, technical and commercial requirements are less restrictive.

Figure 5.20 Delftt Design Guide for Concept Development

Figure 5.21 Representation of an Intercultural Traveler

5.8.1 Identifying and Defining the Cultural Traveler

User identification is a widely accepted principle in the development of product design, however, its identification should not be considered as a trivial process. User identification is a key factor in a user-centered design approach (Kujala & Kauppinen, 2004) Based on the above, it is proposed that a cultural traveler that takes part in an intercultural exchange, is someone who is not getting away from home with the purpose to reproduce the necessities of the home environment in more advantageous and desirable circumstances in a remote land, rather, she/he has an adequate cultural motivation of getting to know the social and landscape values differences from a local culture (Csapo, 2012).

On the grounds of the proposed typology of McKercher and Du Gros (2003), who differentiated five types of cultural travelers according to the level of the importance of culture in their decision to travel, it is possible to suggest as the target user The Purposeful Cultural Traveler; who is defined as the traveler who is interested in learning about the other individual culture or heritage is a major reason for visiting a destination. Cultural traveling is the primary motivation for visiting a destination in order to develop a deep and elaborate cultural experience. On that basis, this cultural traveler profile is aligned with the intercultural sensitivity required in order to encourage the learning of a host culture, which, as mentioned earlier (**Chapter 4.2**), it is necessary for the better understanding of the culture of oneself and from another.

5.8.2 Language Learning through Everyday Situations

A scenario represents the situation that captures the circumstances in which users perform an activity. It shows the motivations of an individual when conducting an activity and at the same time it suggests the possible means to accomplish it. This tool benefits the design process during the envisioning of ideas and concepts by providing a context to the intended user experience. Additionally, it contributes keeping the user in the center of design and development process, and as consequence, providing a better understanding of the implications of a solution that are required not only in terms of functionality and features but also to keep sight the motivations and desires of an individual. Scenarios express proposed or imagined situations in order to explain how the user will interact in a specific context (Bødker, 2000).

As mentioned earlier (Chapter 5.3.1), language learning might be beneficial through a “direct experience”, which involves mental contact with mental phenomena by introspection or; in other words, sensory contact with the results of doing (Robinson, 1930). This study proposes that the language learning can take place during day-to-day activities of an individual, with the purpose of promoting better assimilation of language learning when it is associated with a familiar context/activity. Thus, allowing the intercultural traveler to have a more immersive into the host culture lifestyle.

In that sense, any familiar context/situation might be suitable for the language learning experience as long as the individual chooses to do so.However, with the intention to provide a better understanding for the reader of the present document, three examples are exposed with the intention of exemplifying concrete application scenarios.

The cases aim to support and demonstrate how a specific context contributes and promotes language learning through the direct experience based on day-to-day activities. Where an everyday end-to-end process, serve as a medium to engage the individual in the language learning process (learning by doing. Offering the opportunity to learn a new word and its usage exemplification for simple practical cases.

Defining baseline scenarios will contribute to identify the possible circumstances under which the life and activities of an individual occurs, context scenarios provide guidelines on how a future concept design should be integrated. A context scenario aims to predict how people could act in particular situations, hence its relevance for the design process of a new concept (Iivar et al., 2005).

Figure 5.22 Individuals Experiencing Daily Life

Figure 5.19 Block Diagram of Inputs and Outputs for Future Concept Development

Figure 5.23 Train Station as a Learning Environment

TRAIN STATION

Within this scenario, an individual uses the traveling experience as a context for language learning, more specifically, through the experience of rail mobility. Traveling experience, as an end-to-end process, can be divided into sub-activities in which an individual takes part. These activities might involve, yet not limited, to Payment, Boarding, and Arrival; where the individual performs a task(s) related to that specific activity.

Based on those activities the individual will have the opportunity to learn a new word and its usage exemplification for simple practical cases. For example, buying a ticket, boarding the train or passing through the turnstile upon the arrival of the individual (**Figure 5**.24).

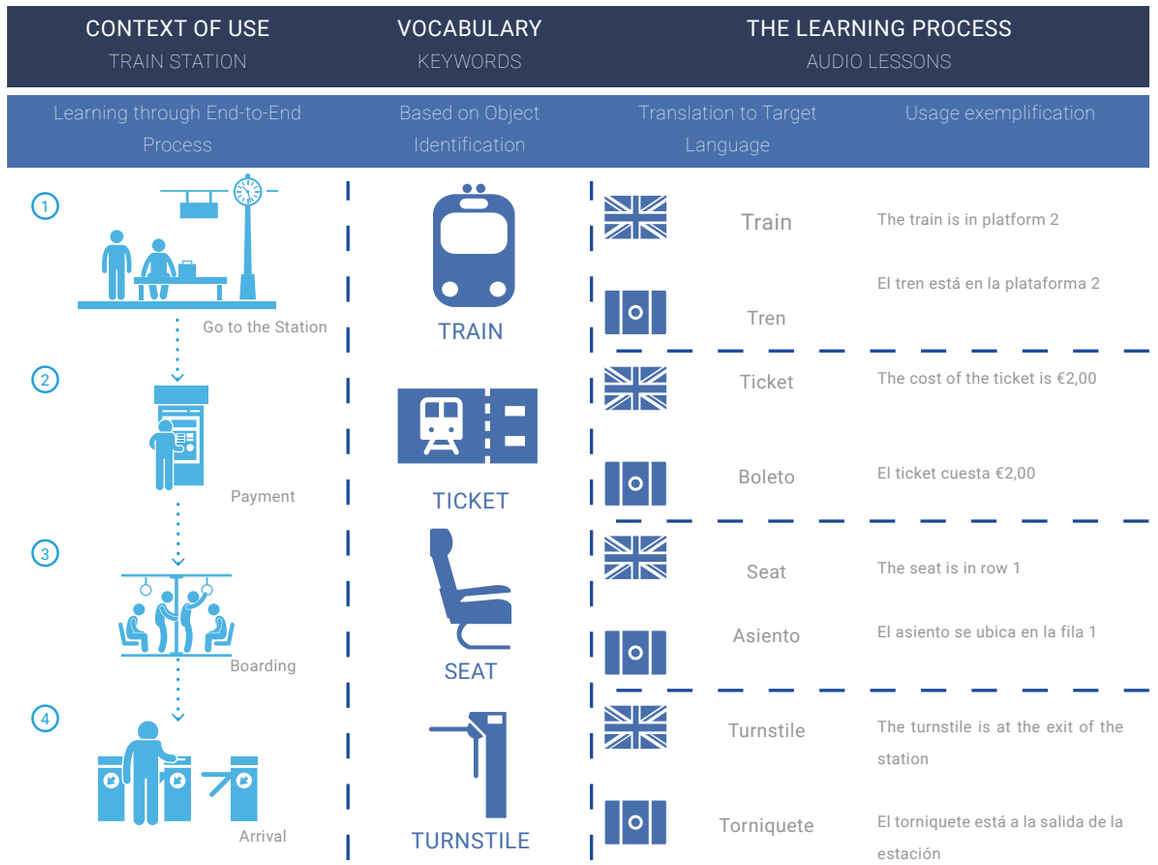


Figure 5.24 Vocabulary Usage Exemplification through Traveling Experience

SUPER MARKET

In this scenario, an individual uses the shopping experience as a context for language learning, visiting a supermarket will become a learning environment. Learning words and its usage exemplification related, yet not limited to Item Selection, Payment, and Packaging.

The activities performed by the individual within this scenario will promote the learning of new words and their usage exemplification for simple practical cases associated with the shopping experience. For example, when looking for an item in the halls or while making the payments at the checkout (**Figure 5.26**).

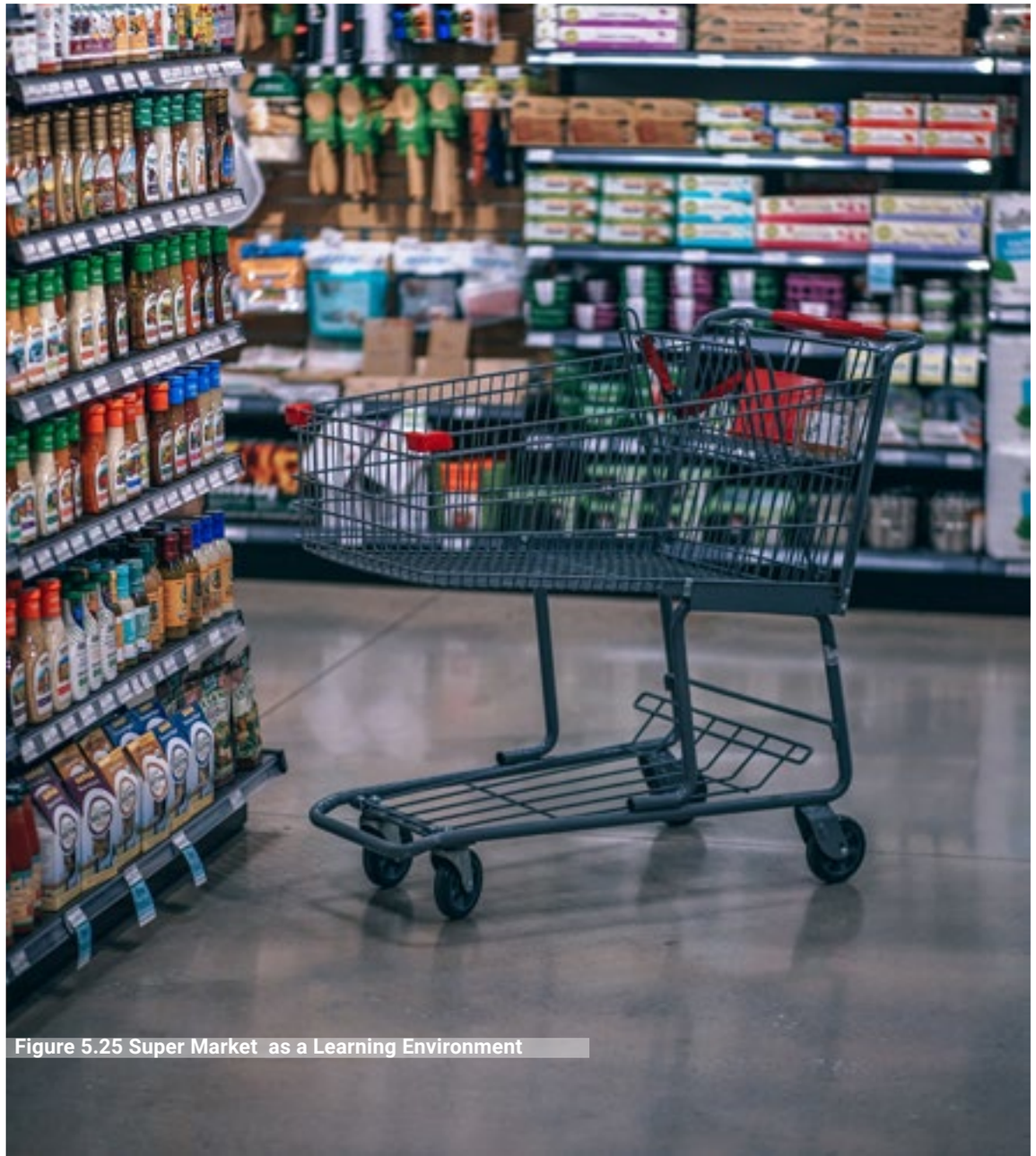


Figure 5.25 Super Market as a Learning Environment

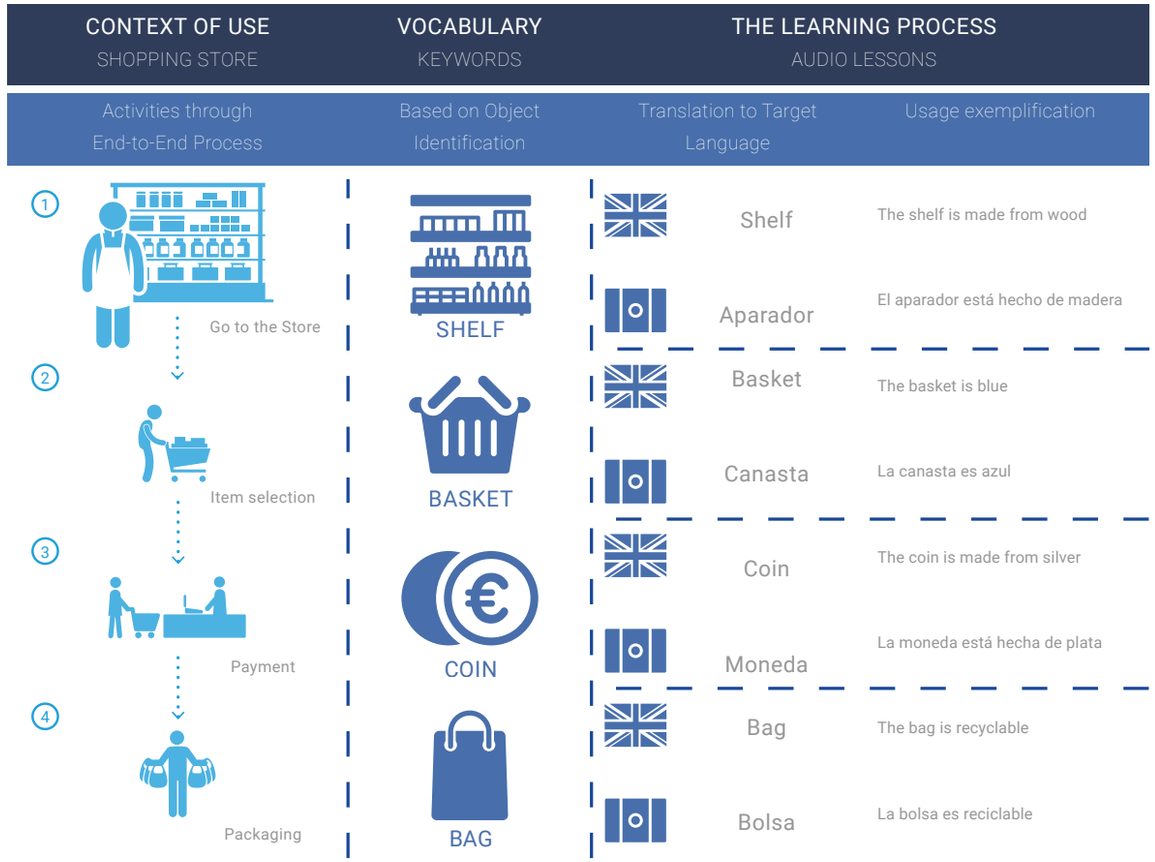


Figure 5.26 Vocabulary Usage Exemplification through Shopping Experience

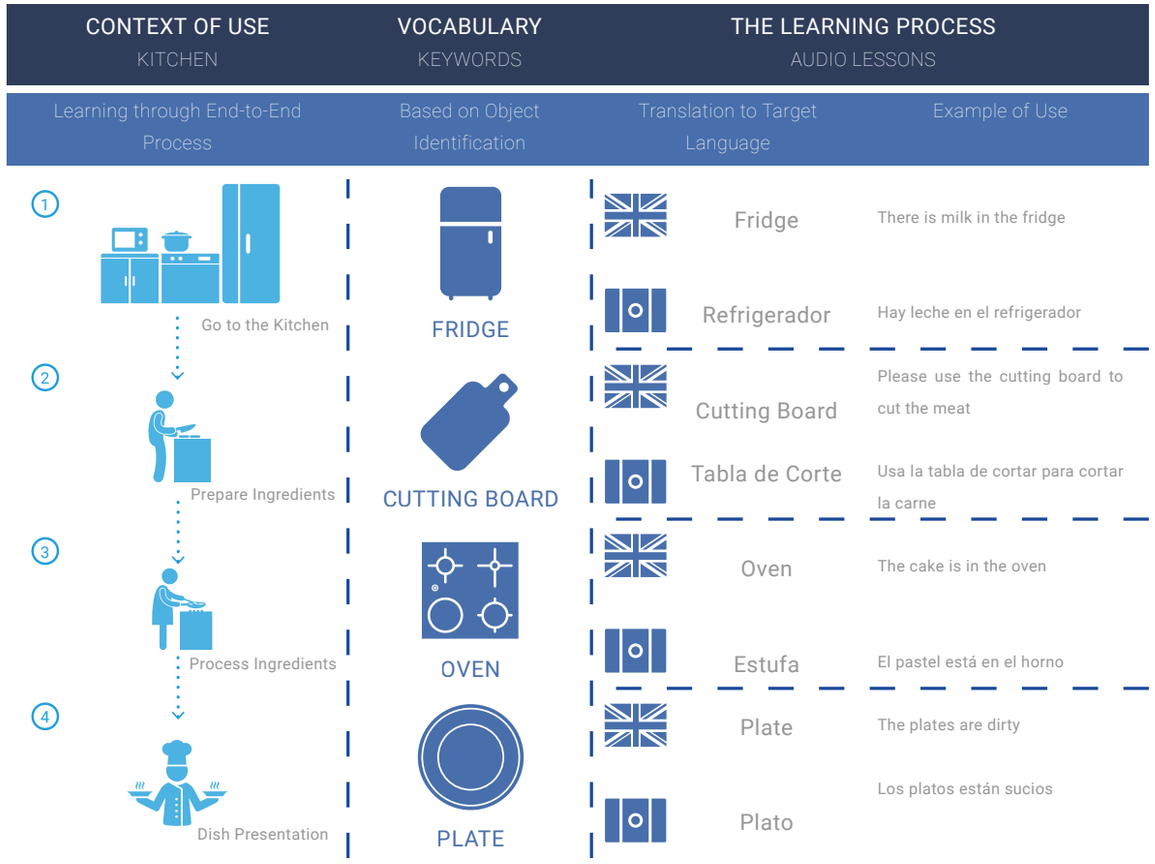


Figure 5.27 Vocabulary Usage Exemplification through Cooking Experience

Figure 5.28 Kitchen as a Learning Environment

KITCHEN

This scenario offers the opportunity for an individual to engage in language learning through cooking experience. This process might encourage the individual to learn a variety of words and its usage exemplification related to this particular context of usage, which might be, yet not limited to the activities of food preparation, food processing, and food presentation.

The individual will be involved in the performance of tasks that will allow expanding his vocabulary through the cooking activity, from food processing to its presentation (**Figure 5.27**)

5.8.3 Concept Design.

As mentioned earlier, this research pretends to propose an emerging concept, which includes research and prototyping activities. However, freehand sketching has traditionally been used as a primary conceptual tool during the early stage of a design process (Fish & Scrivener, 1990). It is considered as the preliminary exploration activity before continuing with further development of the design process, it allows to structure and design problems and for generating and exploring solutions, functions or/and forms (Nik Ahmad Ariff & Badke-Schaub, 2011).

Based on the contextual factors (**Chapter 4**) that will contribute widespread dissemination of wearable technology through the acknowledgment and support of intercultural sensitivity, it is possible to suggest a concept proposal (**Figure 5.30**) that has the potential to devise ways of promoting sensory augmentation capable of encouraging an individual in his language learning process (**Chapter 5.2 & Chapter 5.3**). The integration of Augmented Reality systems into wearable technology promotes a motivating, entertaining, and engaging environments, conducive to an enjoyable learning experience, therefore, allowing the individual to be involved in a rich real-time support environment as he continues with his daily activities, and at the same time, engaging in the language learning process (**Chapter 5.4**).

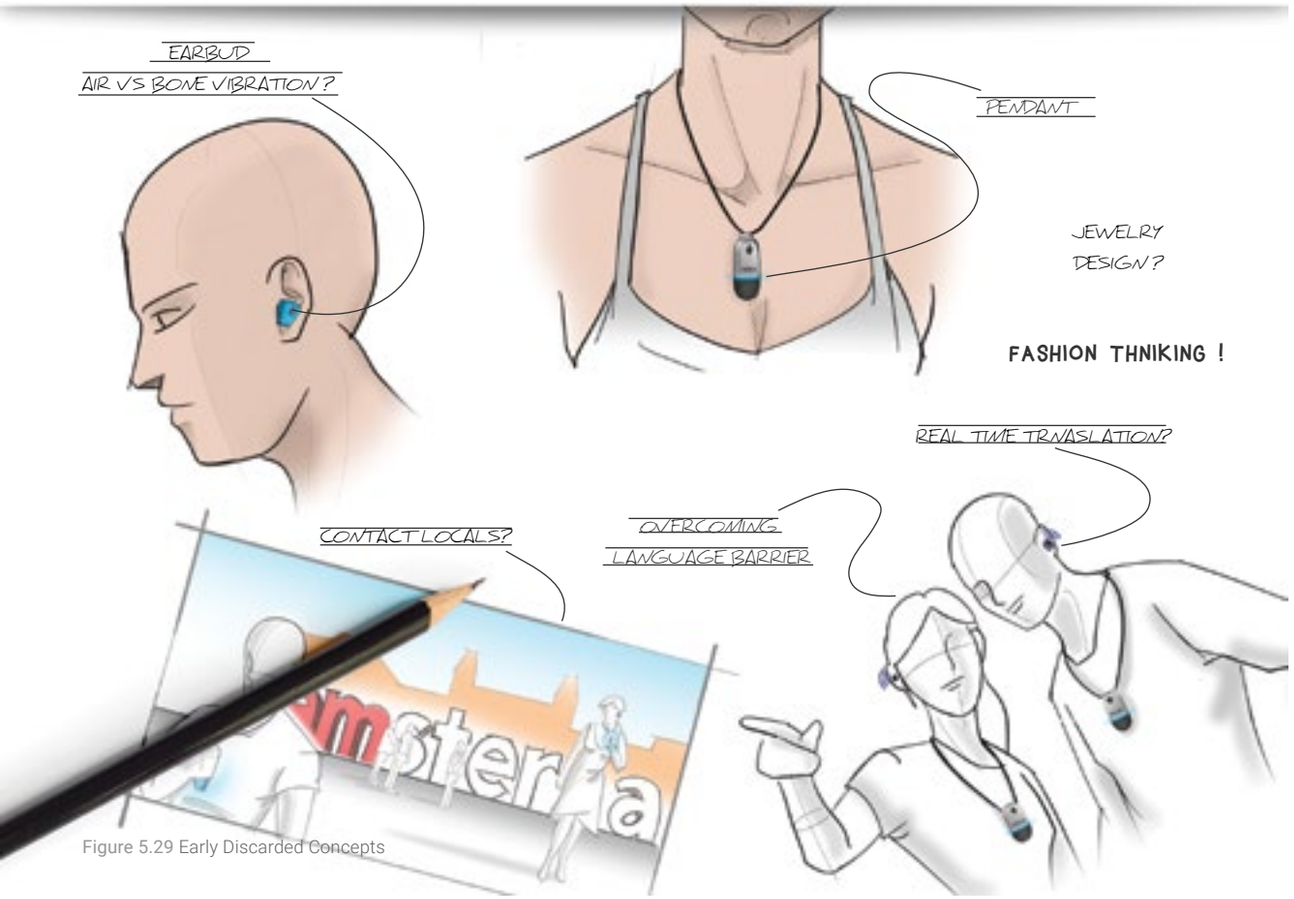
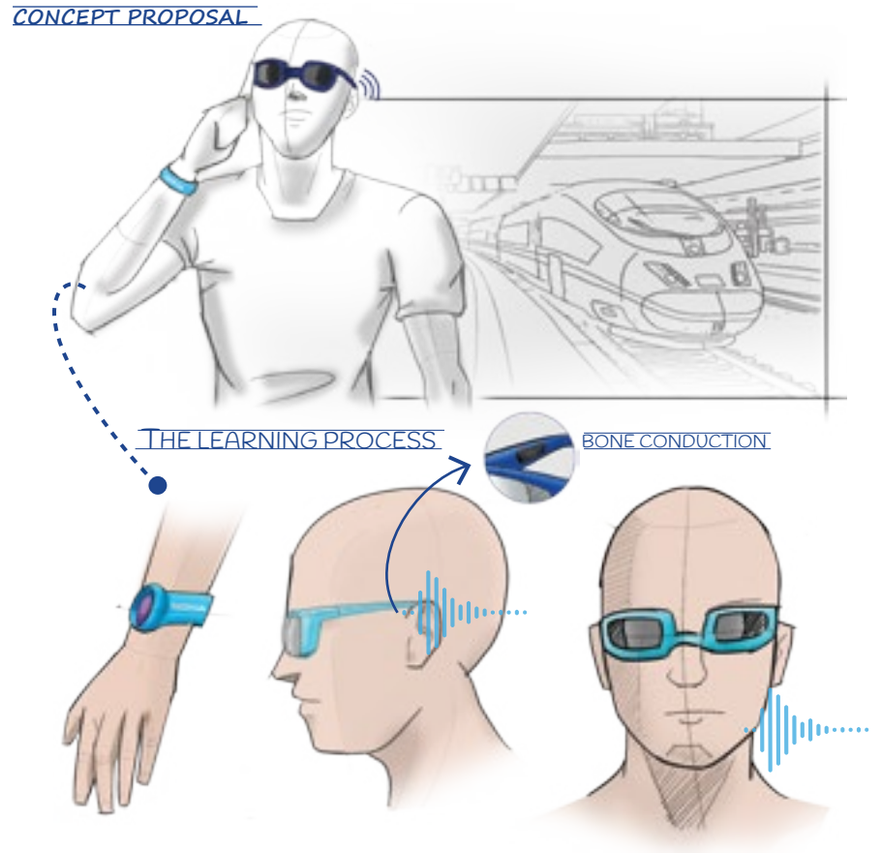


Figure 5.29 Early Discarded Concepts



1 Identify!

Identification through magnetic field sensing

2 Listen !

Audio Lesson based on the object identified by the wearable

3 Practice!

A practical oral exercise is set up for the user, based on the keyword learned.

> *Wearable device that assists language learning by means of sensorial identification of key objects within a chosen context, and its usage exemplification for simple practical cases.*
>
> - Guillermo Márquez -

Figure 5.30 Representation of the Potential Concept Proposal

CONCEPT SUMMARY & DESCRIPTION

Based on the elements explored in **Chapter 5.7,** it is possible to describe concept proposal as follows: On one hand, a bracelet worn by the user to encourage an interaction with objects of his surroundings through haptic feeling within a specific context; in pursuit of promoting an active language learning process based on direct experience of daily activities (Asher, 2000). To that effect, the object recognition process integrated into the bracelet is based on magnetic field sensing, which is not visible to the regular senses of the human being. It is important to mention that each object on the planet is affected by the magnetic field produced by the planet Earth (Chikazumi, 1964). In that sense, the bracelet is worn on the wrist of the user on account of the necessity of being close the contact surface (the hand), which is used as a medium to reach the elements around.

Once the element is grabbed by the user, the signal detected by the bracelet will be sent to the glasses in order to process the information.The glasses with an augmented reality system, it will process the information gathered from the bracelet. This data will be visually presented to the user through the lens of the glasses (Optical Head-mounted Display), accompanied by a short audio lesson which includes the direct translation of the object identified to the target language and a usage exemplification for simple practical cases. This audio lesson is possible through bone conduction technology that is integrated into the frame of the glasses, which allows keeping the ears of the user free with the purpose of providing awareness of his surroundings at the same time.

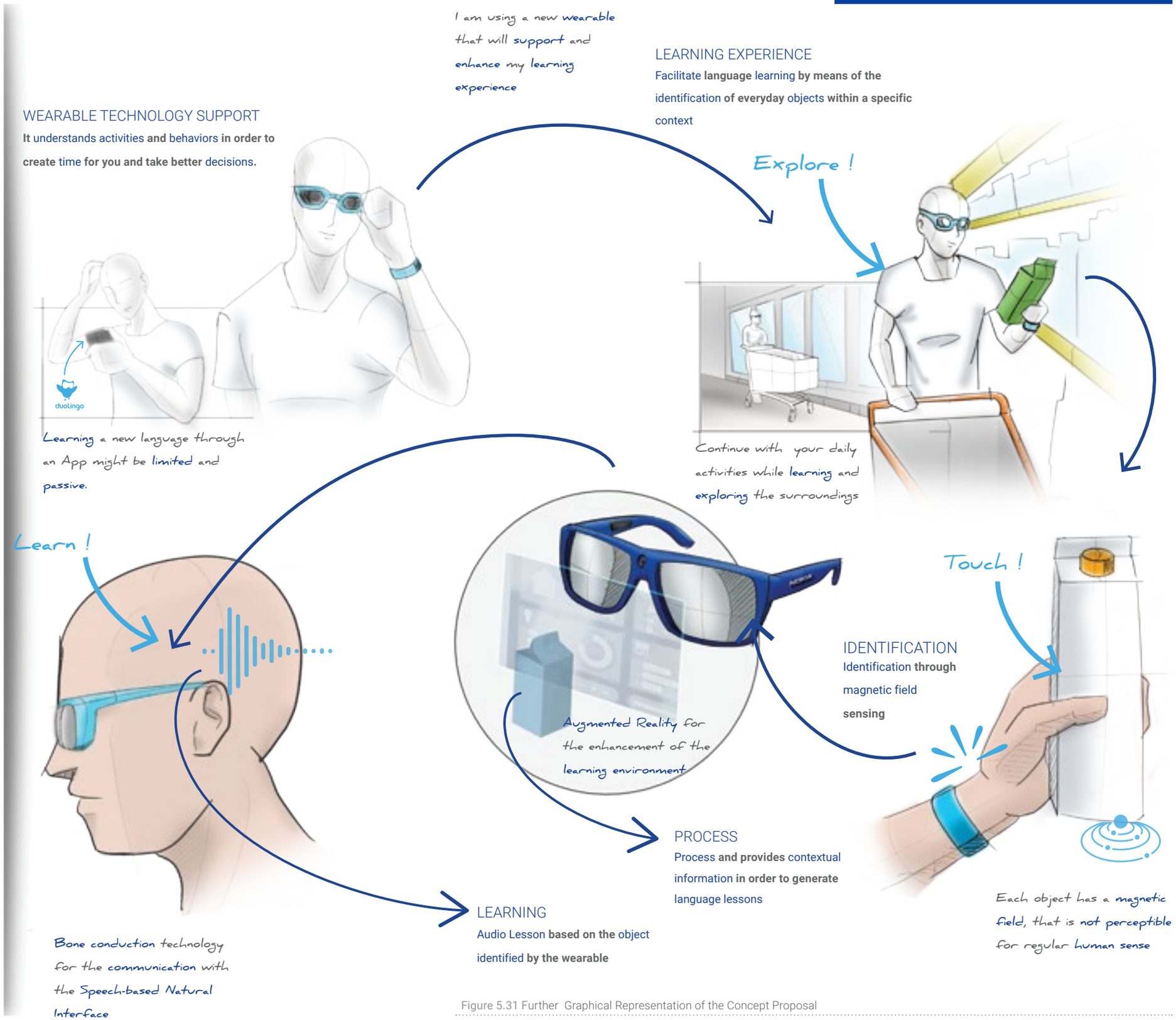


Figure 5.31 Further Graphical Representation of the Concept Proposal

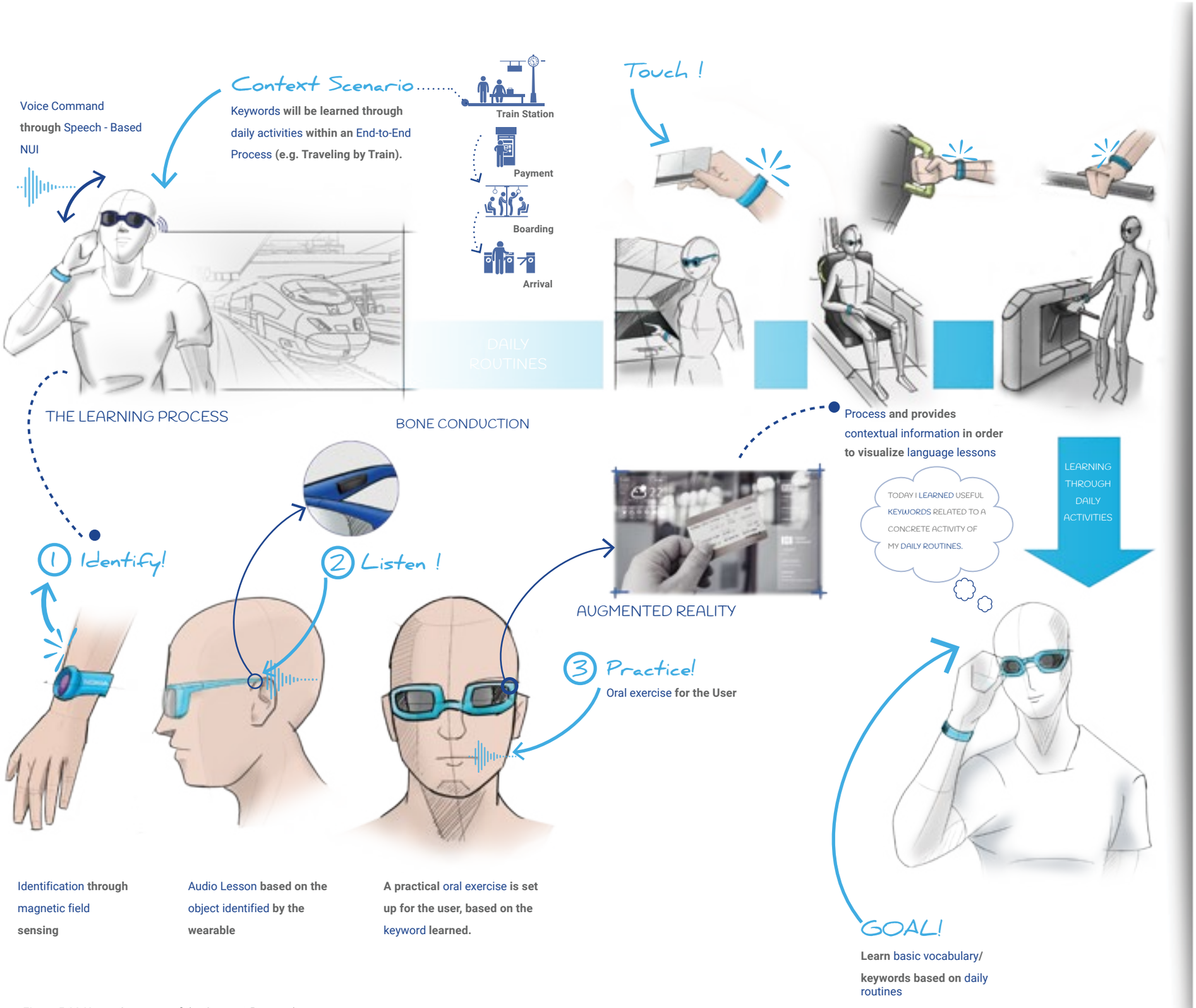


Figure 5.32 Usage Sequence of the Concept Proposal

EXTENDING HUMAN CAPABILITIES

CONCEPT DESIGN USE CASE SCENARIO.

A scenario provides the outline of future technologies that will support users do the things they need and desire to do. It blends a description of some set of real ongoing activities with an imaginative a futuristic outlook on how technology could support those activities better (Nardi, 1992). As seen earlier (**Chapter 5.8.2**), any familiar context/situation might be suitable for the language learning experience as long as the individual chooses to do so. Nonetheless, in this section has been decided to illustrate the interaction of the user with the wearable device within the traveling experience context, more specifically, rail mobility.

When the user undergoes these (sub) activities, he will interact with key physical elements (key objects). These interactions will trigger an audio lesson. For example, if an individual is acquiring/paying his train ticket, at the time his touching/grabbing the ticket, the bracelet will recognize this object and then it will send the signal/information to the glasses. The glasses will process the information and it will present visual information about the object followed by a short audio lesson. This audio lesson will include a direct translation and a usage exemplification for simple practical cases (see Figure 5. for reference), related to the activity performed. The wearable device will encourage the user to orally repeat this audio lesson in order to reinforce the information acquired. This process will be applied to each sub-activity (e.g. boarding, and arrival).It is expected that the user will learn keywords/ basic vocabulary and its usage exemplification for simple practical cases based on direct experiences related to his daily activities.

5.8.4 Concept Prototyping and Evaluation.

As it is known, Design involves a decision-making process, therefore, it is required to move from graphical envisioning (e.g. sketching) towards concrete, testable mockups, leading to the generation of concrete prototypes (Hartmann, 2009). A prototype is considered as a specific representation of a part or all of an interactive system, a tangible object that does not lead to an abstract description that requires interpretation (Beaudouin-Lafon & Mackay, 2003). The purpose of a prototype is to serve as indicators of a future reality (Houde & Hill, 1997) in order to explore and demonstrate the ideas previously generated.

At this stage of the concept development process, experiential prototypes were developed, which are referred as the kind of representation, in any medium, that is designed to understand, explore or communicate what it might be like to engage with the product, space or system which currently being designed. An experiential prototype focus on direct active bodily involvement of the designer in a constructed situation, with the purpose of exploring future situations, and communicating designs to others (Buchenau & Suri, 2000). It was conducted two experiential prototypes in order to illustrate how the user will interact with the system.

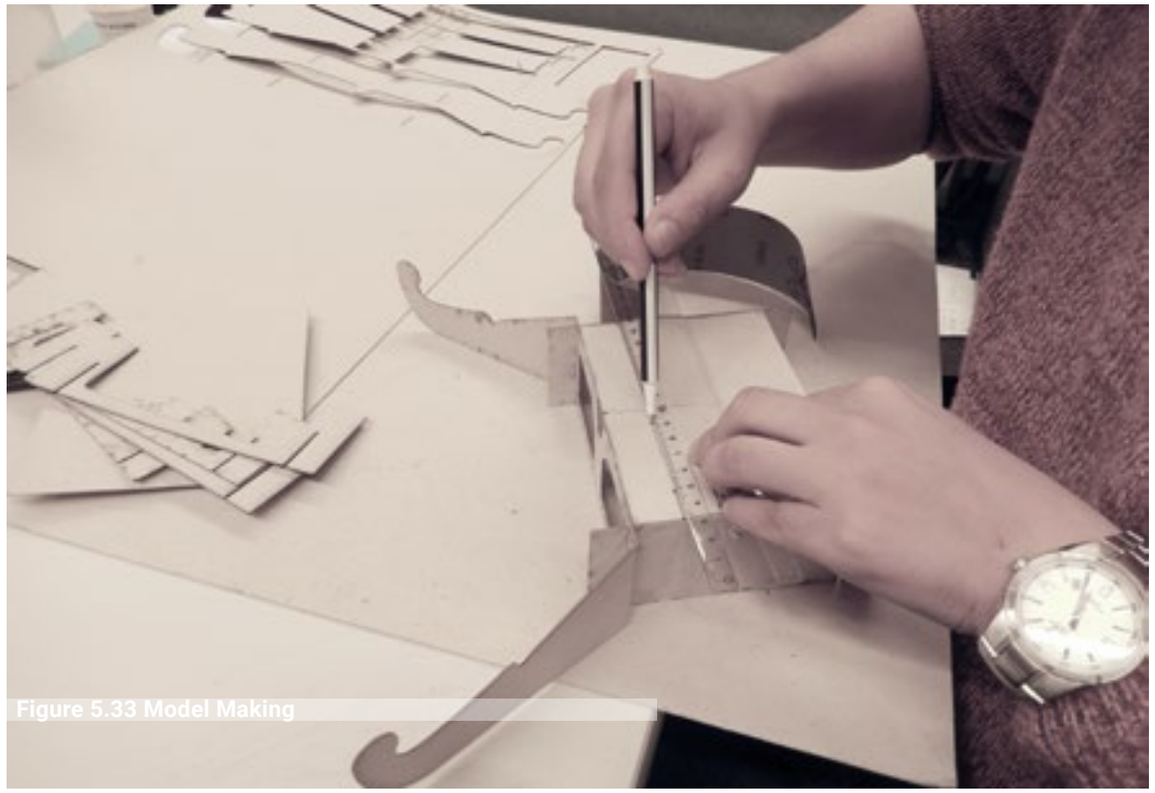


Figure 5.33 Model Making

On one hand, it took place a usability test which involved a general focus on the interaction of the user with the wearable device during the language learning process, thus, evaluating the wearable technology usability. Subsequently, uncertainties aroused regarding the interactivity of the augmented reality system, therefore, an interface experiential prototype evaluation was conducted.

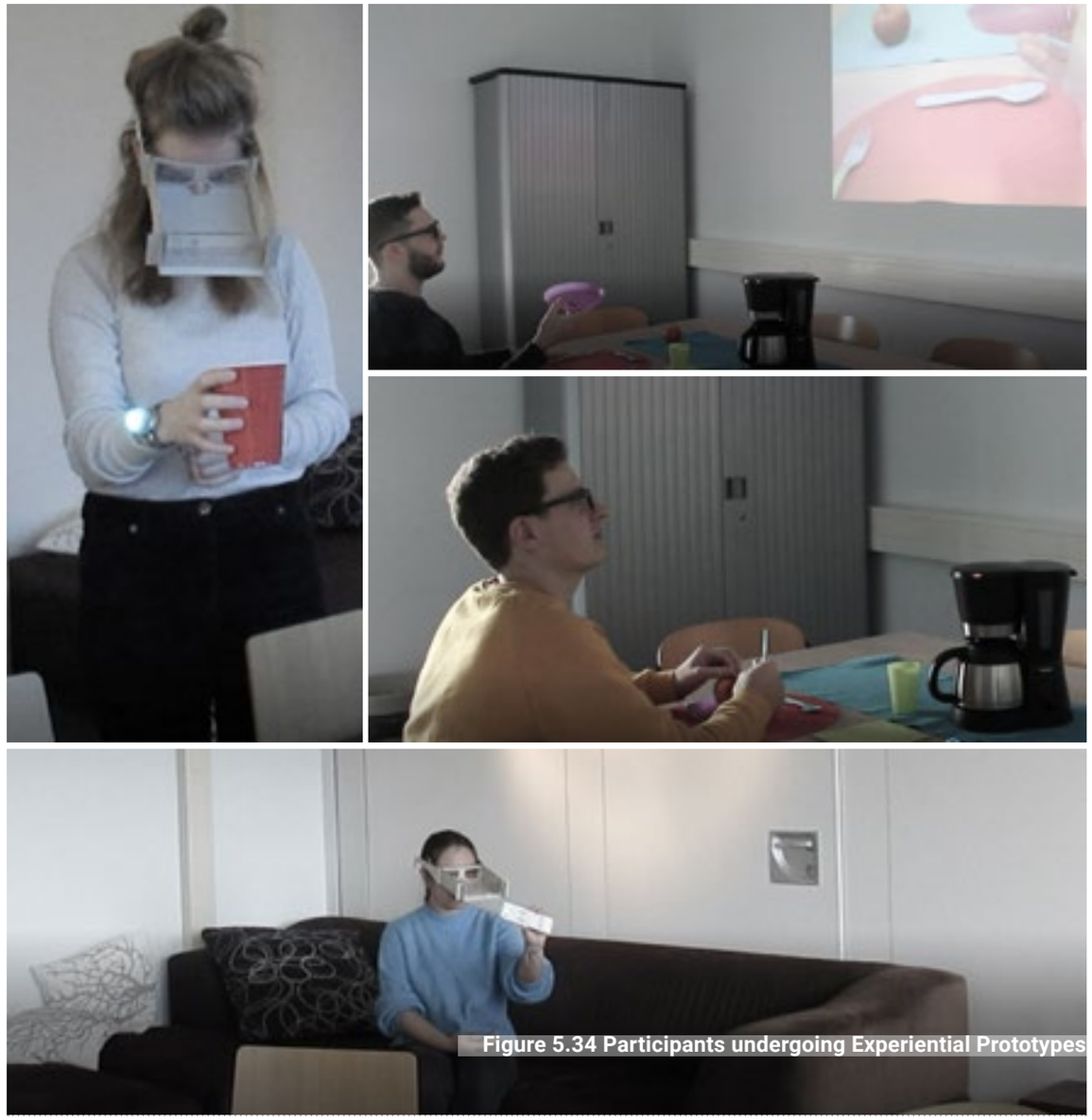


Figure 5.34 Participants undergoing Experiential Prototypes

WEARABLE TECHNOLOGY USABILITY EXPERIENTIAL PROTOTYPE

The wearable devices were prototyped through mockups. On one hand, the smart glasses were embodied in a cardboard mockup with an attachable card slot. These cards aimed to represent an augmented reality vision where information was displayed to the user regarding the object he has recognized. On the other hand, the bracelet was represented by the usage of a regular watch with the implementation of a LED wireless module; which was light it up every time that the participant touch/interact with a certain object as means of representation for a visual feedback to the user.

This test took place in a Semi-controlled Environment within the installations of the Industrial Design Faculty of Delft University of Technology, more specifically at the Comfort Room. This space recreates a living room, which is ideal for the purpose of this test due to the fact it represents a familiar environment for the participants, where usually their everyday activities might take place. Nine individuals participated in this evaluation, in a session of 25 minutes each one, where they have been asked to follow a series of steps/ activities, instructed by the researcher in order to simulate a daily situation. In this particular case, it was recreated a scenario where the participant is about to watch his/her favorite movie/series in his/her living room and needs to make himself/ herself comfortable (See Appendix for the protocol followed).

When following the tasks, the participants interacted with a series of pre-established objects within the room, when those interactions occurred, the wearable device notified the user his discovery in order to provide pertinent information regarding the object. This information was integrated into visual and auditory means, which contained the direct translation to the target language and its usage exemplification for a simple practical case.

To that end, the participants were asked to wear the “smart glasses” and the bracelet, and the researcher through “Wizard of Oz” technique, simulated the “intelligence” of the wearable device. As mentioned earlier (**Chapter 5.5**), this wearable proposes to integrate a Speech-Based Natural User Interface, thus the researcher acted as this interface in order to communicate with participants. Additionally, when a participant interacted with a certain object through his haptic feeling within his visual range, the researcher added the respective cards to the glasses mockup, with the purpose of providing to the participant a simulated augmented reality vision. The wearable device asked the user to repeat orally the word and its usage exemplification as a means of practice/ exercise. Eventually, the researcher provided to each participant an evaluation form for the purpose of assessing the proposed user experience and validating to some extent the words learned through the user experience (five words in total), followed by a short semi-structured interview.

Figure 5.35 Experiential Prototype, Process and Setup

Figure 5.36 Experiential Prototype Evaluation

WEARABLE TECHNOLOGY USABILITY

EXPERIENTIAL PROTOTYPE

GENERAL OUTCOME

The overall perception of the concept was considered as positive, the participants were able to see and experience the value of a learning process through direct experiences (daily activities). When discussing the feedback, a constant among the participants, was the relation and comparison between the concept proposed/experienced and Duolingo, a well-known application for language learning. Although the participants noticed that Duolingo represents a current solution integrated into a personal device (smartphone), they recognized the possibilities of an improved language learning process through the wearable device proposed; on account of the remarkable potential to offer a far better engaging interactive experience.

On the other hand, the purpose of the bracelet was considered as irrelevant in terms of the language learning process. Even though the participants were informed and understood that the functionality of the bracelet was to support object recognition, and therefore, encourage users to use a haptic sensory channel to trigger an interaction with their surroundings; it was perceived as obtrusive element due to the fact that the participants were concerned about what they should touch/interact or not.

Thus, they advised that the wearable should provide the possibility to the user to make a decision regarding which elements/objects are eligible according to their particular interests to trigger an interaction.

As mentioned earlier, through this experiential prototype, uncertainties aroused regarding the workflow and interactivity of the augmented reality system due to the “static nature” of the current prototype evaluated. Nevertheless, the acknowledgment of augmented reality as means of providing contextual information and as a supplementation for the auditory output of the wearable device was considered as a great asset.

AUGMENTED REALITY INTERFACE EXPERIMENTAL PROTOTYPE

In order to In order to corroborate and provide a better understanding of the augmented reality system, it was necessary to generate a more interactive prototype for further evaluation. An interactive interface was needed to be simulated, with that in mind, a series of photographs were shot in a first-person perspective; where a user performed different activities/tasks within a previously selected scenario (simulated dining room). These photographs served as a medium to re-create the visual field of a person, and therefore, by means of an image editing software, a camera lens effect was provided to the photos in order to provide a visual experience closer to the way people actually sees through glasses.

Subsequently, animations were added to the edited visualizations by the use of a basic animation software (Google Slides), for the purpose of simulating how the visual information provided by the augmented reality system will be displayed on the glasses. The visualizations with the animations integrated contributed to recreate an interactive interface, which was displayed during the evaluation test through the use of a beamer. The test will take place in a Controlled Environment within the installations of the Industrial Design Faculty of Delft University of Technology, more specifically at the D-1-770 Room.

This space serves as a small-scale meeting room, however, it was ideal for the purpose of recreating a standard dining room. Nine individuals participated in this evaluation, in a session of 20 minutes each one, where they have been guided through a series of steps/activities, instructed by the researcher in order to simulate a daily situation. In this occasion, it was recreated a scenario where the participant is about to dine his/her favorite dessert at the same time he/she explores objects in the room that might trigger an audio lesson for the purpose of language learning (See Appendix for the protocol followed). The participants were asked to wear a pair of regular glasses that acted as a set of “smart glasses”, indicating to them that they needed to look at the visualization projected via beamer in order to see the information provided by the (simulated) augmented reality system integrated to the glasses.

The researcher guided the participating during the dining activity, with the aim of following a congruent story and a continuous interaction with the wearable device. As in the previous case, the participants interacted with a series of pre-established objects within the room, when those interactions occurred, the wearable device notified the user his discovery in order to provide pertinent information regarding the object. This information was integrated into visual and auditory means, which contained the direct translation to the target language and its usage exemplification for a simple practical case.

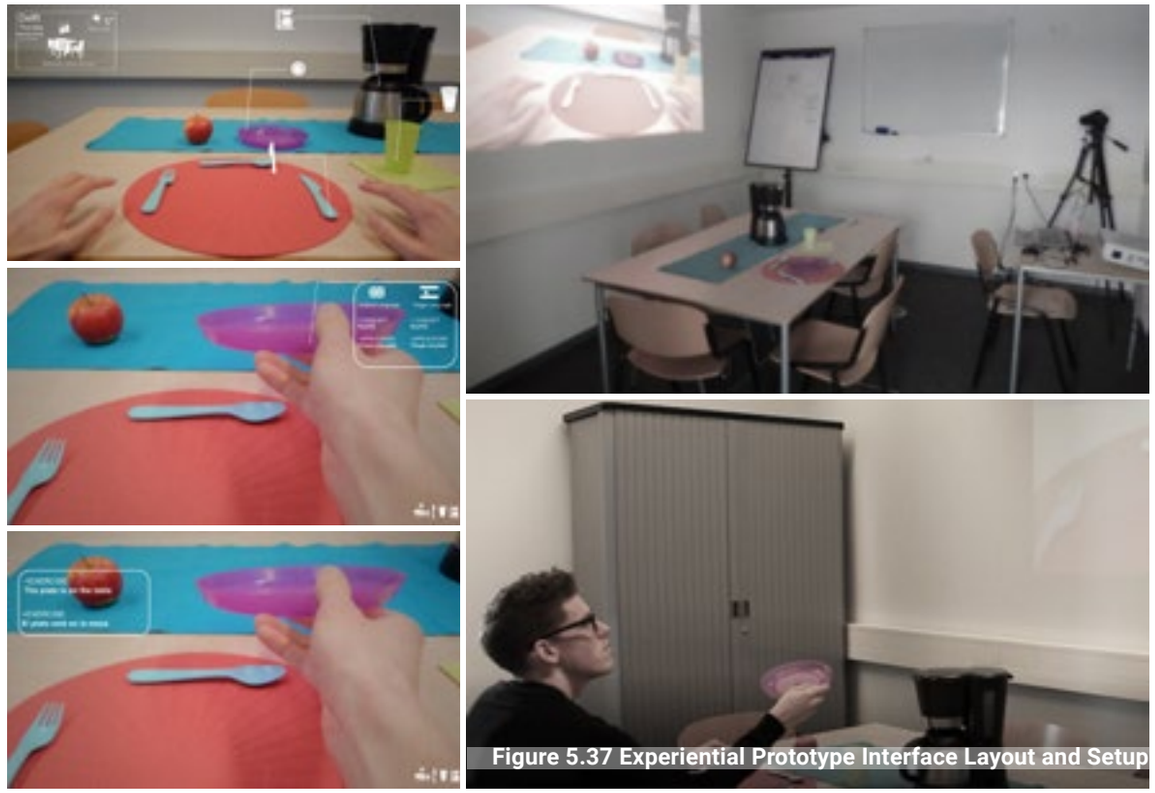


Figure 5.37 Experiential Prototype Interface Layout and Setup

Nevertheless, although similar set up was carried out it important to mention the fact that the integration of a bracelet was eliminated, thus, the object recognition functionality was incorporated into eyeglasses; making even easier the usability of the wearable device for the users. Once again, the researcher used the “Wizard of Oz” technique, with the purpose of simulating the “intelligence” of the wearable device and its Speech-Based Natural User Interface. In this scenario, the smart glasses integrated a scanning feature so as to create awareness in the user regarding the key objects/ elements that will trigger the audio lesson within a specific context (dining room).

Additionally, the visual information displayed was dosed in two parts, firstly was showed the direct translation of the object identified together with and usage exemplification; secondly, another usage exemplification for strengthening and exercising the word learned by the user. The wearable device asked the user to repeat orally the word and its usage exemplification as a means of practice/ exercise. At the end of each session, the researcher provided to each participant an evaluation form for the purpose of assessing the augmented reality interface experience and corroborate the words learned during the evaluation (five words in total). Followed by a short semi-structured interview/ questionnaire.

Figure 5.38 Experiential Prototype Interface Evaluation

AUGMENTED REALITY INTERFACE EXPERIMENTAL PROTOTYPE GENERAL OUTCOME

From this test, it was possible for the participants to experience more accurately the augmented reality system and how this element is integrated into language learning process. The participants placed a high value on the natural way of communicating with the wearable device (Speech-Based Natural User Interface), although some of them expressed their concern about the social conventions that this interaction could imply when using the device in public. Even some of them indicated that there is the possibility to adopt a reluctant attitude towards the wearable device if the only way of communication is verbal, therefore, the presence of basic physical buttons (e.g. power on/off) is needed. Additionally, it was perceived that the experience of “talking to oneself” or “to the air”, still triggers awkwardness among the users notwithstanding that they are aware that nowadays this behavior is more common due to the use of mobile devices.

Related to that, although they value the speech as means of communication with the device, it is needed to consider the implementation of the necessary mechanisms that can provide to the user alternatives or options that regulates the level of participation of the wearable device in terms of auditory output.

Participants extended their opinion regarding the fact that the aural output from the device might become obtrusive when the user requires a certain level of concentration to perform their ongoing daily activities. In view of the foregoing, it was suggested the possibility of providing the feature of switching between an active and passive mode on the wearable, with the intention to make the device adjustable to needs and preferences of the user.

5.8.5 Concept Prototyping Conclusions

	SOCIAL CONVENTIONS	REGULATE INFORMATION OF A.R.	REGULATION OF SPEECH INTERVENTION	AESTHETICALLY PLEASANT	ACCURATE INTERFACE LAYOUT	REWARD STRUCTURE	PHYSICAL CONTROL
	It is a little bit awkward for example at the train station, having this conversation with the device"	*Learning a language through an app on your mobile device, you just stare at your phone… with this [augmented reality] you are more into the world…"*	*This talking interface was talking me all the time and it made stop what I was doing..."*	*Glasses on the face is a very elegant solution, it fits nicely to the social norms..."*	*"The interface design now is cold [transparency], and it is understandable in order to see through the glasses.... but you can get lost..."*	*"Having the direct translations and example of use, it is really strong… that's deep learning, but motivation is also needed..."*	*Speech recognition it is not always accurate, and sometimes awkward... I need buttons for the feeling of activation and controlling"*
INSIGHT	Addressing the fact that people are subject to the influence of social context in the behavioral display rules.	Although augmented reality provides contextual information effectively, there is the possibility that it might become overwhelming.	A Speech Based NUI promotes an intuitive connection with the user, however, its participation should be regulated according to the context of use.	Special attention should be focused on the fact that wearable technology holds a strong value-expressive component for an individual.	The software design implemented into the augmented reality system must considerate and contain user-friendly visual cues (e.g. colors, fonts, pictures, etc.) for better understanding.	It is important to consider that the implementation of a good challenge and reward structure during the language learning experience to promote a long-term engagement.	A reluctant attitude persists towards speech-based communication due to its lack of precision and the social conventions implications, therefore, the integration of basic physical buttons are still needed.
HASSLE	Interacting and controlling the wearable device through the Speech Based Natural Interface can lead to an uncomfortable situation in a public setting.	Providing an excessive amount of visual information through the augmented reality system to the user, it becomes intrusive to his field of view.	An excessive aural output from the device might become obtrusive when the user requires a certain level of concentration to perform an ongoing daily activity.	There is a risk that the glasses might become a bulky device due to its internal components, which might compromise the user appearance.	A flat and insipid layout in the visual information displayed on the glasses has the potential promote confusion and disengagement with the language learning experience.	The language learning process might become monotonous if certain challenges and rewards are not presented to the user.	Individuals perceive speech recognition as inaccurate, thus, a fully operational device only through this feature could lead to the perception of miscommunication and inefficiency.
ADVICE	It is suggested that in addition to the Speech Based Natural Interface, it is necessary to integrate a haptic command control into the hardware of the wearable device.	It is advisable to filter and dose information in pursuit of a better assimilation and processing from the user.	It is important to consider the possibility of integrating a feature that allows regulating the level of participation of the weara-ble device in terms of auditory output.	A proper distribution of the internal components into the hardware will be a key factor to create a seamless design for the glasses.	Ensure a sleek layout for an easier interpretation of the interface by the user. Remove elements that are not providing substantial information and reinforce the useful data visually (e.g. distinction of color).	Further gamification elements should be explored in order to increase and maintain the engagement of the user, such as rewards or unlocking new features.	A balanced combination of a Speech-Based NUI and a traditional haptic command control for the wearable device is needed to encourage an easier adoption and adaptation in terms of usability.

Figure 5.39 Insights Gathered from the Evaluations of the Experiential Prototypes

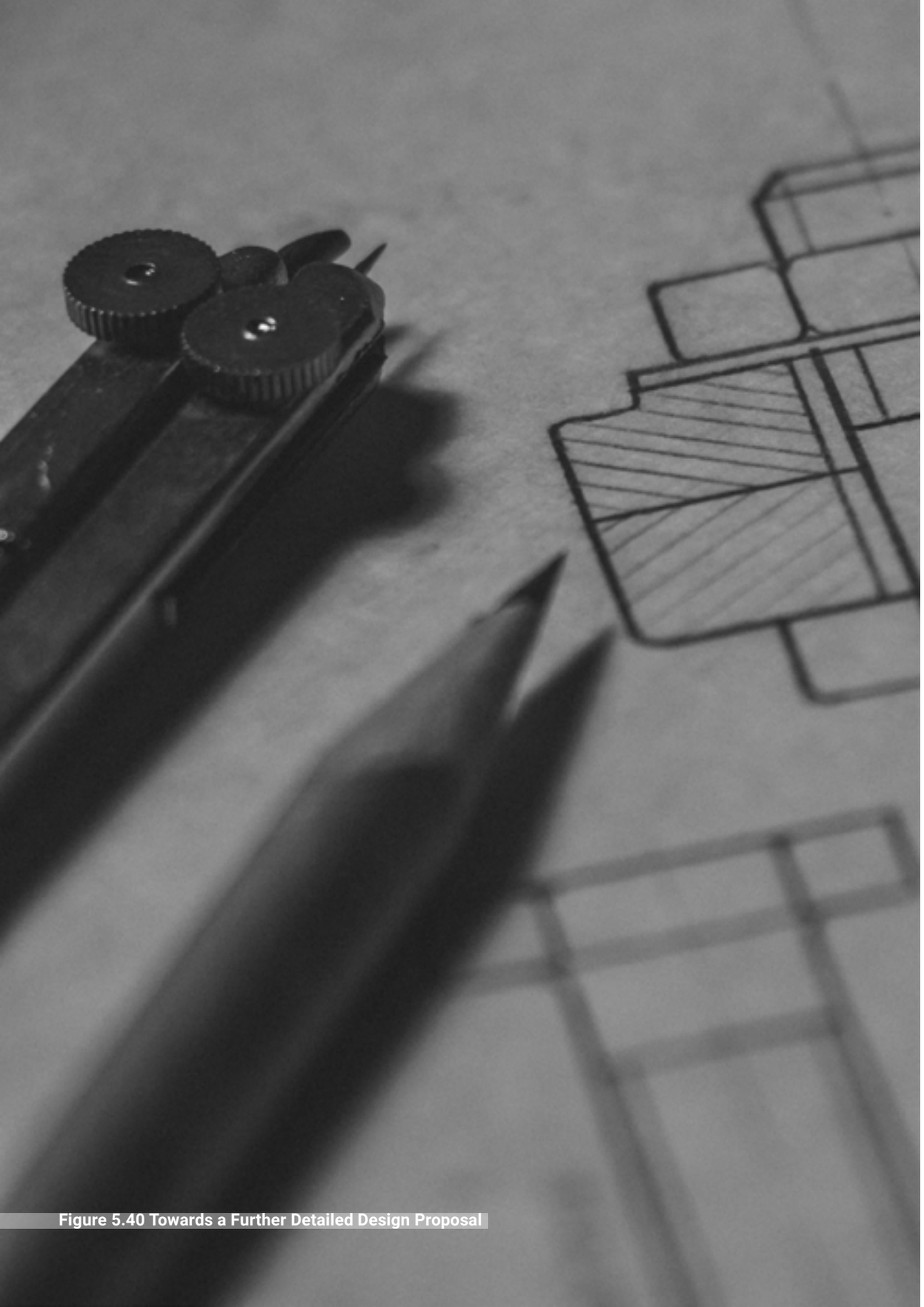


Figure 5.40 Towards a Further Detailed Design Proposal

5.9 CONCLUSIONS.

This chapter allowed to explore the capabilities of wearable technology in a human being through sensory augmentation, in addition to the benefits that entails the integration of a Speech-Based Natural User Interface and Augmented Reality system into a wearable device. On one hand, the speech-based NUI allows a more natural way of communication between the individual and the device. On the other hand, an augmented reality system enriches the learning experience of the user, by making it more interactive through a multi-sensory experience, providing an effortless learning process and contextual information. Nevertheless, it is important to emphasize that regardless any advantage or benefit that technology might contribute to an individual, it would lack any relevance if it does not integrate context and meaning, therefore, during this chapter was important not to lose sight the essential aim of technology as means of support of successful intercultural adaption.

With that in mind, it was considered that technological assistance might be suitable for language learning process, which might foster an intercultural sensitivity within the individual in order to promote attitudes, knowledge, and behavior that facilitate his/her adaptation/ integration with the host culture.

The earlier goes hand-in-hand with the fact that human-machine interfaces should be designed on the basis of a human-machine teamwork, where technology is designed based on human capabilities with the intention to take over the parts of a task that an individual is deficient at, therefore, adopting a role of collaborators.

Additionally, all these elements supported the ideation of a concept design that was tested, refined and evaluated through experiential prototypes, with the purpose of having a better understanding of the interaction between the user and the wearable device during the language learning process. These evaluations resulted in a series of insights (**Chapter 5.8.4 & 5.8.5**) that will be used as input for the next stage of the project that will involve an improved design proposal, which its product embodiment will be based on an eyewear device due to the fact that in one hand, it fits the social norms and the other hand, the technological capabilities suggested are suitable for being implemented in such device. This chapter served as a prelude for the basis of the final concept, where it was possible to corroborate the meaningful and positive impact that such device can have on an individual, in addition to the technological implications that might be involved for its feasibility; which eventually will support a further refinement in terms of usability (interaction) and applied technology (functionalities) for a forthcoming concept.

6.0 CONCEPT DESIGN PROPOSAL.

This chapter will focus on the construction and the further detailing of the concept design proposal, result of the research and evaluation conducted in the earlier stages of the present document. The concept proposal will be structured by unfolding its general aspects regarding aesthetics, ergonomics, interaction (usability) and applied technology (functionalities). As mentioned earlier, this is an emerging concept, where technical and commercial requirements are less restrictive, therefore, the suggested technologies are still under development and need to be refined in order to get an optimal performance. However, it allows outlining a possible future of forthcoming product development.

6.1 INTERACTION SYSTEM

In order to have a better understanding the concept design proposal, it is important to address its interaction system, as referenced above (**Chapter 5.7**), an interaction establishes the means of framing the relationship between a human being and the product designed for them, and as consequence, defining the mechanisms that frame the activity of design (Dubberly, Haque & Pangaro, 2012).The system proposed below is supported by the feedback obtained from the previous phase, through the evaluation of the experiential prototypes (**Chapter 5.8.4 & Chapter 5.8.5**). On that basis, it is important to remind that, although the intended interaction for an active language learning experience in the initial concept (**Chapter 5.8.3**) involved the usage of two wearable devices (glasses and bracelet), it was decided to remove the implementation of a second wearable device due to its implications in terms of usability, due to its potential to hinder the langue learning experience (**Chapter 5.8.4)**. However, such decision does not affect the essence that led to the origin of the first concept. In addition to the above, despite that the use of multisensory channels for learning experiences have suggested a better performance (Minogue & Jones, 2006), it is necessary to avoid the overload of feedback information, which can lead to the miscommunication and misinformation between the device and the user (Norman, 2017).

Hence, for the previously foregoing reasons, it was decided to implement the possibility of regulating the wearable deviceinformation output. Leading to the proposition of incorporating an active and passive setting in its operation mode according to the preferences of the user. The interaction system is envisioned through four main interactions, which are related to a series of activities that the wearable device and the individual perform throughout the general language learning experience, which are as follows:

WEARABLE DEVICE HANDLING

This activity implies the direct operation between the wearable and the user. The persistent reluctance of taking the full advantages of speech based command due to its lack of accuracy and the social conventions involved(**Chapter 5.8.5**) have promoted to suggest as an initial approach to control the wearable device the usage traditional touch control pad, which this research considers as a more familiarized system for the users. By operating the device the user has the possibility to initiate and adjust his/her language learning process as desired (active v.s. passive). However, it can be implemented some basic command options for those who feel comfortable using it.

SCANNING THE ENVIRONMENT

Although the user might be familiar or previously experienced a certain day-to-day environment, the wearable will require being familiarized with such surrounding in order to provide the right contextual information and therefore, channel the data accordingly to the necessities and desires of the user. The execution of this process will allow the user to be aware beforehand of the elements that can set off a language lesson.

FILTERING THE INFORMATION

Once the environment has been identified by the wearable, it will require filtering the appropriate information to the user. It is necessary to identify the objects present in the surroundings that might trigger a language lesson, however, it must be understood the same object can be present more than once, therefore, it should avoid repetitions. Or, in a possible scenario where the object has already been known by the user in a previous learning experience.

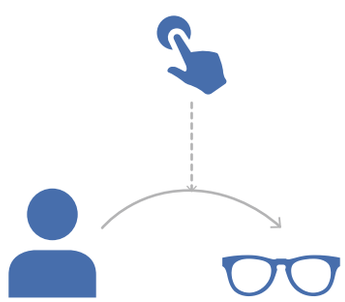
DAILY ACTIVITY ENGAGEMENT

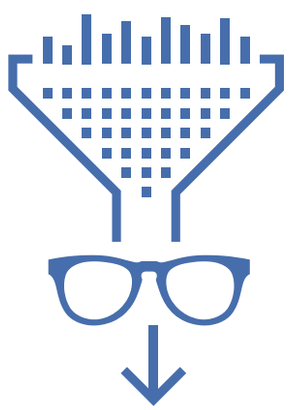
Although the previous two stages might have been represented as sequential processes, their execution should be done in parallel operation due to the fact the user should not be interrupted or slowed down during his/her routine activities. That being said, at this stage the user encounters and performs his/her regular task as he/she usually does, in order to trigger a language learning lesson through direct experience.

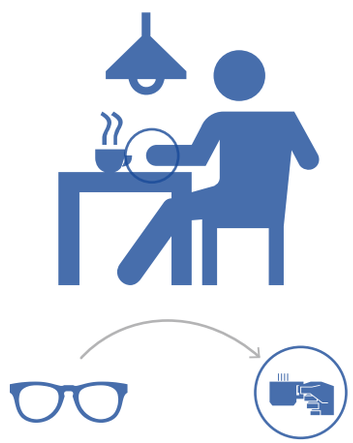
This activity also refers to the explicit gesture of grabbing an object chosen by the user within the specific environment where an activity is taking place. This signal will be interpreted by the wearable as an invitation to prompt a language lesson.

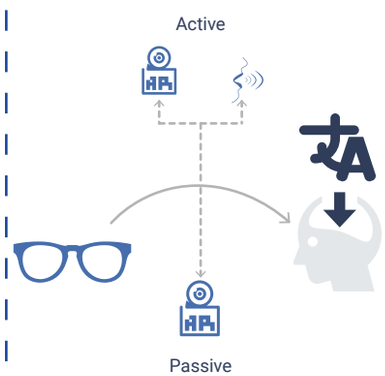
LANGUAGE LEARNING PROCESS

A language learning lesson is triggered as consequence of day-to-day activity from the user. This lesson will be presented through a visual and audio output, however, the user will have the option to determine the level participation of the feedback provided by the wearable. On one hand an active setting, which encourages will encourage the user to perform an oral exercise, this involves audio and visual output. On the other hand, a passive setting where the information is only visually presented to the user, without foster an oral exercise to the user. The incorporation of two settings for user interaction is based on the feedback seen earlier in **Chapter 5.8.5.** The language lesson involves a direct translation of the object chosen in addition to its usage exemplification for simple practical cases. This system is schematically represented in **Figure 6.1**









	WEARABLE DEVICE HANDLING	ENVIRONMENT SCANNING	FILTERING INFORMATION	DAILY ACTIVITY ENGAGEMENT	LANGUAGE LEARNING
INTERACTION					
ACTIVITY	The user operates the device to initiate and adjust his/her language learning process as desired (active v.s. passive).	The wearable scan and gets familiarized with the surrounding in order to provide to right contextual information.	Object identification and filtering information to present the elements in the surroundings that might trigger a language lesson.	The user interacts (grabs) with an object within the specific environment where an activity is taking place. This signal will be interpreted by the wearable as an invitation to prompt a language lesson.	A language learning lesson is triggered either in a passive or active setting, which involves a direct translation of the object chosen in addition to its usage exemplification for simple practical cases.

Figure 6.1 Interaction System

6.2 APPLIED TECHNOLOGY

While this project is considered as an opportunity to propose an emerging concept with the intention of providing an initial guidance for its further development, it will attempt to stamp out questions regarding the potential technologies that might be suitable for the future feasibility of the concept proposal. Thereby, it is important to recall that the technologies mentioned and suggested below might still under development, which entails that it needs further improvement in order to get an optimal performance. By providing relevant information regarding the intended technologies it will be possible to have a good understanding of the technical capabilities of the forthcoming wearable device, thus, delimiting the scope of its functionalities.

Additionally, the fact of encompassing the possible elements that will make viable its future implementation will allow contributing to a technological outline that will set the basis for a future technical complex system, which might be subject to changes or modifications as appropriate. Furthermore, now that a system interaction has been presented on (Chapter 6.3), the technologies driving this system can be determined.

The present document will follow a logical progression of the previously exposed interaction system, in order to propose the desired technological functions in the interest of presenting a general overview of the technological requirements/implications. That being said, the suggested applied technology for the forthcoming wearable device is presented in **Figure 6.2**.

	INTERACTION	FUNCTION	TECHNOLOGY	COMPONENT
INPUT	WEARABLE DEVICE HANDLING	Device Operation	Capacitive Load Sensing	Capacitive Touch Sensor
	ENVIRONMENT SCANNING	Object Identification	Object Recognition Algorithms (Visual Deep Learning Model)	Camera
	FILTERING INFORMATION	Object Identification	Object Recognition Algorithms (Visual Deep Learning Model)	Camera
	DAILY ACTIVITY ENGAGEMENT	Gesture Identification (Grabbing/Holding Objects)	Gesture Recognition Algorithms (Visual Deep Learning Model)	Camera
OUTPUT	LANGUAGE LEARNING	Display of Contextual Visual Information (Active and Passive Setting)	Augmented Reality System	Optical Head-mounted Display
		Speech-Based Natural User Interface (Only in Active Setting)	Bone Conduction	Vibration Transducer/ Speaker

Figure 6.2 Applied Technology

6.3 APPLIED ERGONOMICS

The present document proposes a design ergonomics approach, which implementation occurs during the design process and not a later stage as a corrective method of already existing products. This is due to throughout the design process it contributes to a clearer understanding and a better representation of the ergonomic recommendations with justified prioritization for later implementation into the product design (Sagot, Gouin & Gomes, 2003). It is believed, that the more attention to the application of science and art towards the comfort and safety of an individual, it is more plausible that the end result will have a shaping influence on future design paradigms. Thereby, a successful integration of ergonomics and industrial design will provide an aesthetically pleasing and functionally superior product (Lin & Kreifeldt, 2001).

Although the application of ergonomics discipline involves physical and software system based products (Van der Veer, 2008), at this stage of the development phase, the ergonomic principles will be focused on the design of the hardware (wearable device). This means leaving aside the application of the ergonomic fundamentals for the (software) user Interface design for now; since it deserves its own extensive and elaborated research in the interest of a further implementation.

Having said that, the ergonomic principles applied to the embodiment of the wearable device will lay on anthropometry measurement, which is the science of measurement and the art of application that establishes the physical geometry, mass properties, and strength capabilities of the human body (Del Prado-Lu, 2007). Applied anthropometry in product design provides the suitable product dimensions founded from the human body dimensions. In this particular case, the wearable device has taken the form of eyeglasses, as a result of the evaluation previously done in this present document (**Chapter 5.84** and **Chapter 5.8.5**); eyewear is considered as an important equipment designed to assist the human vision, sight protection, and fashion accessory (Rosyidi, Riyanti & Iftadi, 2016). It has been suggested there are two important aspects that must be considered in glasses frame design: style and comfort. It is believed that the styles of glasses frame are utilized to change the impressions of a human face in addition to its strong relationship with physical attractiveness and personality traits (Heke, 2010; Lo et al., 2012).The present document suggests as an initial approach, to establish the general dimensions of the wearable device based on the critical dimensions of glasses frame using the head and facial anthropometry proposed by Rosyidi, Riyanti & Iftadi, 2016; whose thorough research and methodology can be found in the document “Head and Facial Anthropometry for Determining the Critical Glasses Frame Dimensions”. In that sense, the basic outline of the general shape of the wearable is presented in **Figure 6.3.**

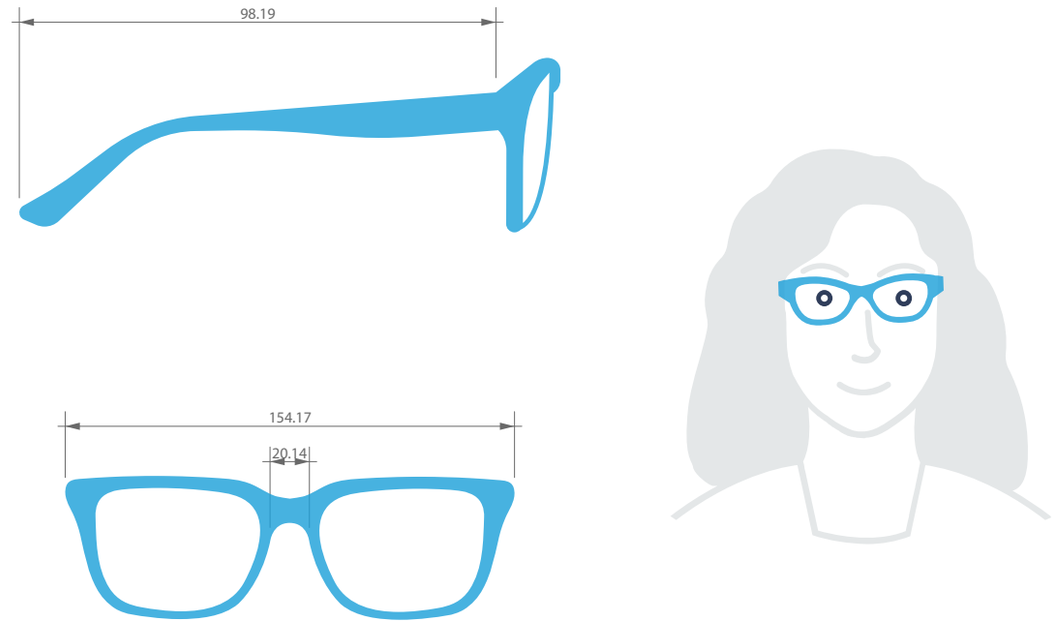


Figure 6.3 Schematic Representation of Critical Glasses Frame Dimensions for Female and Male Based on Rosydi et al., 2016

6.3 NOKIA'S DESIGN DNA

The design proposal aims to be congruent with the design language that Nokia applies into its products, as previously mentioned, it is suggested that Nokia implements semantic translation to determine its core values, semantic meaning in product design is constructed through a triadic interaction or relationship (Møller, n.d, Pierce Edition Project, 1998). Additionally, by considering its Scandinavian design roots, Nokia is a company whose design values are built on FRIENDLINESS, COMFORT, FUNCTIONALITY, and HUMAN-CENTEREDNESS; earlier phones of Nokia have been proof of that, where general curves of the phone were used to express user-friendliness (Møller, n.d.).

To respond visually and emotionally to the design values of Nokia, it is necessary to communicate by reference previous instances of design elements in a variety of different products (Garner, S., & McDonagh-Philp, 2001). A Mood board constitutes descriptions of the overall aesthetic impression the items in a category should create based on colors, proportions and cultural connotations (Eckert & Stacey, 2000). The value of a mood board in the design thinking process lies on its potential to integrate and support solving strategies, by increasing the possibility of converging in a relevant and innovative concept proposal (Garner, S., & McDonagh-Philp, 2001). The proposed Mood-board is represented in **Figure 6.5**.

Figure 6.4 Nokia Product Range

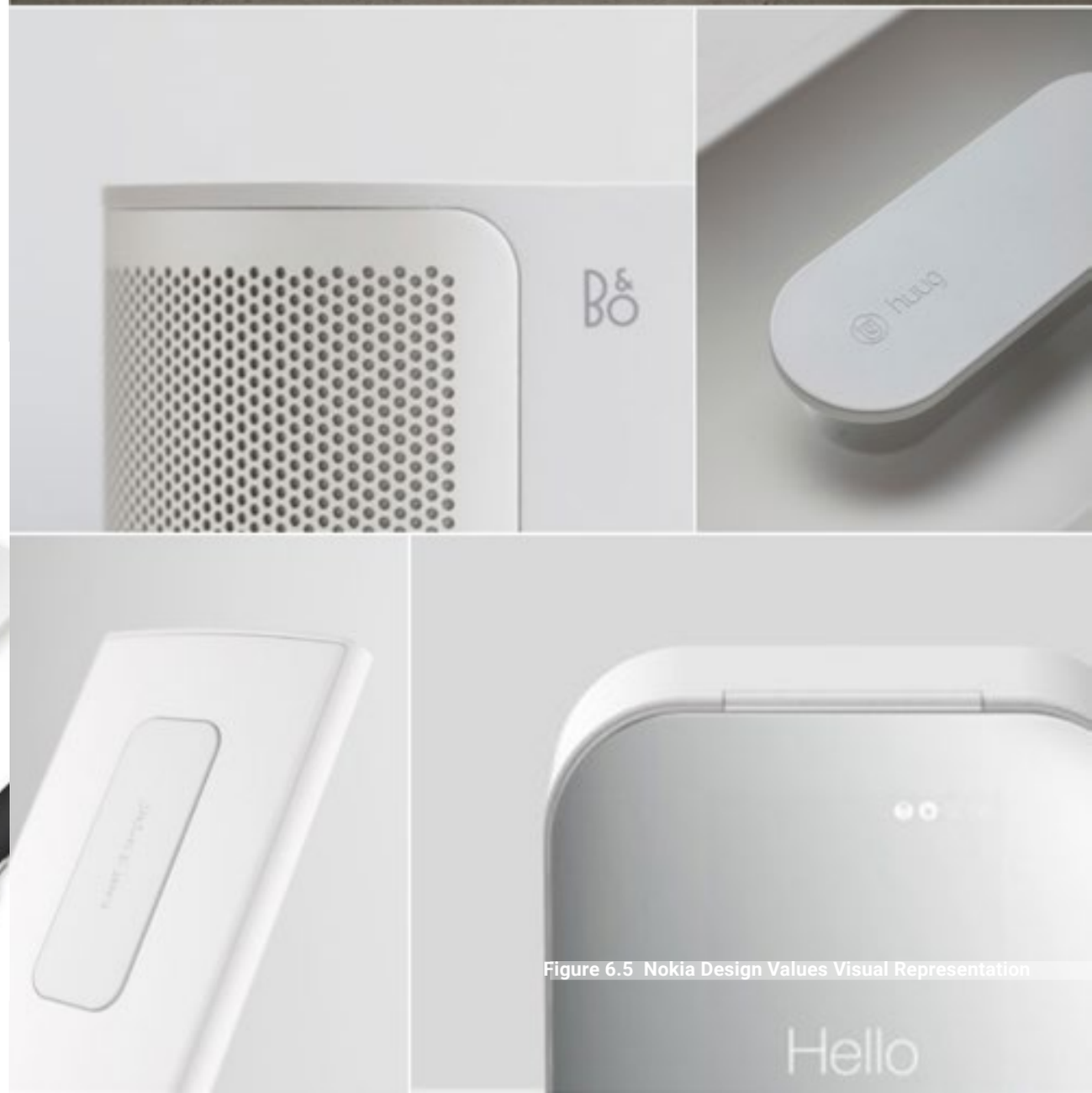


Figure 6.5 Nokia Design Values Visual Representation

6.5 CONCEPT PROPOSAL DESIGN SUMMARY

A wearable device that assists language learning by means of sensorial identification of key objects within a chosen context, providing direct translation and its usage exemplification for simple practical cases. Active direct language learning experience is supported by the implementation of augmented reality system, which provides offers the individual to experience a powerful contextual, on-site learning experience and serendipitous exploration and discovery of the connected nature of information in the real world.

6.5.1 Technical Features

There are different technologies integrated into the physical product. The selection of these technologies is documented in **Chapter 6.2.** Different technology manufacturers have released similar product (smart glasses), such as Microsoft, Intel, Google, IBM to name a few. These companies have implemented and experimented with different technologies in recent years in order to continue redefining and refining such product, therefore, it can be said that wearable eyewear is not a field completely mastered. However, this research aims to present the basic components that conform the architecture of the wearable device proposed, which are described down below. Figure 6. shows a schematic representation a possible internal arrangement of the components, which are integrated into one of the frames of the glasses.

VIBRATION TRANSDUCER

To communicate audio information to the user, bone conduction technology is suggested. This component is an electromechanical transducer, which converts electric signals into mechanical vibrations, sends sound to the internal ear through the cranial bones. Bone conduction keeps the ears free in order to keep the individual aware of her/ his surroundings when wearing them, and at the same time, it promotes a personal and private communication with the device.

MICROCONTROLLER

The electronic components have to be controlled (microcontroller chip) and wired. The product will contain one PCB. The main battery is connected directly to the main PCB to power the electronics, the vibration transducer will require being wired.

LI-ION BATTERY

To supply energy to the wearable, it is suggested to use these batteries due to custom made size, do not have to be replaced, so the product does not have to be opened by the user, and it allows to be recharged.

CAPACITIVE SENSOR

The user must be able to interact with the device to use the UI presented through the Augmented Reality System. The capacitive button is chosen to implement due to its facility of implementation, it can be placed under the top shell, which prevents any section lines on the top surface in addition to its reduced thickness, which allows being mounted almost flush on the PCB.

MICROPHONE

As a mentioned earlier (**Chapter 5.8.5**), voice command is still a reluctant feature for most of the users due to social conventions, however, its potential as a more friendly natural interface makes it a not totally disposable option. **Chapter 2.2.5** mentions the possibility of wearable technology to promote and generate new social conventions (Dvorak, 2008; De Sol Pool, 1983), therefore, it might be possible to think that speech based recognition will be widely used as a preferred choice of communication with devices.

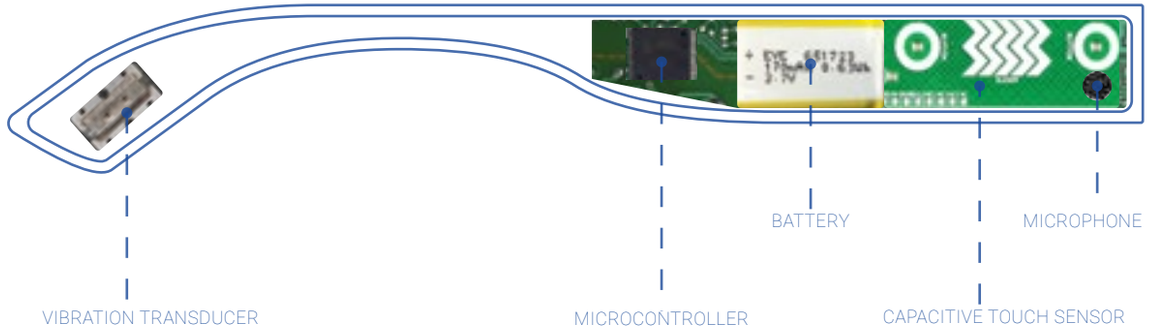


Figure 6.6 Schematic Representation of Critical Components Embedded in the Glass Frame

Figure 6.7 Concept Details

OPTICAL HEAD-MOUNTED DISPLAY

It is capable of displaying an augmented reality to the user. A binocular head mounted display (“HMD”) using one diffractive optical combiner permits the user to see a real-world image via external scene light. It is generated by image sources mounted on the right ear arm, the image light is seen by the user as a virtual image superimposed over the real world as an augmented reality.

The image source may include a variety of compact image source technologies that are used in various micro-displays and pico-projectors such as liquid crystal on silicon (“LCOS”) displays, quantum dot array displays or light emitting diode (“LED”) arrays. It is important to keep in mind that since the clear see-through substrate is typically a flat substrate without optical power so as not to distort the external field of view, the clear substrate must be angled 45° degrees (Figure 6.)

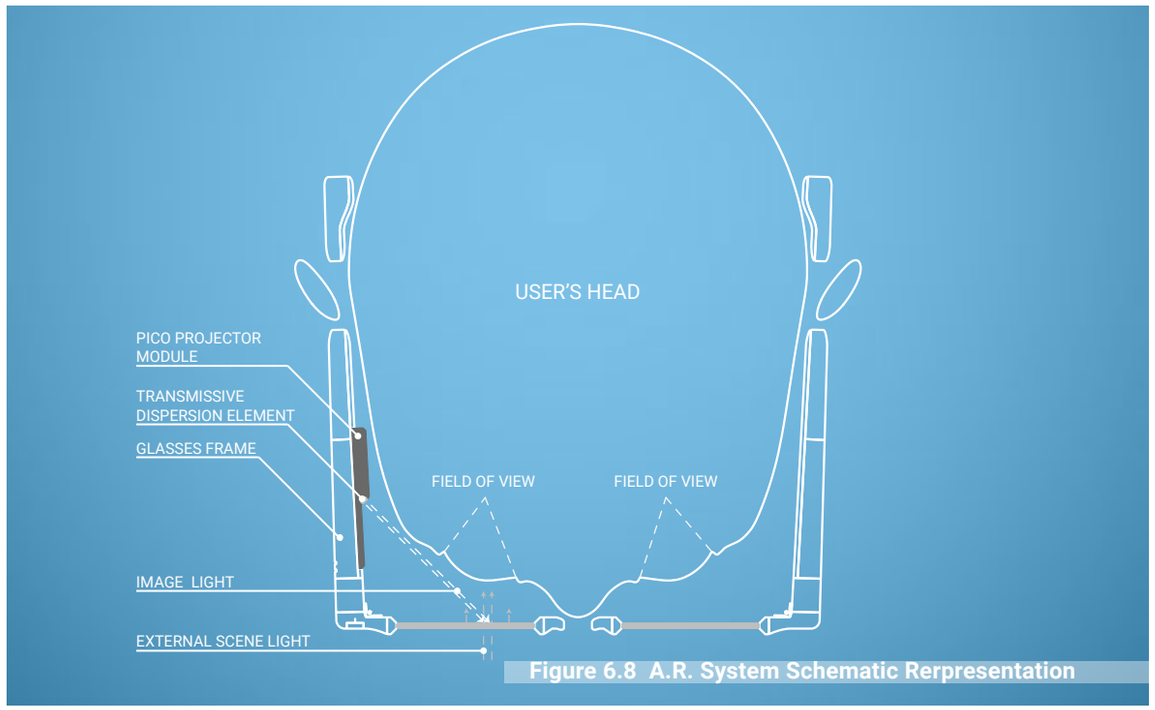


Figure 6.8 A.R. System Schematic Rerpresentation

Figure 6.9 Camera Detailing

VISUAL DEEP LEARNING MODEL

Deep learning (also known as deep structured learning or hierarchical learning) is part of a broader family of machine learning methods based on learning data representations, as opposed to task-specific algorithms. Researchers have sought to adapt the image-based deep learning framework to perform activity recognition(John et al., 2016), although far from being perfect it is possible to suggest and predict that in the coming years that machine learning will be more accurate.

For the purpose of this design proposal, it is assumed that visual deep leaning will support the device in the tasks of gesture recognition and object recognition, through the implementation of an external camera integrated into the frames of the glasses for data input. Object and gesture recognition data representations need to be developed in addition to a multimodal approach with the purpose of increasing the processing accuracy and efficiency.

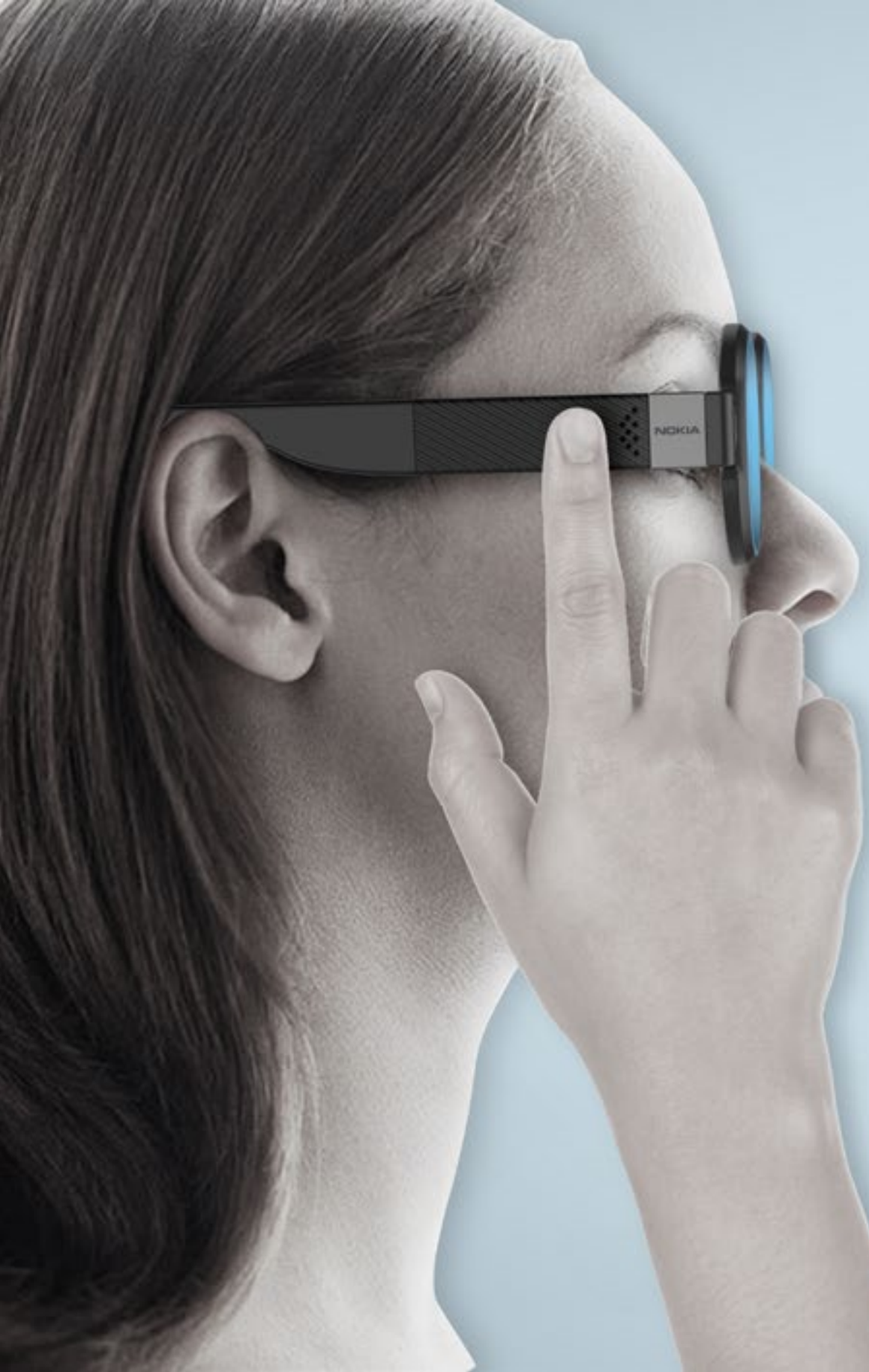
6.5.2 Product Interaction

In addition to the embodiment of the product and the technical features displayed earlier, its interaction with the wearer is an aspect that it should not be overlooked due to an interaction establishes the means of framing the relationship between a human being and the product designed for them. Thus, it is important to address the key elements that are involved in the user-product relationship. As mentioned earlier (Chapter 6.1), in order to control the wearable device it is proposed the use of touch control pad as the main mechanism for manipulating and navigating through the wearable software. The key elements are addressed hereinafter.

POWER ON/OFF BUTTON

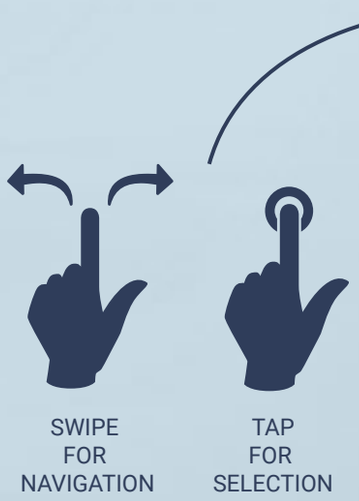
Located in the right-top front corner of the frame of the glasses is located a power on/off switch button to activate and deactivate the device. The reasoning behind having the user to press a power-on button on the device is due to the fact that the wearable cannot be used without the consent of the user. Thus, the individual although is wearing the device, it is up to him/her to make the decision of activating and using the features (software) contained in the wearable when he/she considers convenient.

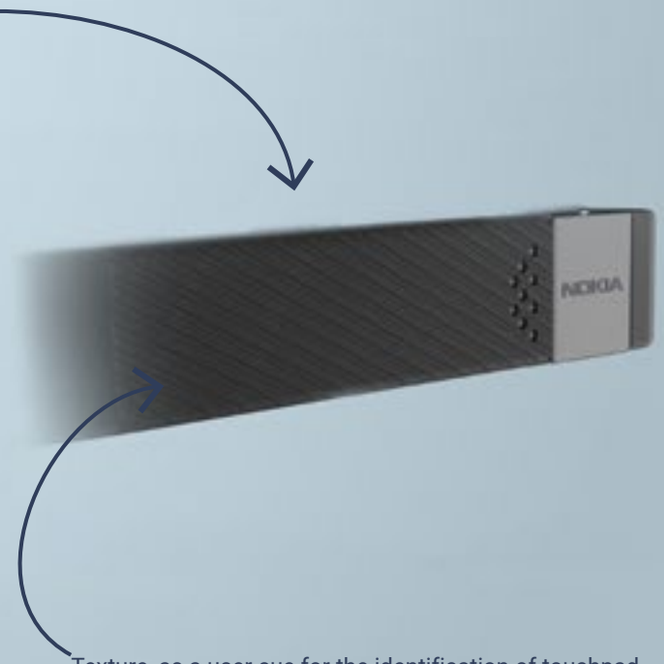
PUSH BUTTON



TOUCHPAD

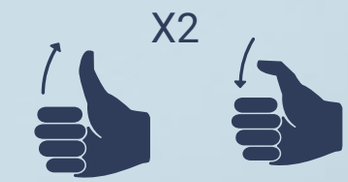
Located in the right frame of the glasses, its purpose is for navigation and selection of features contained in the software of the glasses. It can detect the tap of the user in order to activate and proceed. Although currently it is envisioned to incorporate swipe and tap gestures, there is room for further detailing for interaction which might include yet not limited to for example long press features. These interaction points, are subject to each software needs and specifications, thus, it is required further exploration in terms of the relationship between a software application and user interaction.





GESTURE RECOGNITION

A gesture recognition is needed in order to control and regulate the information provided to the user. Although the wearable is capable of recognizing the objects that are present within a specific environment, it is necessary to provide the user with a mechanism to control and filter such information. To that effect, it is proposed to use a double thumb-tap when holding/grabbing an object as a specific hand gesture recognition. This gesture aims to provide the user the possibility of choosing from which element desires learn more information (Language Lesson).In that sense, a double tap aims to transpolate a common user cue from the digital world into a physical one, in addition to the fact it will allow keeping the interface layout as clean as possible, for example, it contributes to avoiding extra elements such as pointers, box frames.



Double thumb-tap as the gesture for triggering a language lesson.

Hand gesture recognition through learning data representations.

Figure 6.10 Context Representation for Acitve Mode Learning

ACTIVE LEARNING SETTING

A language learning lesson is triggered as consequence of day-to-day activity from the user. This lesson will be presented through a visual and audio output. On one hand, the visual output aims to provide the user with information regarding spelling and grammar (the last one, only applies when showing the practical usage exemplification), while on the other hand, the audio output aims to afford knowledge regarding punctuation and pronunciation to the user in addition to the encouragement for the user to perform an oral exercise during the language lesson.

This setting is envisioned for the users who feel more comfortable interacting with a speech-based natural interface and for those who, although might not feel totally at ease using this feature, they require an active learning setting for a faster improvement. Additionally, it is expected that this feature will be more high-likely used in a private environment (e.g. at home), due to the implications of the social conventions related to publicly converse with a machine/device.

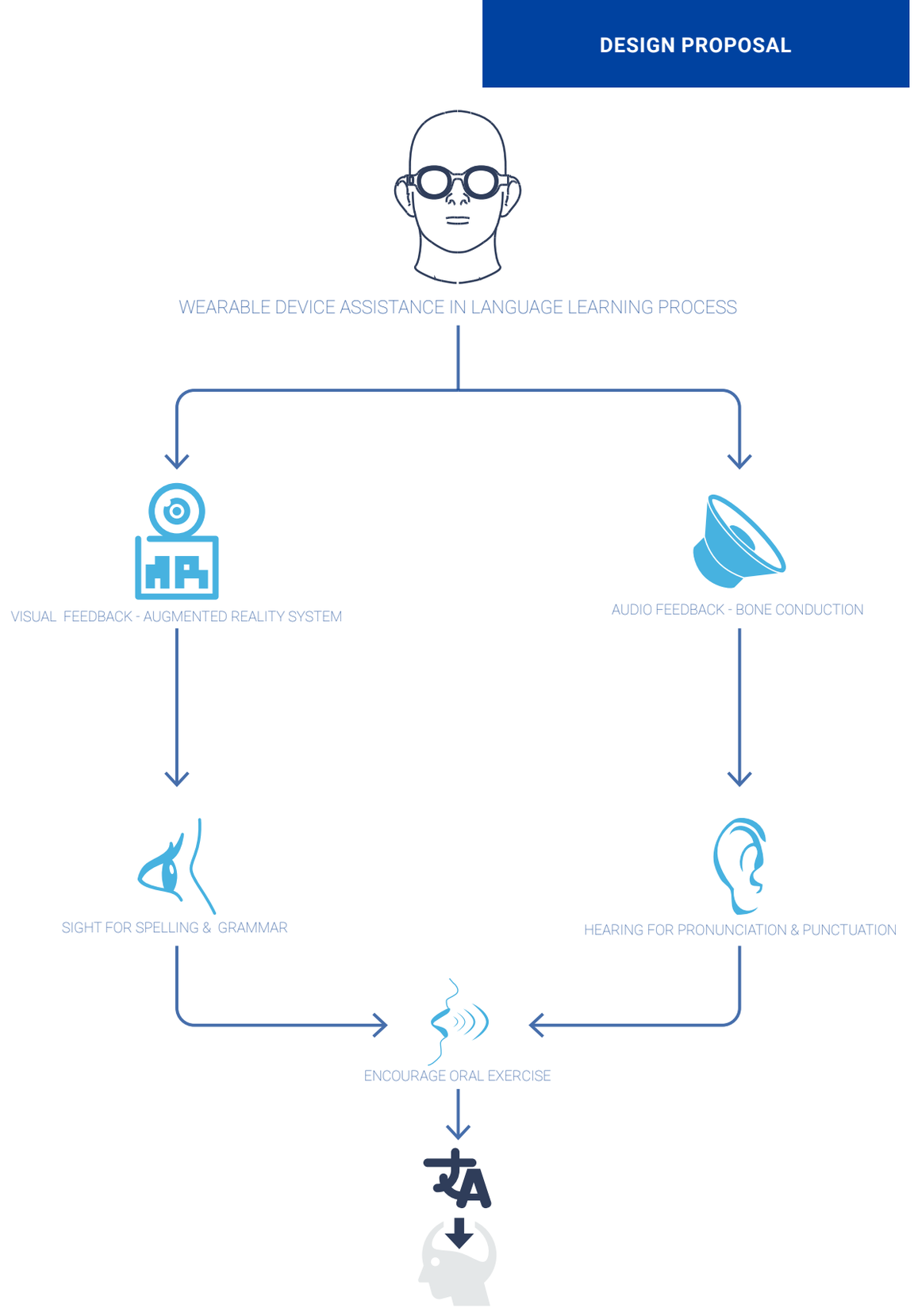


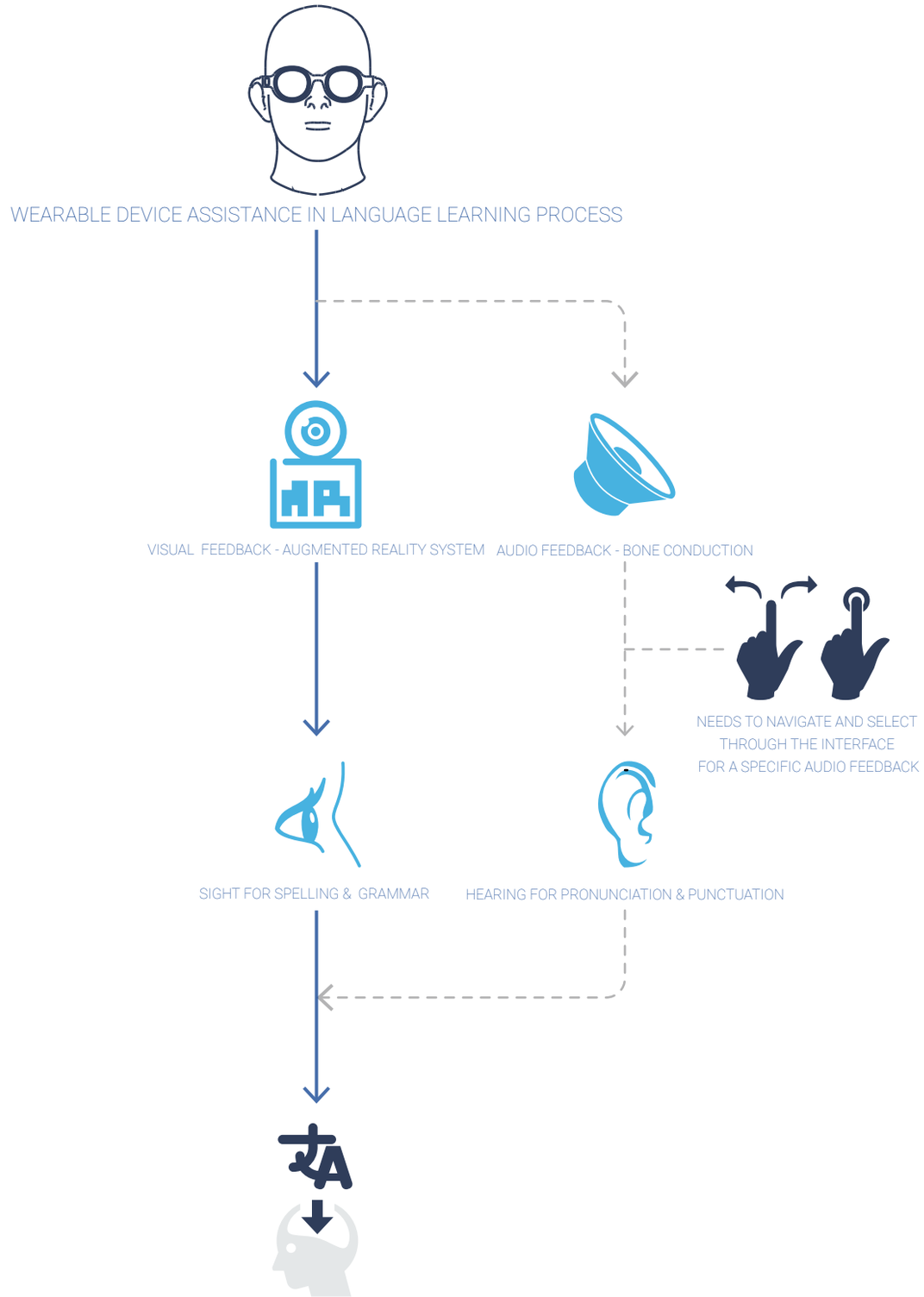
Figure 6.11 Schematic Representation of Active Learning Seeting

Figure 6.12 Context Representation for Passive Mode Learning

PASSIVE LEARNING SETTING

A language learning lesson is triggered as consequence of day-to-day activity from the user. This lesson will be presented through a visual output, with the option of providing audio only if it is requested by the user. The visual output aims to provide the user with information regarding spelling and grammar (the last one, only applies when showing the practical usage exemplification), while on the other hand, the audio output aims to afford knowledge regarding punctuation and pronunciation to the user. It is important to mention that if the user requires for any reason complementing the visual information that is taking place with audio output, he will require to navigate through the interface using the touchpad and chose the related audio information.

This feature does not encourage the user to perform an oral exercise during the language lesson, its aim is just only visually present him the information. This setting is envisioned for the users who do not feel comfortable interacting with a speech-based natural interface, and/or considers an audio output as intrusive. This feature does not encourage the user to perform an oral exercise during the language lesson, its aim is just only visually present him the information. This setting is envisioned for the users who do not feel comfortable interacting with a speech-based natural interface, and/or considers an audio output as intrusive. Furthermore, this feature is expected to be highly used in a public setting (e.g. train station, shopping mall).



PASSIVE LANGUAGE LEARNING SETTING

Figure 6.13 Schematic Representation of Passive Learning Seeting

6.5.3 Interface Basic Design Guidelines

Augmented reality applications are based on context, which affects user interface elements (e.g. placement, color, and size). The earlier leads to the fact that depending on the situation, certain interactions will be preferred, these situations can be affected by social conventions, safety reasons, effectiveness just to name a few. In this particular case, the dilemma of social conventions has played a main role in the aspect of controlling the device (touch vs voice command).

The augmented reality system showed in the present concept proposal, consists of animated media, which are traditional 2D media elements applied to augmented reality. These elements User cues are considered as key elements that inform an individual what components of the User Interface are designed to be interacted with, and how to interact with them.

AUDIO CUE

Sound contributes to, on one hand, notice off-screen objects, and reinforce the ones that are within the field of view. Audio cues aim to promote surrounding exploration and enhance/complement visual information. For the purpose of language learning process, it is used as a medium to improve and support the punctuation and pronunciation of the learner.

VISUAL CUE

This information has the purpose to inform the individual the elements that are designed to be interacted with, and how to interact with them. It is suggested that adding hover states to buttons and highlighting intractable elements are effective methods to engage the individual in such interactions. For the language learning process, the visual cues aim to provide the learner useful information regarding spelling and grammar.

Figure 6.14 Visual Representation of Augmented Reality System

6.6 EVALUATION

An evaluation was conducted to test the user experience and the aesthetics of the design proposal. On one hand, a video was used to demonstrate the user experience/interaction to the participants, while on the other hand a scale 1:1 physical mockup alongside with renders (digital visualizations) were provided to evaluate the appearance of the concept proposal. For this evaluation 25 respondents took part, from both genders within an age of 20 to 31 years old.

USER EXPERIENCE EVALUATION

Effectiveness: It refers to the fact how successful the learning process is perceived according to the participants involved, almost 70% has considered it as an effective method (**Figure 6.15)**.

Unobtrusiveness: It refers to the way how the learning process is seamlessly integrated into the daily activities of the user. Results showed that the respondents tend to perceived it as an unobtrusive method, around 70% (**Figure 6.16**)

Difficulty: It refers a how hard would be to acquire a new language using the method presented. On this matter is hard to have a concrete answer with the current results, participants expressed that each language might represent a different level of challenge to each individual. Further analysis and evaluation need to be done on this aspect (**Figure 6.17**).

Enjoyment: It involves the pleasure experienced during the language learning process. Most of the participants (around 80%) perceived the language learning process as joyful (**Figure 6.1**8).

Engagement: This aspect refers to the level of participation triggered by the language method presented to encourage the learner to actively be part of his/her language learning process. Around 70% of the participants perceived that this method could promote a higher involvement from their part during their language learning process (Figure **6.19**).

Figure 6.15 Results for Effectiveness Dimension.

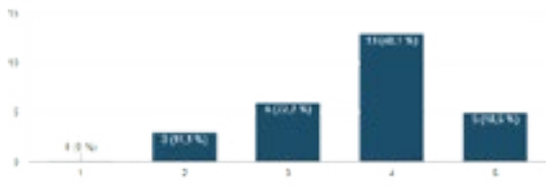


Figure 6.16 Results for Unobtrusiveness Dimension.

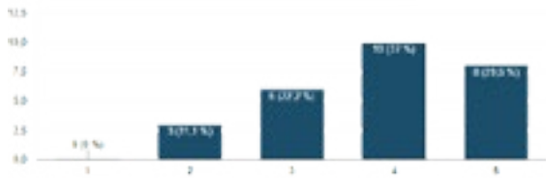


Figure 6.17 Results for Difficulty Dimension.

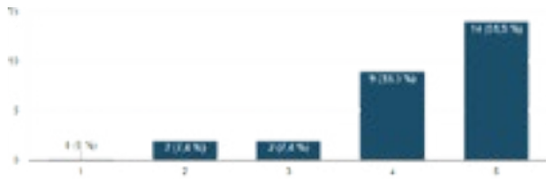


Figure 6.18 Results for Enjoyment Dimension.

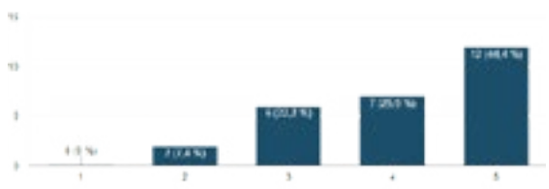


Figure 6.19 Results for Engagement Dimension.

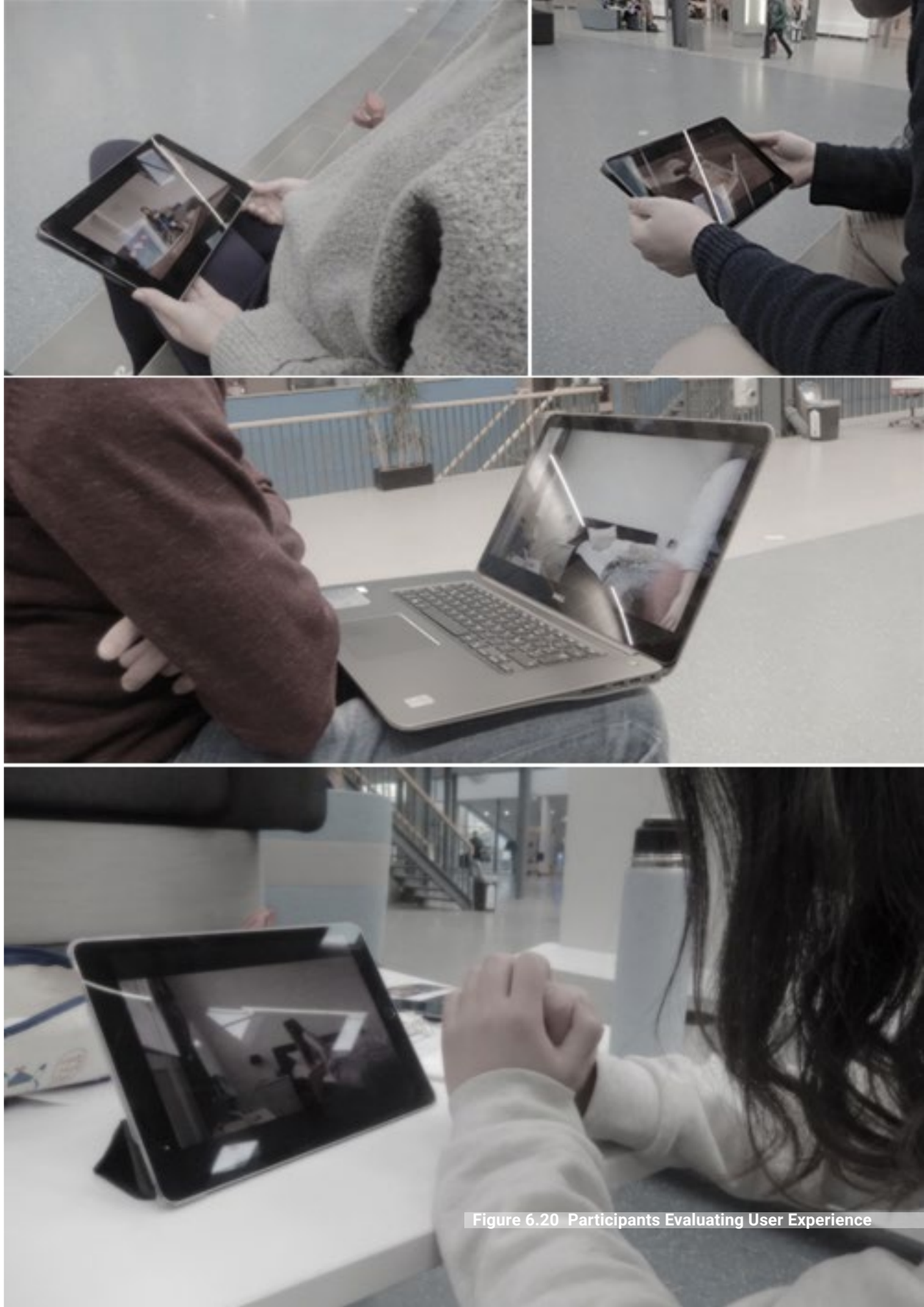


Figure 6.20 Participants Evaluating User Experience

Figure 6.21 Participants Evaluating Aesthetic Appearance

AESTHETIC EVALUATION

General Appearance: It refers about the positive/negative perception of the wearable device in terms of aesthetics. At this moment around 40% of the participants showed a neutral stand, therefore, it is hard to conclude any concrete answer regarding this aspect. On the other hand, aesthetics is subjective, and due to the fact of the diversity of the people involved in this test, the current proposal did not cover such diversification. On that basis, is possible to assume that not all the tastes were covered (**Figure 6.22**).

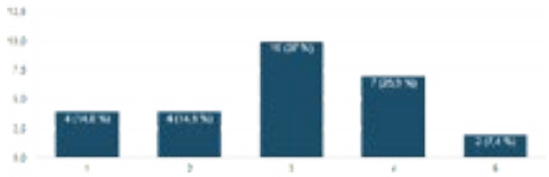


Figure 6.22 Results for General Appearance

Fashion v.s. Tech Orientated: This aspect refers how the participants percieve the product if it is seen as a gadget or as a fashion accessory. The current proposal was perceived more like a gadget rather than a fashion accessory. However, a common thinking among the participants was the fact that the front frame plays a key role in how an eyeglass suits the shape of the face of the wearer. Further exploration in terms of style is required in the concept proposal (**Figure 6.23)**.

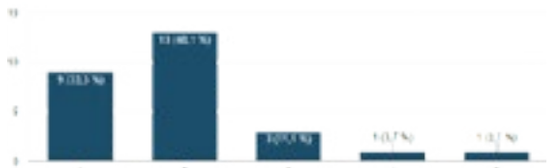


Figure 6.23 Results for Fashion vs Tech Orientated

Friendliness: It involves how the product positive/ negatively triggers the willingness of an individual to use/wear the device based on its appearance. Around 60% of the participants considered the wearable device as a friendly, however, it was mention that there is still room for improvement to highlight even more the elements that make a device more visually friendly (**Figure 6.24**).

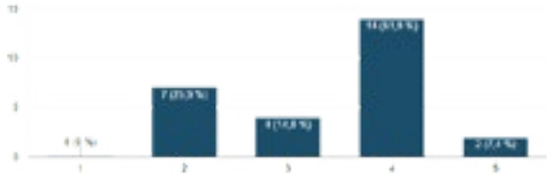


Figure 6.24 Results for Friendliness

Neatness: It refers to the perceived quality of the product. The participants perceived the product as a “high quality-end product”. However, a deeper research should be done in terms of CMF (color Material and Finishes) in order to propose a right combination of materials and colors (**Figure 6.25**).

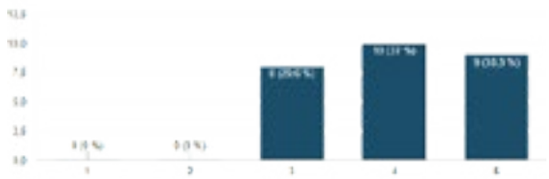


Figure 6.25 Results for Neatness

6.7 RECOMMENDATIONS

This section explores and suggests recommendations that can be taken into account for further development and improvement of the current state of the design proposal. This product should be seen as an ecosystem, which involves a seamless integration of software and hardware in order to provide a meaningful/enjoyable language learning experience. Based on the above, it is possible to suggest that further improvements can be classified into the following aspects:

HARDWARE

In terms of product embodiment, further test and evaluations should be done related to ergonomics. It is important to consider and define which would be the best position for the bone conduction speaker. It is possible to assume that might exist more suitable contact surface areas than others within the human scalp for an optimal performance of the bone conduction system.

Regarding the position of the camera, in the current proposal, it is located at the right top corner of the front frame, which it is visible for the individuals around the user. This decision is based on the belief that product should be “honest”, thus, deliberately the camera is exposed to the outside viewer instead of hiding it, which might attract privacy concerns and disruption of established social conventions (been filmed/recorded without permission). However, the camera purpose is not to record the environment user, it is used as visual input to perform the involved object and gesture recognition processes for the language learning procedure. Based on the earlier, it is possible to suggest that the camera can be hidden from the outside viewer to perform this task more discreetly. However, as a personal belief of this researcher, this could be considered as a dishonest product. At the moment, it is hard to define what it would be the best approach, it is believed that time will show which direction should be taken, and perhaps in the near future, individuals would feel more comfortable with the presence of cameras that are integrated into smart glasses. Thus, there is a high potential for creating/modifying social conventions with the implementation and future evolution of wearable technology.

In terms of style/appearance, the fact that wearable technology can be integrated into the form of eyeglasses allows endless opportunities for fashion exploration. The current proposal only has shown one possibility, however, fashion trends can be implemented to diversify this product for different market segments (e.g. casual, business, and sports to name a few). It is important to note, that the shape of the front frame is a key factor to determine which style suits the best to a person, according to the shape of his/her face (e.g. triangular, oval, rounded, etc.). The current concept still preserves a gadget appearance perception, thus, further, improvement should be done, such as a depth exploration of trend analysis.

Another important factor that highly influences the general look and feel of the wearable device, it is its internal architecture (electronic components). At the current state of the design proposal, most of the components are possible suggestions without any clear definition in terms of size and capabilities. However, the following components can be highlighted: The battery, its size will determine a perfect balance between performance and durability; the microprocessor, this component is the brain of the wearable technology due to the fact it processes all the data (algorithm recognition; output and input data) the complexity of such tasks will determine its dimensions. However, it is believed that a suitable miniaturization can be possible with the continuous improvement of technologies. Finally, the optical head-mounted display technology that makes possible an augmented reality system. This feature can involve different solutions from LCD, LED, and vertical cavity surface-emitting laser to name a few. Again, it is hard to define the best solution at this moment, further analysis of this components needs to be done to select the most appropriate for the capacities and functions intended for the wearable.

SOFTWARE

Designing content for augmented reality systems is an emerging labor, which implies a depth knowledge of user experience and user interface design in order to create a meaningful experience. As it is now, the concept proposal requires a depth analysis of the areas mentioned earlier, it requires a more clear definition regarding interaction implications between the different modalities offered (active mode vs passive mode). There is a great opportunity area to implement gamification elements, using the case study of Pokémon Go as a background information, it is possible to suggest that language learning process can be enhanced and enriched with such elements, including gratification features (e.g. unlocking new functionalities, increasing difficulty, etc.).

For the further improvement of the interface layout, it is required depth understanding and application of the science of color theory. Use contextually and culturally appropriate colors (e.g. green- proceed/ acceptance, red - stop/danger.). Regarding text content, it is important to study and determine the amount of text is needed for such interface, when to apply light text on dark background or dark text on a light background are the best contrast schemes for reading. Those elements should be addressed in depth for further improvement of the interface. Ideally, it would be advisable to connect the software to a cloud, allowing the user to keep track of his/her progress and share knowledge among pairs. As mentioned earlier, the fact that individuals share similar goals will promote a long-term commitment to the wearable device, thus, trigger a healthy competition among users. If the software is connected to a service platform, it is more likely to create a sense of community, and as a consequence, it is more likely to have a higher dissemination of such technologies. A depth study in market research is required to determine how this platform will support and complement the usage of the wearable device.

6.8 CONCLUSIONS

As it is shown in the present document Augmented Reality (AR) gaining more popularity and ubiquity as hardware and software become more accessible. The implementation of wearable technology as an embodiment medium for augmented reality systems strengthens the possibility of an even higher adoption of Augmented Reality Systems. This proposal has shown that provides and it is perceived as a valuable proposal, allowing cultural integration through the support of language learning process for the users. Although, similar solutions already exist through the use of mobile phone applications (e.g. Duolingo), the combination of augmented reality system and wearable technology offers a higher level of enhancement during language learning process, which can be seamlessly integrated with the daily activities of an individual, without the concern to dedicate "special time" to such activity, thus giving priority to tasks that might be more important for an individual.

Although it is difficult to predict how many words an individual can learn with this concept proposal due to the fact that each individual might have different learning habits, it is assumed that if the person wears the device daily will be able to learn between 5 up to 10 words per day, which will result in a total number of words at the end of each month around 150 words 300 words. Additionally, depending on the language, the number of basic words that are needed to be learned in order to understand a basic conversation is different, however, it is suggested that these number goes around 1,000 up to 3,000 words (McCarthy, 1999). With that in mind, the learner will be responsible for how frequent will use the device for the purpose of achieving his/her personal goes, nevertheless, the device should provide enough flexibility to adapt to the demand of the user learning necessities.

On the other hand, it is true that the complexity required for gesture and object recognition to fulfill the demands of the current concept proposal will take several years to perform as accurate as it is shown on the video. However, this researcher strongly believes that this accuracy and precision will be achievable in the forthcoming years (10 years, as an educated guess), examples such as YOLO (You only Look Once) which is a system that allows detecting objects in real-time has shown promising progress (Redmon et al., 2016). The double thumb-tap gesture recognition it might be achievable through the application of real-time hand gesture recognition using finger segmentation principles, which is currently being developed to go deeply into detail about the static and the dynamic gesture of the fingers (Chen, et al., 2014). These examples support to some extend the future feasibility of the current proposal.

As mentioned earlier, although the appearance/style plays a key factor in the technological push of wearable technology, its main value lays on the benefit that can provide to the user, its impact on the actions and behavior of the user. There is special interest in the application of smart glasses, although you might think Google as the pioneer of the "implementation" of such devices back in 2013, Nokia showcased a smart glasses concept almost 10 years ago that incorporates mixed reality, presenting a possible future for "mobile devices" (Dannen, 2009). In that sense, it is possible to suggest that Nokia forecasted even earlier what could be the next direction for mobile devices, smart glasses.

That being said, the opportunity for Nokia lies in platform design, a space for meaningful applications capable to produce a positive impact in the daily life of the individuals, which will lead as a consequence, to the dissemination of wearable technology (in this particular case, smart glasses). Smart glasses are becoming a technological trend, both, large companies and startups (INTEL, Laforge, Sony, to name a few) have been focused on the development of its own version of what could be the "perfect smart glasses", thus competing to set who will be the leading platform for the implementation of wearable technology.

Figure 6.26 Nokia Smart Glasses Concept Showcased in 2009

6.9 REFLECTIONS

The present document shows an example of how a meaningful application, in this case, the support the language learning process can contribute to the adoption of a technological platform. It lays the foundations for Nokia to create meaningful content that will contribute the adoption of wearable technology, not based on the technical capabilities of certain technology, rather in the fact of the consequences in human behavior (lifestyle).

The major challenge during this project was to define a clear objective/purpose from the start. The fact of implementing a technology without a meaningful purpose does not allow a relevant impact on human life, therefore, my intention was to communicate the importance of the application of a “human-centered” design approach. To that end, I used the VIP (Vision in Product Design) method to define a clear vision of a meaningful purpose for wearable technology. However, I do feel that way of thinking was not recognized by the company advisor, perhaps, I was not able to communicate properly to him why it is important to have this kind approach within a project even if it is a technology push-based research. This experience allows me to realize that there is an opportunity for me to improve my communication skills to clearly transmit the core values of my design process, which often were faded into the background when actually should have been brought up to the front in order to clearly demonstrate and support critical design decisions.

An extension of the earlier one, due to the efforts and time invested to find a meaningful purpose for the implementation of wearable technology, the time for detailing and deep development was reduced, which, eventually led to some design gaps that could have been avoided/reduced even more, if more time for development would have been dedicated. On the other hand, the complexity of this project might suggest that at least two students are needed to approach this endeavor more in-depth, where the synergy of different expertise such as User Experience, Interaction Design and Product Design (Design for Interaction and Integrated Product Design master students) will make possible take even further this challenges.

Last but not least, as a part of a collaboration with a company, I would have been expected a better support in terms of resources, which not necessarily means that it should cover financial matters, rather it can involve a more active role from the company such as share facilities for testing, provide useful contacts for deeper research, just to name a few. For future opportunities of collaboration for the next generation of students, might be wise to clearly define the exact role of the company within the project.

Figure 6.27 The Thinker

7.0 REFERENCES.

Hereunder are presented the sources that supported the present document, where the expertise from different disciplines has contributed the execution of this research. Ranging from computer science, psychology, engineering, technology, sociology, and design, to name just a few; enriching the result of this project that led to the vision of a concept design proposal. These sources of information were divided into literary and online based.

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