Adding value to research and technology through integration of artists in projects and synergy creation between creative industries, entrepreneurs, researchers and arts

STARTS Residency Public Report
Magic Lining

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The artwork is about changing one's self and body perception through the insight of the garment one wears. It is about shifting fashion paradigms from external to internal, and proposing a novel haptic outfit. The work builds on the scientific project *MAGIC SHOES*, and exploits the emerging e-textile materials for achieving it. The project alternates between scientific research and artistic ideation with prototyping. During the residency the artistic partner of the project spent 2 intense periods of 2 weeks in the host institution *Universidad Carlos III de Madrid* in Spain and distributed time collaborating with *Tallinn University Human-Computer-Interaction Group* as well as smart textile studio *Spell*. The residency has contributed to both, the artistic and scientific parties greatly. From the artistic perspective the concept developed much further by the knowledge and methods inserted by the scientists. The idealistic idea gathered some actual grounds. From the scientific project point of view, the artist brought in an alternative way of working, as well as new directions to explore further later on. The results of the residency have been presented in various international exhibitions and conferences, talks as well as in one scientific paper published in an international scientific conference. One other scientific paper co-authored by all project partners has been submitted to a high-impact international scientific conference and is currently under review. The project contributes new knowledge to the developing trend of art-science relationships. *Magic Lining* project goes on after the closing of the project, to explore further the notion of changing one's body perception and behavior from the garment's inside.

Haptic clothing, smart textiles, e-textiles, self perception, body perception, multisensory perception, vibration, fashion.

*The paper is partially based on a submission to CHI2019 titled "**Magic Lining:** Altering One's Body-perception Through E-Textiles" (Therefore we ask this document not to be published before January 2019)

I. INTRODUCTION

Technologies change our perception of reality moving towards augmentation and enrichment of sensory inputs, including one's own body and its capabilities. For instance, an ongoing research exploits recent findings that sensory feedback related to one's body can be used to alter body-perception [1-8, 9-10,11-14, 16-18, 20-21] and investigates the use of such feedback in technologies aimed to facilitate positive changes in body-perception, and the tightly linked emotional state [15] and motor behavior [6]. The final aim of this research is to facilitate exercise adherence highlighting potential opportunities for health, sports, rehabilitation, virtual reality or gaming.

Being a forerunner of potential future products that would be going beyond current applications like smart shoes [19], our MAGIC SHOES research team applied to be a part of the VERTIGO STARTS art-science residencies project where a scientific project is paired with an artist

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forming a unified team from a very early stage of research and development.

Our artistic team member has been working for years in the space of changing people's behavior through textile design solutions. Now, the VERTIGO STARTS collaboration brought this quest to another level by building on a scientifically grounded research. What kind of a body feeling a wearer would prefer? How to create a sensation of air, water or other perceived substance flowing inside of one's body, instead of one's mundane sensation of body motion using MAGIC SHOES research project insights and technological tools (e.g., sonification)? And what other body sensations would appear with these changes in close-to-the-body design?

Figure 1. Altering one's body-perception through e-textiles. This figure represents our concept. Sensory-feedback integrated in the inner part of the garment changes the perceived body "material", impacting on body-perception.

While the outer layer of the garment or textile is meant for being exposed to the world outside of ourselves, there is also the inner, very intimate and hidden side of each textile/material. It exists only for the wearer, and it is in a constant touch with our body. It is similar to the notion of having different body images for "self" and for the others. We might dress ourselves up to play a certain role or to fit into a context. Clothing influences the way we behave in social situations, representing a public image of oneself and reinforcing an individual's self-concept and self-confidence [23]. In addition to the "enclothed cognition" [22] that primarily focuses on the symbolic meaning and the physical experience of wearing the clothes, Magic Lining art-science project explores the opportunities for embodied cognition [27-29] by applying body-centred design principles [26].

It is an illuminating experience for an artist to find supporting empirical data to the hypothetical artistic idea. The presented work builds on the Research through Design approach [24] in combination with neuroscientifically-grounded user studies that use questionnaires, interviews and behavioral methods to assess body-perception [1-8, 9-10,11-14, 16-18, 20-21]. At the intersection of neuroscience research on mental body-representation (MBR), human-computer interaction (HCI) and real-life smart textile applications, our work presents relations between tactile material sensations and a person's body-perception.

II. ARTWORK

The artwork's contribution is two-fold. On one hand we present a series of prototypes that allow the public to experience the sensations that are similar to being a cloud, water, or rocks. Those have been used as part of the process of understanding the relationship between the material and the wearer, vibration movement patterns and sensations. The prototypes have acted as carreiages of the knowledge within the project. On the other hand we present a final piece – a haptic dress – *Magic Lining*. This allows the public to imagine how such clothing could look and be worn. With the artwork we look into changing one's body-perception and self-perception through the inside of their clothing. We invite people to feel as if they are made of a different material than usual. They could feel as a cloud, water or rocks. But we also ask questions, such as how to present and experience such haptic fashion? It is not only for the eyes or ears. The wearable sensations really need to be experienced. We try to convey the feeling through photos and video. How to express the sensation of feeling like a cloud, water, or rocks to people that are not wearing the dress but only observing to someone else wearing it? Except from the performer's face, there doesn't seem to be any visual cue that the viewer could read. Similarly, it would be impossible to present such piece on a fashion catwalk as a new trend, as it would be impossible to understand what the model feels while "wearing the sensations".

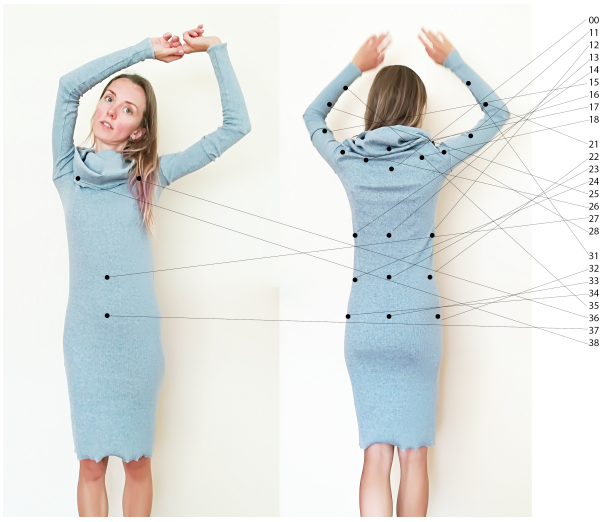

Figure 13: The vibration motor positioning on the final prototype - a tubular haptic dress. Video of the final piece: https://tinyurl.com/magiclining

III. METHODOLOGY

We followed an iterative design process intertwined with two user studies with two different prototypes on the

effects on body-perception of various vibration patterns within textile (spatial haptic metaphors), all leading to the production of a full piece of garment where vibration patterns and materials alter body-perception (Figure 1). The work presented here has woven together artistic expression with scientific knowledge and resulted in valuable insights for both communities.

IV. CO-CREATION PROCESS

From the perspective of transdisciplinary collaboration, we all had a number of observations. First, in terms of expectations, both artistic and scientific parties wanted to experience a shift in perspective, thinking out of the box, cross-pollination between areas of expertise. And both sides experienced that. Following approaches from scientific practice gave structure to the artistic practice, and vice versa the artistic approach allowed moments of insightful "chaos" to the scientific project.

Second, in terms of the things that could be done differently, the part of learning from each other was certainly crucial. Spending time together and achieving common understanding and language was very important for moving forward, and sometimes too short. We would definitely be interested in the opposite exchange as well: scientific residency outside the research lab. Being in the studio of our artistic team member was very inspiring. Many ideas were conceived that would need additional time to be realized.

Third, in terms of co-creation process, the collaboration was very fruitful and inspiring, leading to understanding that a common co-creation space would be a plus. Certainly having an iterative chain of designing, making a prototype and testing it using quantitative research methods with participants allowed us to move fast in a solid manner.

Fourth, from the perspective of the best moments of the collaboration, seeing the realization of an idea, being right about your prediction or even discovering something unpredicted was definitely one of such moments. Other memorable moments are those where your way of thinking is challenged and at the end you understand that other way is possible, and sometimes, even more interesting.

V. IMPACT

The empirical results from testing Prototypes 1 and 2 show that various haptic metaphors induced using vibrotactile patterns are possible, in other words, one can *wear* different sensations using e-textile. Contraction/expansion patterns could be used to alter the perception of body posture, size or weigh among other properties (Prototype 1). Importantly, the material of inner garment itself interacts with the vibrotactile patterns (Prototype 2) and therefore should be taken into account when designing for haptic clothing.

Since the vibrations delivered via textile are still relatively novel, one should take into account the surprise factor and also the habituation factor that is common with tactile actuators (both mechanical and electrical). Hence, a long-term usage of this wearable technology still has to be studied. However, the use of haptic metaphors as tactile icons or tactons could be very effective given specificity of somatosensory stimuli and its role in flight-fight type of reflexes. The somaesthetics research domain and applications related to designing for various bodily experiences, like Soma Carpet, will certainly benefit from our findings [30, 31]. Importantly, as advertised by *Teslasuit*, the personalization of patterns is probably the key of such haptic clothing.

Throughout the process we discovered, similarly to Satomi and Perner-Wilson [26], that e-textiles development can be very tailored. Every project is a new invention, using the knowledge from previous work, but always solving new challenges in new ways. Working with a performer for the final piece confirms exactly that. Not only needs the garment fit her body, and movement desires. The dress has to trigger sensations pleasant or inspiring to her. Everything from the physical garment to the placement of the vibration motor arrays, to the programming has to be tailored for the specific use and user.

The work makes us wonder about the fashion of the future. Is it something that has to be "experienced" rather than seen? How would the future catwalk be like? Could we instead of wearing the newest cuts and patterns of famous fashion designers, *wear* the emotions they design instead? And could we download the desired emotions or feelings directly to our second skin?

VI. FUTURE DIRECTION AND ACTIONS

From the perspective of the future work, we have a number of directions that deserve exploration.

First, multisensory prototypes where vibrotactile stimulation is paired with sound (or other sensory feedback) is a very promising direction where auditory-haptic metaphors could be more easily created using minimalistic tactile stimulation (e.g., filling-in effects as in [32] and references therein). Another multisensory pairing could be related to chemosensing and chemosignalling [33];

Second, our prototypes were only used for delivering sensations; however, closed-loop bio- or neurofeedback systems could be possible. For example, in the recent project *Bisensorial*, a neuroadaptive vibroacoustic therapeutic device used music and vibrotactile stimuli applied to the user's back to induce desired mental states [34];

Third, while the haptic clothing is a personal device, using this in social settings and combining it with other sensors (e.g., a magnetic compass in [35]) creates countless possibilities for different social interaction scenarios, from passive like in a new type of cinema, to active, as in a participatory theatre.

VII. CONCLUSION

The work has benefited and inspired both, our artistic as well as scientific partners. We have presented the process and results internationally: World Usability Day (WUD) Tallin 2018 (three talks – one art/design talk and two science talks - and a two-day workshop), Tallinn Creative Incubator (talk and demo), 5th International Conference on Movement and Computing (demo and paper), Textile Futures seminar (talk), Centre Pompidou, and CHI Conference on Human Factors in Computing Systems (one paper under review) and received interest for it. We see great potential in carrying the work further.

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