From Stigma to Objects of Desire: Participatory Design of Interactive Jewellery for Deaf Women

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Abstract. Quietude [1] is an EU funded project that aims at creating interactive fashion accessories and jewellery for deaf women to experience and make sense of sounds. Through Participatory Design, a series of prototypes were developed to scaffold design inquiry and develop human-centred solutions. Deaf women and women with different levels of hearing impairment were involved in various activities throughout the design process, from in depth interviews, inspirational workshops, and co-design activities, through to body storming with experienciable prototypes. Each design iteration consolidated the theoretical grounding and the definition of new forms of design support. The latest suite of accessories addresses a number of needs of deaf people, from functional needs like ambient awareness and safety, to hedonic needs like aesthetics, curiosity, possibility to express a personal sense of style when accessorizing the body.

Keywords: Interactive jewellery · Disability · Deaf women · Co-design Participatory design

1 Introduction

Disability can represent a tremendous opportunity for wearable design. In Design Meets Disability, Pullin [2] shows how design and disability can inspire each other. By discussing insightful design cases, he states that disability can force some new questions onto the agenda that can actually open up new ways of thinking from subjective viewpoint, and not just in terms of better accessibility. Balancing the tension between a functional approach to disability with a more ethical and aesthetic exploration of technologies supporting disabilities is therefore quintessential.

This is the challenge of Quietude [1], an EU funded project within H2020 WEAR Sustain, which develops jewellery products addressing the complex tangle of functional, ethical and aesthetic needs of women with hearing impairment.

Quietude aims to "change stigmas into desirables" [3] by designing smart jewels to counteract the negative impact of disability. In the project, disability is not seen as a problem to solve or an impairment to hide [4]. It is regarded as an opportunity to bring

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mindful attention to aesthetic, ethical and cultural values in designing solutions for hearing impairment.

In fact, the proximity of jewels to the human body emphasises aspects of materiality which go beyond the visual, involving ergonomics (e.g. weight and tactility), personal meaning, style and expression.

2 Related Work

There is a growing interest in the design community for wearables for deaf people. Vibeat [5] is an interactive jewellery for deaf and hearing impaired people which translates different musical tracks into specific vibrations. This design offers a parallel sensory experience of music conveyed by the sense touch.

Neosensory's Versatile Extra-Sensory Transducer (VEST) [6] is a garment designed to map information stream such as sound, vision, or data (e.g. stock market data or state information of an aircraft) to a wearer's sense of touch, using vibration in real time. While functionally effectively, VEST's aesthetics remains limited. Cute Circuit's Sound-Shirt [7] allows a deaf person to feel music on their skin at live symphonic concerts. The wearable device maps instrument groups to body locations through light. Vibrohear, is a bracelet designed for deaf blind to communicate to the wearer the volume and distance of the sound [8]; Music For Deaf People, is a concept collar designed by Frederik Podzuweit that converts auditory input into vibrations [9].

None of the above mentioned designs widely explores the full potential of accessory design: materiality, aesthetics, relation to the body and personal values remain in the background.

3 Design Process

A mixed group of experts including deaf women, designers, ethicists, technology experts and a psychologist joint the design process. Participatory design activities [10] like inspirational workshops, in-depth interviews, co-design and body storming with experienciable prototypes unfolded throughout the design process to elicit needs, envision and reflect upon solutions, incrementally develop and refine prototypes.

The initial inspirational workshop took place in a Fab Lab, and involved four deaf since birth women, two sign language interpreters, an ethicist, and a mixed group of designers, technology experts and makers [11]. The group of deaf participants was composed by an architect (40 years old), a psychotherapist (41 years old), a special education teacher (30 years old), a university student (21 years old). The workshop aimed at inspiring each other and stimulating an empathic understanding of deafness. Initially participants were prompted to reflect on feelings of deafness which were mapped on body maps using simple post-it notes (see Fig. 1 left).

The activity continued with an exploration of materials with different visual, tactile and behavioural features which were paired to the feelings identified on the body maps (see Fig. 1 left). Some participants located "frustration" around the ears and under the armpits to mean that deafness is considered as something to hide.

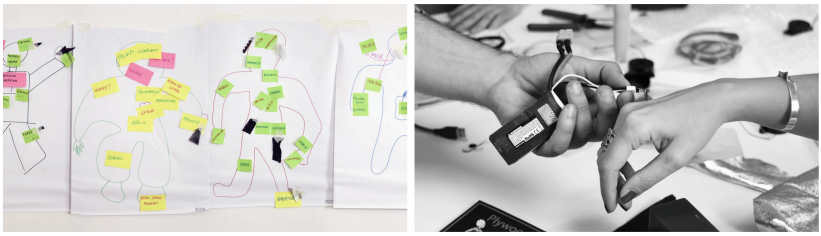

Fig. 1. Body maps and technology exploration

The discussion about the positioning of the post-it notes stimulated the participants to make needs and desires emerge during the exploration.

The next phase regarded a technology exploration (see Fig. 1 right). Participants experimented with simple vibration circuits including transducers and vibration motors. This exploration was inspiring to appreciate the sensitivity of participants to vibration and micro-movements in different parts of the body. From this phase we learnt that deaf people have very different sensitivity to vibration. Some of them are not sensitive to vibration around the wrist, some others are very sensitive on the neck and the bones around the ears.

The workshop disclosed complex needs of deaf women and contributed in knowledge to the design inquiry.

- There is a clear need of awareness about meaningful personal sounds (e.g. pet, doorbell, name, etc.) and public notifications, such as alarms, announcements in public spaces, police whistles, and more.
- Safety is fundamental to avoid that sounds requiring a quick response (e.g. a car horn from behind) go unnoticed by a deaf person with negative consequences.
- Jewellery products should be adaptable to individual preferences. As said above, during the workshop our deaf experts showed different sensitivity to vibration. The position on the body and the behaviour of the jewellery should be defined according to individual preferences and sensitivity.
- Deaf people are curious about the quality of sounds and would like to experience them with other senses (e.g. sight, touch, on-body vibrations).
- Medical aids usually conform well to medical needs, but they neglect complex aesthetic needs of the individual. Hearing aids should be beautiful, smart and comfortable to wear.

A co-design session followed involving one deaf participant, the university student who participated to the previous workshop. Staring from the outcomes of the inspirational workshop, the co-design session was based on hands-on activities and rapid prototyping.

A preliminary set of jewellery prototypes was developed (see Fig. 2). It included:

- A bobby pin with interchangeable parts that move according to the ambient sound detected by directional microphones embedded in a brooch. This object signals deafness to others and crucial sound events to the wearer.

Fig. 2. Bobby pin, armband and 3D shape-change necklace

- An armband that translates different sonic qualities of the ambient environment, including range, volume and direction into vibrations.
- A 3D shape-change necklace that expressively enacts live or recorded sounds, translating the sounds into physical expression.

These prototypes were a vehicle for materialising questions and creating a common ground that resonated with design inquiry and human-centred research. In this activity of thinking-through-making [12] participants designed solutions which inspired one another in an incremental generation of forms and interaction behaviours.

3.1 In-depth Interview

Low-fi prototypes developed during the co-design session were incrementally refined toward the development of working prototypes. Some of them were abandoned, some others were transformed. For example, the bobby pin was not developed further since it created interferences with the hearing aid; the brooches were not implemented as single accessories since the microphone was embedded in the necklace. The design team decided to concentrate on refining the necklace and developed other accessories like a ring with embedded LEDs that light up to represent the frequency of incoming sounds.

A new and more advanced jewellery collection was exhibited at the 2017 Florence Biennale of Contemporary Art. This included a necklace, a ring and a number of interactive single modules which could be assembled to encourage visitors to envision scenarios of use and provide us with additional feedback. Several people with hearing impairment visited the stand. A deaf lady with a cochlear implant accepted to be interviewed. The interview took about 1 h and was video recorded. The lady said that hearing loss shouldn't define people in any negative way, making them stupid or disengaged. *"I think that Quietude would help because, when you think of hearing loss, you don't think of fun, you don't think of pretty. You think of ugly. And I wanna change that. I don't like that….So, this is what I like about Quietude. It infuses hearing loss with something friendly and something beautiful. If my hearing loss were to be visible, well - the beauty of what you're doing is that you're making it visible from a beautiful and fun way. And that's what I love."* Another theme concerned communication and the quality of hearing. *"I think people with hearing loss want to be able to hear. They want to be able to communicate, they want to be a part of... the world!"…. "I really, really hear wrong. In fact, if you're in the hearing world, you're in the hearing world. If you're deaf, you can communicate by signing. If you're having hearing loss, you're*

kind of in between: not really in the heart hearing world because you don't hear perfectly, but you're not in the deaf world, because you don't know how to sign…. And there's a big difference between people who are deaf and cochlea implants…… (pointing at her implant) *"So, this is a processor. Every cochlea implant is a surgical procedure. This is a magnet, on the inside of my skull there's another magnet, which connects and the inside magnet is attached to the electrons that go over my cochlea. And it's an electrical, it's, it's electronic. I'm actually a computer… You see in cochlea implants you hear electronically, you don't hear acoustically".*

The lady suggested to define our target community in a clearer way, adapting the jewellery system to the different needs of deaf people and people with different levels of hearing impairment. People with hearing loss live in the hearing world. They use hearing aids or cochlear implants or assistive listening devices. Sometimes the hearing devices do not allow a clear comprehension of sound, e.g. it might be difficult for some people to distinguish between the door bell and the interphone at home. Our jewels could support people with hearing impairment providing means to tag sounds of interest whose occurrence could be notified by the jewellery system through vibrations, light, or kinetic modifications. On the other hand, deaf people have little or no comprehension of words and generally communicate with sign language. Our system could support their curiosity about sounds, letting them to experiment with sound through other senses, like touch and sight.

4 Jewellery System Design

Building upon the new input, our design process evolved with additional prototyping sessions and participatory design activities. From the feedback received at Florence Biennale, we started improving our jewels by introducing new features. The accessories were designed as a modular system which can be configured in different forms and on-body use.

The modules embed sensors and actuators allowing self-actuation and kinetic modifications in presence of particular sounds. The system's behaviour can be defined and fine-tuned through a smart phone app that works with the accessories. The app allows personalisation of both input and output, and the construction of a personal library of sounds that can be monitored for and replayed on demand through the accessories.

The concept design phase was inspired by a powerful metaphor that emerged during the initial inspirational workshop. One of the participants used the expression "feeling under water" to describe deafness as a hushed feeling of the perception of sound. Coherently with this metaphor, the suite of jewels was inspired by the sea world. The modules resemble sea-urchin shells and the palette of colours reflects images of sand, deep ocean and coral. The jewels were conceived as modular structures which can be assembled to create personal jewels. Modularity addresses the need emerged during the workshop of placing and playing out the jewellery on parts of the body which are more sensitive to vibrations and micro-movements.

Modules are realized using laser cut regenerated leather, felt or fabric petals which are folded and sewed to create a shell-like shape. The jewellery system was assembled

in a craftsmanship way: modules were sewn by hand, connectors were fabricated recycling flat connectors of obsolete computers, and most of all no glue or binders were used. An innovative design was studied to connect the modules through 3D printed interlocked supports. The electronic components are placed in an octagonal shaped PCB that keeps the modules fixed and stable in horizontal position. Some modules contain electronic boards and sensors (e.g. the Bluetooth communication board and the microphone), some others contain actuators (e.g. LEDs, servo-motors, vibration motors), some other are empty and are used to enrich the aesthetics of the system. This modular system allows the creation of a variety of fashionable jewellery including necklaces, armbands, brooches etc.. We developed three necklaces with different behaviours: kinetic transformations, light patterns and vibrations (see Fig. 3).

Fig. 3. 3D shape-change fabric modules (left), felt necklace with light patterns (center), regenerated leather necklace with vibration (right).

The jewels sense sounds in two modalities: in real time continuous monitoring, to notify the wearer of the frequencies and the amplitudes of surrounding sounds; at the occurrence of specific sounds defined by the wearer through the mobile app.

The 3D shape-change necklace provides micro-movements in response to external sounds, whilst the necklace embedding LEDs and the one with vibration motor use light patterns and vibration respectively to represent incoming sounds. The actuators embedded in the three necklaces are directly mapped to the intensity and amplitude of incoming sounds.

The design of the 3D shape-change necklace was probably the most complex. Shape-change modules contain a servo motor that changes the orientation of the petals bending them towards the lower center of the module.

The combination of the micro-movements of the petals of different modules results in a coordinate and expressive movement of the overall structure. Incoming sounds are filtered by a bandpass filter to detect their intensity and amplitude.

The system detects three frequency bands each one actuating micro-movements of a module. The same implementation is used also for the other two necklaces, which differ only for the type of actuators used to represent incoming. This solution allows to create a rich and expressive behaviour of the necklaces representing nuanced qualities

of sounds. Several tests were made in indoor/outdoor, public and private contexts to identify the most significant frequencies to detect. After testing, we decided to use low-mid, mid, and high-mid frequency bandpass filters. We decided not to filter low and high frequencies because, in real contexts, theses frequencies rarely occur.

The jewellery system is connected to a smartphone application (see Fig. 4) which allows personalisation of sound recognition in input and kinetic transformation and shape change in output.

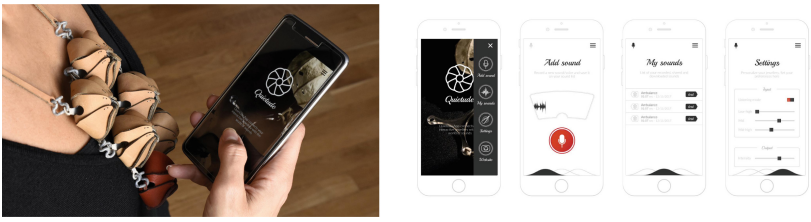

Fig. 4. Smartphone app.

Key features of the application are the management of the kinetic, light or vibration output on the basis of a comprehensive sound recognition process; and the setting up of a personal library of sounds. The user can create a library of sounds by recording personal meaningful sounds through the microphone embedded in the jewels. Afterwards, sounds are labelled and stored in the app to allow real time sound monitoring and on demand playback.

5 Experimenting with Experienciable Prototypes

The three necklaces were presented in a public event. About 50 deaf people attended the presentation and some of them tried out the prototypes in body storming scenarios.

Some people pretended to dance in a disco following the light patterns emitted by the necklace. Other participants envisioned scenarios at home or in the car where sounds like the doorbell or the horn where notified through vibrations. A deaf lady was fascinated about the behaviour of the jewels. She was amazed to see and feel her voice through the necklaces and tried out the system several times having fun.

The vibrating necklace was the most appreciated and the most personalised since people showed very different sensitivity to vibration. The app was considered extremely simple to use and easy to manage.

The aesthetics of the accessories was recognised as a paradigm shift in the design of hearing aids. Fun and beauty were considered a way to dignify deafness and a step forward in overcoming the stigma of disability.

Other experiments were conducted with 4 hearing impaired persons and an Italian sign language interpreter to understand how the jewels can expressively enact live or recorded sounds through cross-modal associations with light and vibration patterns [13]. 6 short scenarios were presented to the participants, each one depicting a story

containing a particular sound (alarm, ambulance, home appliance, policeman whistle, doorbell, car horn). The sounds selected as stimuli were defined during interviews with deaf women who identified the most useful sounds to be notified in indoor and outdoor daily life situations. The association between sounds and light/vibration patterns was implemented following Harrison et al. [14] who assessed potential expressive forms in which information might be conveyed.

Just after reading story, the deaf women were invited to watch three different light patterns and to associate one of them to the sound described in the scenario. The procedure was repeated with the vibration patterns. The scenarios were randomised as well as the light patterns. At the end of each session, an in-depth interview was conducted to collect qualitative comments.

The most recognised light patterns were the alarm, the doorbell and the car horn. 1 person correctly associated all patterns, 2 persons answered correctly 4 (alarm, doorbell and car horn and ambulance) and 3 (alarm, doorbell and car horn) times respectively and 1 person found the task very difficult.

The association between light patterns and sound types was considered interesting to explore and potentially effective to use. The ladies, including the one who found the association task difficult to perform during the experiment, felt confident to be able to learn the correct associations between light patterns and sounds after a training period. The app can help in this respect.

The most recognised vibration patterns was the home appliance which was recognised by all persons. The alarm, the ambulance, the car horn and the police whistle were recognised by 3 over 4 persons. The doorbell was recognised by 2 over 3 persons.

During the post-test interviews, participants agreed to consider the vibration patterns easier to understand than light patterns. Vibration was considered more discrete and comfortable even if it should be customisable since the intensity we set was considered a bit invasive. People would prefer a subtler vibration corresponding to incoming sounds that could not be detected otherwise.

The light behaviour was considered less practical in everyday life situations but suitable as a “public display” for environmental sound awareness. For example, in transit centres, people heading in myriad directions, with varied intentions, may be unexpectedly influenced at any moment by varied factors to which they must constantly attend. A deaf person can overlook the challenges that a hearing person might be experiencing due to distracting noises in this kind of scenarios. Social situations can bring a minefield of challenges.

Further experiments with deaf persons regarding the 3D shape-change necklace, as well as the design of cross-modal associations between sounds and other sensorial modalities than hearing are ongoing. The current version of the jewellery system offers a versatile platform to experiment with and engage deaf people in envisioning a more sustainable future.

6 Reflections and Lesson Learnt

Disability has its own stigma, pervasive in every society, which generates profound social barriers. One of the goals of Quietude is to contribute to mitigate the stigma of hearing loss by leveraging in ethic and aesthetics.

Participatory design was adopted to explore our vision about disability considered as an opportunity for design rather than a problem to solve and confront it with the real experience of people with disability. The design team promoted the project to develop aesthetically sophisticated objects that draw inspiration from deaf women's personal experiences; acknowledging that personal expression, visibility and discretion can be intertwined.

The approach is a combination of design research, participatory design and making, which employs rational judgments and empathic concerns with the goal of creating prototypes that clearly communicates the research contribution. The project demonstrated that disability can enlarge our vision of human variation and difference and can put forward new perspectives for design.

Our prototypes have been constantly imagined, assessed, improved, and enriched together with the deaf women [13]. Their responses to the prototypes were multilayered and insightful. There were slight differences in each person's perceptions to the jewels, but each individual expressed a perceived resonance with demand a common appreciation of the importance of supporting the need of beauty and individual style that any person, including hearing impaired persons, has when accessorizing and clothing the body.

Working closely with deaf women we learnt that technologies should be experiential and respectful [15], that is they have to respectfully address all human skills, including the social ones through rich, natural, and meaningful interaction possibilities. This vision requires societal, cultural and aesthetic sensitivity to be achieved [11]. Medical aids can be elegant and smart to wear as any other accessory which adorns our body, so to minimize the social stigma.

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References

1. Quietude: www.quietude.it. Accessed 28 June 2018
2. Pullin, G.: Design Meets Disability. The MIT Press, Cambridge (2009)
3. Norman Donald: http://www.jnd.org/dn.mss/design_meets_disability.html. Accessed 28 June 2018
4. Cherney, J.: Deaf culture and the cochlear implant debate: cyborg politics and the identity of people with disabilities. Argum. Advocacy **36**, 22–34 (1999)
5. Vibeat: http://www.designindaba.com/articles/creative-work/wearables-helping-deaf-feel-beat. Accessed 14 Apr 2018

6. Vest: https://www.redbull.com/us-en/neosensory-vest-interview. Accessed 28 June 2018
7. Cute Circuit's Sound-Shirt: http://cutecircuit.com/soundshirt/. Accessed 28 June 2018
8. VibroHear: http://www.abledata.com/product/vibrohear. Accessed 28 June 2018
9. Music for Deaf People: https://www.fastcompany.com/1653578/how-collar-could-help-deaf-people-hear-music. Accessed 28 June 2018
10. Bjerknes, G., Ehn, P., Kyng, M., Nygaard, K.: Computers and Democracy: A Scandinavian Challenge. Avebury, Farnham (1987)
11. Wilde, D., Marti, P.: Exploring aesthetic enhancement of wearable technologies for deaf women. In: 13th ACM SIGCHI Conference Proceedings Designing Interactive System. ACM, Hong Kong (2018)
12. Ingold, T.: Making: Anthropology, Archaeology, Art and Architecture. Routledge, London (2013). ISBN 978-0-415-36723-7
13. Marti, P., Iacono, I., Tittarelli, M.: Experiencing sound through interactive jewellery and fashion accessories. In: Bagnara, S., Tartaglia, R., Albolino, S., Alexander, T., Fujita, Y. (eds.) IEA 2018. AISC, vol. 824, pp. 1382–1391. Springer, Cham (2019). https://doi.org/10.1007/978-3-319-96071-5_140
14. Harrison, C., Horstman, J., Hsieh, G., Hudson, S.: Unlocking the expressivity of point lights. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Austin, Texas, USA (2012)
15. Overbeeke, C.J., Djajadiningrat, J.P., Wensveen, S.A.G., Hummels, C.C.M.: Experiential and respectful. In: International Proceedings on Proceedings of the International Conference 'Useful and Critical'. UIAH1999, Helsinki (1999)