WEARABLES
as medium of expression between bodies

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This thesis introduces the exploration of making wearables as a collaborative expression between a performer and a participant in a performative participatory installation. With a phenomenological view on our embodied experience with technology, the methodological approach is program/experiment dialectics, mixing experiments in the lab with exploration in the field. The thesis introduces the full process, the program and experiments where the perception (the embodied interaction with the materials and the context) of the designer/researcher and participants has been a great resource of the iterative process of creating the prototype from sketching in digital material, to prototyping and testing. From the making of the final prototype it is concluded that, the participant and performer express shared movement as the performance is constituted by both technology and human agency - both wearable and body acts - in the interaction between interpretation, body, and experience on the one side, and concept, wearable, and technology on the other. As a methodological knowledge contribution it is stated that program/experiment dialectics is a generous space, allowing elements from several other methods, non linearity, and intuition, to be part of the process, where researcher (and participants) are phenomenologists. Phenomenology in interaction design is an attribution to research through design as a method that allows room for active participation of the lived body in different stages of the design process - a development of the notion of embodiment beyond situatedness - acknowledging the interplay between bodies and technology, that users, artifacts, and contexts influence, touch, and touch back each other.
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1. INTRODUCTION

By its very nature, wearable computing evokes a visceral response, and will likely fundamentally change the way in which people live and interact. In the future, devices that capture our lifelong memories, and share them in real-time, will be commonplace and worn continuously... (Mann 2013, p. 23.8.3).

The field of wearables is blurry and undefined. There is no clear definition. The term covers everything from an everyday object like the smartphone to smart clothing in which fashion merge with technology, to medical devices, and artistic media art pieces. Wearables are embedded in, and produce knowledge and interactions with, the world, and it indeed also make the world.

Steve Mann, described as founding father of wearables, has been inventing, designing, building, and wearing computers for more than 30 years (Mann 2001). He describes the field of wearable computing as more than, and beyond, smart clothing. He uses the term “Body-Borne Computing” and “Bearable Computing”, and thereby include all manner of technology on or in the body: implantable devices and portable devices (Mann 2013).

Where everyday wearables like smartphones and other portable devices could be considered to be contributions to increase physical distance between people with a focus on verbal communication at the detriment of communication using the whole body, artistic wearables can contribute with embodiment and physical connection between bodies fighting the amplification of physical detachment (Berzowska 2005).

Mann stresses that the distinction between wearable computers and portable computers (smartphones, handheld, and laptop computers) is that the goal of wearable computing is to position or contextualize the computer in such a way that the human and computer are inextricably intertwined. In this sense, wearable computing can be defined as an embodiment of, or an attempt to embody, Humanistic Intelligence. In the field of Human-Computer Interaction (HCI) the tradition is to think of, and separate, the human and the computer as different entities that interact. In Humanistic Intelligence theory, the wearer and the computer, with its associated input and output facilities, are not seen as separate entities, but here the computer is regarded as a second brain and its sensory modalities as additional senses, in which synthetic synesthesia merges with the wearer's senses (Mann 2001).

Where Mann stresses the individual body merging with the machine, I second Berzowska, who considers wearables as a way of connecting bodies. To me wearables aren’t just a second brain merging with one wearer’s senses, but possible second skins, when the data is lived on, by, and with the body, as translators, interpreters, sensors and vehicles. This happens as the translation occurs from the body, through the machine and is received by another body. Wearables are an intimate integration of human and nonhuman actors (Lamontagne 2010), where users, context, and artifact affect each other and possible merge, as an integration of bodies and technology.

For wearables to function as an integration of bodies and technology, a user interaction, or a threshold for the interaction to begin is a necessity. Therefore a wearable computer typically has an output device that the user can sense, and an input device with which to communicate explicitly with the computer (Mann 2013).
2. RESEARCH FOCUS & PROBLEM DOMAIN

With offset in wearables, my goal is to explore a collaborative expression between performer and participant, and between body and technology within a performative participatory installation. The area of investigation can be divided into three: user, artifact, and context:

1. **User:** Performer and participant.
2. **Artifact:** Wearables made in an exploration of materials through prototypes & experiments.
3. **Context:** Performative participatory installation.

### 2.1 Research question

How can material exploration, through prototyping and experiments, lead to wearables designed as a collaborative expression between performer and participant in a performative participatory installation?

### 2.2 Wearables

The development in the area of wearables is mainly more accessible technology. From the controlled conditions of the traditional scientific experiments taking place in a lab-like setting, technology is now embedded into our daily life. We carry around tracking technologies like the GPS to facilitate embodied interaction in the real world. Technology gets smaller and more and more handheld, and our access to technology, free and open software, hacker culture, and DIY culture, gives us unlimited access to knowledge.

The majority of research done in the field of wearables has been done in the lab, in life, work, and field during the last 40 years. Due to the rapid development of small, integrated processors, computers today can be embedded into traditional everyday objects (Moen 2007). Embedded platforms like Arduino, RFIDs, sensors, actuators and mobile devices, things that can act upon, measure, or provide services based on real-world entities (Hachem, Teixeira & Issarny 2011) - they all enable miniaturized, embedded, wireless, computers to be worn on, and warmed by, the body, enhancing the ability to transport, store, communicate, and modify personal data (Kozel 2007).

Where constructing the technical side of wearables used to be a laborious process that required considerable breadth and depth of expertise in programming and electronics, in the realm of free and open software, hacker culture, and DIY culture, today, there are many systems that aim to make working with hardware easier (Kaufmann & Buechley 2010). The advent of novel materials and various toolkits enables novices to design and build their own wearables without desktop applications. E.g. the LilyPad Arduino, a fabric based construction kit to design and build soft wearables and other textile artifacts. The LilyPad represents a good example of novel directions in the creativity expansion in tradition of technology and interaction design (Buechley et al. 2008).

The challenges in wearables still evolve around usability issues such as weight, volume, and power consumption (Cuartielles et al. 2013), but as technology today is more robust the focus is also more and more on expression and aesthetic e.g. tactile and intimacy with garments, as the field of wearables spreads from media art to fashion, entertainment, and every day life.
2.3 Wearables as expression

Wearable computers shape the way in which the world is experienced because, in one way or another, they mediate the wearers’ engagement with the world, arguably more intimately than ever before (Ana Viseu 2003, p. 22).

The increasing mobile and participatory public favor performative and interventionist practices over traditional art object, as barriers between functionality and aesthetics possible break down (Ryan 2009).

Besides the technological aspect and accessibility, another area of investigation is a deeper understanding of how the user, the context, and the artifact affect each other. The notions of situatedness are interesting to explore as the attributes; user, context, and artifact often merge. There is an increasing interest in exploring new focus areas of computing and interaction; emotional, embodied, aesthetic, physical, pervasive, ubiquitous, and tangible. In the area of artistic wearables, these terms intertwine in the embodied experience of wearing technology: the individual emotional experience of being a wearer, the aesthetic and physical materiality of the artifact, and the potential pervasive and ubiquitous experience; they all influence the whole embodied experience of the integration of bodies and technology.

We carry around technology, wear it on our skin, and weave it into our clothes. Computing is incorporated intimately into our daily life and experiences, as we live with, and through our technologies (Hansen & Kozel 2007). This highlights the need to consider, not just the cognitive, intellectual, and rational, but also the emotional and phenomenological aspects of our embodied experience with technology.

Expression can be anything from verbal expression to bodily expression and emotions, communicating our mood, identity and state of mind. The broad range of anger to boredom, and from intimacy to pragmatism, can be expressed in a word, a movement, or a facial expression. Goffmann makes a distinction between expressions given and expressions given off, both are related to modes of communication, the first is the concrete, intended, and conscious form of expression; verbal communication, and the second is the non-verbal presumed unintentional communication (Goffmann 1959). I use the word expression in the sense of a creative and personal way to express one self, related to our emotions, mood, and bodies’ movement.

Expression is the manifestation of being a wearer. Like art and music can communicate and express emotions, I explore the bodies as non-digital material that express emotions, mood, and movement in collaboration with the wearables. Whether it is possible to make a shared expression between participant, performer (and artifact) - wearables as mediums of expression - has to do with the fact that bodies and wearable possible merge. The physical expression between two bodies may be synchronized movement or even the experience of expressing something erotic or pleasurable together - but the expression is constituted by the artifact; bodies and wearables communicating a collaborative expression.

Technology, bodies, and the social are intertwined in wearables. An interactive experience in a performance situation necessitates social interaction between performer and participant. Experiencing a performance is both an individual experience, and an opportunity for cohesion, and the feeling of community between the participant and performer and technology.
2.4 Wearables & performance

By situating the intended use of wearables in a performance situation, with interaction between performer and participant, both input and output are placed on a body, highlighting the focus on a collaborative expression between the two bodies. Furthermore the use situation calls for an understanding of the context, and the way artifact, users and context influence each other.

*Performative installation* refers to the emerging trend of computer-mediated performances that falls between installation and performance. Together with the related *participatory installation* “...they are influential for expanding the narratives and physical scope of the traditional roles for performer and audience...” (Kozel 2007, p. 164). I have combined the two into performative participatory installation, as my use situation will be a performance-like set up, where a performer invites a participant into interactive play.

The interaction with technology can turn an audience from passive spectators to active co-creative participants. Instead of the reductive binary notion of either active or passive, I want to use technology as a medium of expression, supporting the shared experience between two bodies.

Performance art breaks with linear communication in the absence of structure and form. My initial point is that the definition of the experience is related to perception, and embodiment, as well as the context. By placing the testing of the wearables in an artistic performative context: performance participatory installation, the participants are free to create their own meaning, and the action of the participants creates the performative situation.

Marinis (1993) describes movies and television as non-theatrical performances, as opposed to theatrical performance where the physical presence of both sender and receiver takes place simultaneously with the production and communication. The work is produced in the moment and it produces meaning in the room while it is experienced. Performance is thereby constituted by participants, translating, and producing meaning while it is experienced. Performance is a complex socio-political phenomenon, which can be summarized as human action and expressions, mixed with the dynamics of objects and context (Irwin 2008). This could be a description of daily life, but as oppose to everyday interaction between humans, objects, and contexts, performance offers a creative space for transformation where expressive actions are related to an awareness of one self and others, and a freedom to play with different roles of identity, real, and fictional.
3. RELATED WORK

There are numerous examples of wearable-based projects. The agenda and purpose variates from a focus on tangible data output in sport and medicine to a dazzling effect in fashion, a focus on technology and communication, and the more social aspects and phenomenological emotional side to the interaction in media art and performance.

This chapter is divided into three parts: 3.1 The market, 3.2 Technology & performance, and 3.3 Wearables & research. The market, represents a little history and examples of commercial wearables predominantly from the field of cyber sex as it fits an emergent erotic and intimate expression that occurred in my experiments. In Technology and performance I sketch the use of technology in performance art and give examples of work with a focus on the performer/participant relationship, and different notions of performance. And in Wearables and research, I sketch examples of academic research done in the artistic field of wearables.

My work is inspired by all three categories, and I situate my work in the artistic academic research category, which gives me the freedom to explore, experiment, and investigate in a generative and suggestive nature. I do not aim for one perfect solution, ready for commercializing and production. This allows me to focus on the earlier mentioned new focus areas of computing and interaction: the embodied experience of wearing technology.

3.1 The market

Many wearables are centered around technology exploration and (erotic) communication. Steve Mann is living proof of everyday inextricably intertwinedness of human and computer, e.g with his development of Digital Eye Glass Eye Tap, from 1981 to the present.

An early form of wearables is within the field of cyber sex, e.g. Teledildonics, where electronic sex toys are controlled by a computer to reach orgasm (Teledildonics 2013). With offset in the field of electronic sex toys and transmitting stimuli from one person to another, there is Ayah Bdeirs’ Teta Haniya's Secrets (2008), a line of electronic lingerie, inspired by a Syrian tradition where electronic toys are hacked and integrated in panties (Teta Haniya's Secrets n.d), and JennyLC Chowdhury’s Intimate Controllers (2007), an example of touch being used intimately as game controllers, mixing wearables with gaming. The game is played by couples touching each other via embedded sensors placed in boxer shorts and a bra (JennyLC Chowdhury n.d.). The idea has recently been adopted by condom manufacturer Durex, introducing Fundawear, an app that controls underwear (Durex Fundawear 2013).
Yet another example is the company *CuteCircuit*. CuteCircuit is a London based company, they have been making hand made couture dresses with technology since 2004 ([CuteCircuit n.d.](#)). An example of a CuteCircuit project is the *Hug Shirt*, a bluetooth and java enabled telephone device allowing users to exchange physical stimuli over distance - formed as a shirt that receives sensor data from hug pressure, skin temperature, heartbeat rate, and time span of the hugging (Cuartielles et al. 2012).

### 3.2 Technology & performance

The use of analog and digital sensor technology in a performance goes back to the early performance art: Merce Cunningham and John Cage’s *Variations V*, in which photoelectric sensors were used to mark the position of dancers and trigger musical devices (Torpey & Jessop 2009). Today, technology is commonly used in performance. The Danish based performance group Recoil, is known for their use of technology using “technology as an equal and interactive partner to the performing artist…” ([Recoil 2013](#)). Troika Ranch, a New York based company, “creates contemporary, hybrid artworks through an ongoing examination of the moving body and its relationship to technology.” ([Troika Ranch 2013](#)).

Where Recoil and Troika Ranch primarily use tracking technology, the examples of wearables in performance or performative contexts are: *The Ping Body* ([1995](#)), and *Mediated Body Suit* ([Mads Hoby 2010](#)). In the live performance *The Ping Body*, by Australian, Stelarc, the movements of the body’s own nervous system are replaced by an external data system controlled by activity on various internet domains. The data collected trigger muscle stimulators ([V2_events n.d.](#)). The performance is an interesting example of of how to consider the body material.
The Mediated Body Suit, is a suit worn by a performer who engages in social play with a participant. Performer and participant each wear a pair of headphones, and when they touch each other’s bare skin, they hear a complex sound pattern. The sensing has a range of touch values, from a few centimeters, to light touch and full contact (Hobye & Löwgren 2011). The work is an interesting exploration of haptics in a performance context.

Yet another example of an experience within a participatory live-art context is *The bodyweather* performance, where the participants are guided through a series of body-focused experimental stations of different experiences using biofeedback technologies, drawing attention to internal physiological processes though a responsive soundscape (Loke, Khut & Kocaballi 2012).

From the perspective of a wearer e.g. a performer, the experience with technology can expand the body, follow movement, and control sound, light, or visuals. When this is combined with the experience of yet another wearer - a participant, it is not just a one way interaction of control, but rather it is an opportunity of a shared collaborative experience.

### 3.3 Wearables & research

*cyberSM* (1993), by Stahl Stenslie and Kirk Woolford, is a haptic bodysuit where the focus is on the ability to transmit physical stimuli from one participant to the other. The suits are connected over an international telephone line, allowing the users to remotely stimulate each other (Stahl Stenslie n.d.). Stenslie and Woolford’s work is an interactive art piece representing early research of wearables.

Known in the field of soft computing is Joanna Berzowska from XS Labs, a design research studio that focuses on innovation in electronic textiles, reactive garments, and wearable computing (XS Labs intro n.d.). An example of a XS Labs work is the shape-changing garments *The Skorpions*. The garments modulate personal and social space by imposing physical constraints on the body using electronic fabrics,
shape-memory, and mechanical actuators (Skorpions n.d.).

V2_, Institute for the Unstable Media, is an international media laboratory (1994), founded as an artist collective in 1981, with a focus on the relationship and interactions between different media and the relationship between art and scientific disciplines. They have a long practice of presenting, supporting, and (co-) developing wearable technology in collaboration with artists and universities (V2_ research n.d.). Valerie Lamontage has been artist in residence investigating V2_ as a test subject for an ethnography of practices of wearables. She is a digital media artist-designer, theorist, and curator researching techno-artistic frameworks combining human/nonhuman agencies, and furthermore she is the owner and designer at 3lectromode.com, a wearable electronics atelier dedicated to fashion-tech innovation (V2_ Valérie Lamontagne n.d.). An example of her work is *Peau d’Âne* (2005-2008) where dresses transform according to weather readings. The data is sent via XBee communication to embedded microcontrollers and the dresses change and transform in real time (Lamontagne 2013).

Another related work is *whisper[s]* (by Thecla Shiphorst & Susan Kozel), an art research project that was developed in collaboration with v2_lab from 2002 to 2003. *whisper[s]* is an acronym for wearable-handheld-intimate-sensory-personal-expectant-responsive. It is a participatory installation that collects breath and heart rate data from the bodies of participants, and through visualization and sonification techniques, enables participants to interact, interconnect, and interpret their own, and other participants internal data in both playful and responsive ways (Shiphorst & Andersen 2004).
4. METHOD & KNOWLEDGE

My research approach is research through design, with design practice as knowledge production. Through experimental design research – a practice based approach driven by experimentation (Brandt et al. 2011), it will be an explorative process where prototypes and experiments are performed in parallel with reflection, re-conceptualization, and analysis: program/experiment dialectics.

In design research driven by programs and experiments, programs act as a frame and foundation for carrying out a series of design experiments and interventions (Brandt et al. 2011). Redström describes the notion of program/experiment dialectics, as, how the research process unfolds over time, as program and experiments influence, challenge, and transform each other (Redström 2011).

The mutual dependency of program and experiment stems from the programs need for materialization, while experiments need some kind of intention or direction to really work as an experiment in research (Brandt et al. 2011): “We interpret the program through experiments. Through the way we set up the experiment, we present a certain perspective on the program” (Brandt et al. 2011, p. 35).

The purpose of the program, is not to test it, as to prove if it is right or wrong, there will be reflections and analysis upon each experiment I make, but it is rather in the relations between program and experiments that most important knowledge is gained (Brandt et al. 2011). Therefore the frame/program of my research will be suggestive and open for the unexpected depending on the experiments to come alive.

Evaluation of programs and experiments can be evaluated in different ways. From the inside – based on if they succeed in fulfilling their own intentions, and from the outside, based on to what extent they suggest viable changes and alternatives to, or developments of, existing theory and practice (Redström 2011). I will do both. The inside will be represented by my exploration in the lab and field, the development of the wearable, and analysis of the testing will be discussed in relation to the program in chapter 10. Discussion. The outside, will be represented in my use of theory and discussed in chapter 11.

Contribution to knowledge.

Closure or termination of a program relies on time and materials, and how we align research in such restraints (Brandt et al. 2011). When thinking and doing intertwine, as they do when we make things, how things unfold also depend on what works – on what can be done here and now, with the materials of the design situation (Brandt et al. 2011). This illustrates the need to manage materials and the many agendas that influence the process: the people, the material, and the context.

Regarding prototypes, when you work with digital material, there is a range from a simple mock-up made to enact scenarios, to fully functioning detailed technical interactions with the device. Since my investigation area has focus on the digital material driven by experimentation, and due to the time limit of the project, I will not be making fully functioning detailed technologies, but rather iterations of mock up-like prototypes, combining experiments in the lab with explorative design in the field.
5. THE PROCESS

A frame (program) is set up around my research question, and experiments are made to materialize it. By the nature of the dialectics relationship, these will overlap, both thematically and in practice. Experiments and prototyping happens simultaneously, mixing my work in the lab with testing in the field.

The first step is to formulate the program, the intention or direction. The second step is the materialization, realizing the program through experiments. Hence the dialectic relationship between program and experiments, the steps will influence, challenge, and transform each other, and furthermore happen in parallel with reflection, conceptualization, and analysis.

5.1 Program

The frame is my research question: How can material exploration, through prototyping and experiments, lead to wearables designed as a collaborative expression between performer and participant in a performative participatory installation?

Lamontagne describes wearables as constituting a unique potential for an intimate example of human/non-human performativity: “… as the technical and aesthetic raison d’être of wearables is to “do” - to enact some form of change when placed on the body - they constitute a unique potential for a very intimate example of human/nonhuman performativity” (Lamontagne 2012, p. 5-6). Where Lamontagne describes a general change, I wish to explore wearables as a collaborative expression, where wearing wearables transform the bodies into a collaborative expression between bodies and technology.

5.2 Experiments

I will do experiments and exploration of digital materials to wear in a performative situation. The key element is to explore wearables as collaborative expression between two bodies and the technology. The wearables need to fit the body and be pleasurable. The experiments will be made as a digital material exploration in the lab, using the embedded platform Arduino and various input/output solutions.

The notion of lab is inspired by Koskinen, Binder & Redström (2008), where the lab method is referred to as being the mainstream in design research. In the field of technical design it orients from natural science, and within design research it is close to experimental psychology. From observing and identifying what happens to variables changing, to research focusing on perception, emotions, and social skills, the focus is on exemplary processes of inquiry, rather than finalized results (Binder 2007).

The experiments can be divided into two areas of explorations: lab exploration and field exploration. The lab experiments explore input/output solutions, and the form and comfortability of the wearables, considering that they need to fit the body, be pleasurable, light, resilient, and expressive. They are predominantly focused on the technical and material possibilities, performed and tested by myself. The field exploration will be experiments tested in a field (a performative participatory installation situation), where the focus will be on the collaboration between two bodies. The field experiments are described in chapter 7. Exploration in the Lab and 8. Exploration & conceptualization, and the testing part of the experiments in chapter 9. Exploration in the field.
6. INTRODUCTION OF THEORETICAL TERMS

6.1 Research though design

Design-based research compliments methods like ethnographic research and field studies. It enables us to learn more about the real world by changing it, and reflecting on our experiences in understanding problems, design solutions, and procedures (Obrenović 2011). Research through design (RtD) is very similar to action research, both have sequences of iteratively planning, acting and observing, followed by reflection, and furthermore both approaches involve interdisciplinary teams (Zimmerman, Stolterman & Forlizzi 2010). Furthermore exploration of a wide space of potential designs, through sketching, scenarios, narratives or design proposals, is crucial in achieving a good outcome, in the RtD process (Gaver 2012).

Many have challenged the term RtD, looking to position the research approach more formal in relation to theory and design practice. Zimmermann, Stolterman & Forlizzi (2010) discuss the need for a more formal and rigorous research approach, as they find RtD an emerging and unrefined approach. They argue that it is an approach not commonly associated with theory development, and they discuss the need to establish a common ground, an agreed upon method to document the knowledge that emerge from this type of research. They argue the need for critical analysis of theoretical outcomes through analysis and criticism: “Serious critique of theoretical propositions is the first step towards any kind of theoretical synthesis.” (Zimmerman, Stolterman & Forlizzi 2010, p. 317).

Gaver (2012), on the other hand, considers it a risk to make standards as this leads to self-policing - a restrictive of a form of research that he values for its ability to continually and creatively challenge status quo thinking. According to Gaver, the attempt to establish standards for RtD may adopt, or be interpreted in terms of inappropriate “scientific” models of research and theory for the field. He argues that if designers were to change their practices to design for comparison or refutation, they would no longer be doing RtD. As the notion of making falsifiable statements, or arrange tests to refute such statements, runs against the grain of the methodological approach of RtD (Gaver 2012).

To me, it is obvious that RtD is of generative and suggestive nature, rather than it being verifiable through falsification. Research and design cannot be separated. Design is as much a medium and a process as it is a result, and should not be reduced to a theoretical formal rigorous approach. In a practical design process the need to twist and turn methods and theory is essential, and this is the strength in RtD - that it is a flexible interaction between practice and theory. Having said that, criticism is always good: “We need to learn from the role of the critic in more mature design disciplines, and specifically the interplay between creative practice and criticism…” (Löwgren 2007, p. 11). Löwgren (2007) argues that design can lead to knowledge and specifically that interaction design (IxD) can lead to scientific knowledge. Triangulating practice, empirical theoretical, and analytic grounding. Also, I do find the notion of challenging RtD very inspiring, and many have elaborated the term beyond RtD. E.g. Brandt & Binder (2007), who propose the term constructive design research, referring to design research where construction takes the center place and become the key mean in constructing knowledge, and Hobye & Löwgren’s (2011) research through explorative-design, a combination of experimental design in the lab and explorative design in the field.
RtD entangles the relationship between the material and the social aspect, and it reveals how research is done through design, and design through research (Bærenholdt et al. 2010). In my case the social is the particular segment: performer and participant, revealing that the social is not a generic category. A design process is about more than materials and technology. Our embodied interaction with the materials and prototypes becomes part of the process.

6.2 Embodied interaction

Dourish (2001) introduces the term Embodied Interaction in the book *Where the Action Is: The Foundations of Embodied Interaction*. Dourish describes the characteristics of the dominant research directions in the field of HCI dealing with the development of new technology in the area of ubiquitous computing. Dourish divides the research into two fields: tangible computing and social computing. Embodied interaction leads to six design principles. Furthermore he introduces embodiment, not only as a phenomenon of the physical world but also a stance on the social world, through the phenomenologists Husserl’s being-in-the-world and Merleau-Ponty’s elaboration of the role of the body in perception and understanding.

Dourish emphasizes that embodiment is of participative status, as a way of being, rather than a physical property: “Embodied Interaction is the creation, manipulation, and sharing of meaning through engaged interaction with artifacts” (Dourish 2001, p. 126), thereby stressing that embodiment is about the relationship between action and meaning. Where Dourish’s notion of embodiment is limited to an account of situatedness, I intend to further investigate and develop a notion of embodiment by working with bodies and physical expression.

Since 2001, technological development has made phenomenology relevant beyond the “avant-garde” technologies described by Dourish. E.g. the design of everyday technologies are more and more inherently tangible, mobile, social and ubiquitous (mobile phones, social media, and full-body interaction games) (Svanæs 2013).

Descartes’ body-mind split, in the so-called cartesian dualism, has played an important role in the perception of the body and technology, where the body is reduced to a passive object. This is of great opposition to Merleau-Ponty’s term flesh, where the body is a part of the world. The phenomenological perspective stresses that knowledge is based on corporeal lived experience.

6.3 Merleau-Ponty’s phenomenology

In *Interaction Design for and with the Lived Body: Some Implications of Merleau-Ponty’s Phenomenology*, Svanæs (2013) show how core elements of Merleau-Ponty’s phenomenology of perception are relevant for a theory of embodied interaction. His focus is on embodied perception and kinaesthetic creativity. He stresses that all human interaction with digital technology is embodied, in the sense that the technology is physically omnipresent in our everyday lives. Furthermore he relates the discussion of embodied perception and kinaesthetic creativity to how we design for, and design with, the lived body: “The best way to design for the lived body is to design with the lived body. The benefit of designing for the body with the body is that it gives the designer direct access to how the imagined product will feel for the end-user.” (Svanæs, 2013, p. 27-28).
He describes Merleau-Ponty’s perspective, not as a substitute for existing IxD perspectives, but rather, as offering the interaction designer more angles from which to approach the design challenge at hand. The main challenge in planning an IxD project is to allow room for active participation of the lived body (Svanæs, 2013).

According to Merleau-Ponty, philosophers of reflection do not acknowledge the paradoxical condition of all human subjectivity - the fact that we are both part of the world and co-extensive with it - constituting but also constituted. (Reynolds 2004).

In Merleau-Ponty’s two first works, *The structure of Behavior* and *Phenomenology of Perception*, phenomenology becomes a general method for understanding the paradoxical link of the “objective” and the “subjective” dimensions of the perceived world (eds. Diprose & Reynolds 2008), while in his later work, *The Visible and the Invisible*, he calls for a hyper-reflection to express the distance between reflection and the pre-reflective; second order reflection. Including the reversibility of touch and concept of flesh, both are introduced with reference to Husserl (eds. Diprose & Reynolds 2008).

Merleau-Ponty offer examples of the body as a mean of communication, making it clear that a subject-object model of exchange deprives the existential phenomena of their true complexity:

> When I press my two hands together, it is not a matter of two sensations felt together as one perceives two objects placed side by side, but an ambiguous set-up in which both hands can alternate the role of ‘touching’ and being ‘touched’. (Reynolds, 2004: 31).

The reversible reflection is when the body touch a non-human object, this object is not merely an “object” but another fleshy substance that is capable of reversing the present situation and being mobile and even aggressive. So any meaning of the absolute distinction between being in the world as touching and being in the world as touched, deprives the existential phenomena of their complexity (Reynolds 2004).

The experience of the world precedes our reflection of it, as opposed to the traditional philosophy of the reflective (Descartes and Kant) where traces of this experience leads back to its conditions in the activity of consciousness, that thereby becomes the ground from which the world is reconstructed. Phenomenology reverses this priority by recognizing that the world exists prior to any analysis or act of consciousness. Hence the pre-reflective experience that doesn’t detach the subject from the world it experiences (eds. Diprose & Reynolds 2008).

Kozel addresses Merleau-Ponty’s relation of reversibility in relation to digital material: “...I am both subject and object, and am able to be disrupted by attending closely to my embodied experience and impact that others (including digital others) have on me.” (Kozel 2010, p. 211). And furthermore how this affects the role of the designer:

> ...I touch the world, certainly I do when I handle materials in the creative process, and these materials touch me back, challenging my autonomous role as creator of knowledge and bestower of meaning. (Kozel 2010, p. 206).

In Kozel’s book *Closer*, her Merleau-Pontian-inspired approach to bodies and technology emphasizes the role of the pre-reflective and the hyper-reflective loop in the process of phenomenology as an important consideration of bodies and computer technologies. This is important for two reasons: first, as a method to listen and receive information from our bodies, possible through an attempt to access the pre-reflective and this occurs without positioning the naive distinction between body and mind. And secondly, the role...
of the pre-reflective can open a way for understanding the “deep entanglement between reflection and experience, between thinking and making” (Kozel 2007, p. 22-23).

Kozel describes hyper-reflection as *partnerships between thought and action*, exemplified by the act of movement by a dancer, both function through a state of flux (Kozel 2007). Our bodies evolve in a dialogue with a complex physical and social world, e.g. training systems which have informed post-modern dance as based on a conceptualization of the body as an organism in flux (Ed. Carter 1998).

### 6.4 Kinaesthetics, aura, & haptics

Sensorimotor skills and active touch are complex processes that have been explored by researchers over the last few decades (Moussette 2012). Haptic sense and modality comprises a variety of different sensorial channels. It is commonly accepted that the haptic sense encompasses thermoceptive, nociceptive, kinaesthetic, and tactile perception (Moussette 2012):

Kinaesthetics describes the perception of one’s own body motions, through actuator and sensory capabilities of muscles and joints. It leverages proprioception - one’s own conscious and unconscious perception of the forces, torques, movements, relative positions and angles of neighboring parts of the body. Tactition or tactile reception encompasses mechanical interactions with the skin. Tactile perception necessitates direct contact and/or relative motion between the skin and the objects of interest. (Moussette, 2012: 48).

Touch is active acquiring content delivered through movement (Schiphorst 2009). While the field of kinaesthesia is kinetic motion, the proprioception is the sensory faculty of being aware of the position of the limbs. As Merleau-Ponty states, our experience of the world is always grounded in our bodily movement in it. Our kinesthetic sense therefore conditions the manner in which we experience the world in framing our embodied actions, by providing a sense of spatiality and bodily-motor potential in our relation to the physical and socio-cultural world (Fogtmann, Fritsch & Kortbek 2008).

Aura is also viewed as a field, field can be poetic or metaphoric but also literal because the body does emit and exist at the overlapping of electromagnetic fields. In Walter Benjamin’s (1936) concept of aura, a work of art is defined through it’s aura and authenticity, and technical reproductions diminish the aura (exemplified by a picture of a painting). My use of aura is as a field, literal emitted energy and communication between people through technologies.

### 6.5 Use of theoretical terms

To me it is evident that my interaction with the material, my body and memory influence the process of the making. My embodied interaction with the materials and the prototypes, when working with materials (digital as well as non-digital), has a strong phenomenological approach. I touch and I am touched back. Phenomenology thereby plays a big role, both in my exploration and prototyping process in the lab, and in my testing in the field, and in the overall research area: the inherently communication and expression between bodies and technology in wearables.

Besides my relationship with the material, the choice of different input/output devices in the laboratory exploration will be grounded and discussed based on kinaesthetics, aura, and haptics. In the final part of the thesis; *11. Knowledge contribution*, I intend to further develop a notion of embodiment through my work with bodies and physical expression.
7. EXPLORATION IN THE LAB

The digital material exploration in the lab is centered around possible input/output solutions ready to wear in a performative participatory installation by a performer and a participant. The experiments explore input/output solutions, and the form and comfortability of the wearables, considering that they need to fit the body, be pleasurable, light, resilient, and expressive.

The lab experiments are predominantly focused on the technical and material possibilities, performed and tested by myself, these will later be tested in a field exploration where the focus will be on the expression between two bodies. Experiment one to five were executed between the 9th of April and the 10th of May, 2013:

- Experiment one // soft materials
- Experiment two // IR remote vs. capacitive sensing
- Experiment three // possible outputs
- Experiment four // pulse reader as input
- Experiment five // form and materials

The key element is to explore materials for a collaborative expression between two bodies and technology within a performative participatory installation.

In experiment two and three I will explore distance and aura by testing infra red (IR) remote technology vs. capacitive sensing, and different possible outputs. The focus is to explore inputs that enable exploration of proximity, distance, and expression between two bodies. The idea is to place input/output on two bodies: participant and performer. The input side could be an IR sender connected to an Arduino board placed on a participant, and the output an IR receiver connected to an Arduino board worn by a performer. Experiment four is exploration of an alternative input - a pulse reader. In experiment one and five I will explore form and materials, the wearables need to fit the body, and be pleasurable and easy to move around in.

Moreover as prototyping is both method and object of research, I have been exploring different digital labs. I have worked at Digital Design Lab at Aarhus University, Connectivity Lab at Medea in Malmö, Illutron collaborative interactive art studio in Copenhagen, and my living room turned into a workspace. I will get back to a discussion on how the environment, the social, and different materials influence and inspire the process of prototyping and exploration in chapter 7.6 Different work labs.

7.1 Experiment one // soft materials
The first experiment was done at the Digital Design Lab at Aarhus University, during the SImDeR conference, I attended a workshop about materials for physical interaction. We worked in teams of two, I did a prototype in collaboration with Marie-Louise Wagner (Digital Design student at Aarhus University). It’s a simple sleeve wearable made out of felt and conductive yarn, when you squeeze the yarn a RGB LED changes color. This experiment functioned as a kickoff to consider more comfortable materials, and the beginning of the materialization of the program.

7.2 Experiment two //IR vs. Capsense

Distance and aura is very interesting as communication and expression between two bodies. Aura has a mystical caressing sense to it, and distance can be experienced as a play with the intimate personal space. Both could be described as proximity exploration, and as channels of communication that invite both intimacy and potential invasiveness.

The IR remote technology works really well for triggering input/output between two bodies, and it is quite easy to control the distance via different size resistors (tested with the sketch examples IRrecvDemo and IRsendDemo from the Arduino library IRremote). Aura by capacitive sense works through fabric (leather in my testing), but it is tricky as it gets stable by being electrically grounded. The capacitiveSensor library function by turning two or more Arduino pins into a capacitive sensor, which can sense the electrical capitance of the human body (Playground Arduino n.d.). But when the ground wire is not electrical grounded, the data from the electrical capacitance of the human body is too unstable to use as output. And being dependent of a wire grounded is obviously not an option in wearables (tested
with the sketch CapSense from the Arduino library CapSense). The result of the experiment was to use IR remote technology as proximity between two people, and the next step to explore possible outputs for this.

### 7.3 Experiment three //possible outputs

- **Goals:** Exploring different outputs: sound, light, and text.
- **Location:** Connectivity lab, my living room, & Illutron.
- **Participants:** Me (also present at the Connectivity lab: other students, and at Illutron: other working members).
- **Materials:** LEDs, old headphones, display, electronics, Arduino boards, Arduino sketches, computer, leather glove, leather boots, sewing machine, & soldering iron.
- **Results:** Outputs were too simple.
- **Next step:** Combine input/output.
- **Contribution to program:** Data as choreography.

The idea was to make different outputs that could work with the IR remote technology and the capacitive sense as input (now only IR remote technology). I constructed a glove with a speaker inside, made a sleeve with blinking LEDs, and a wristband with text on a display.

**Sound**

The idea of the glove with the speaker was as replacement of a headset as output for sound. It could be placed on the performers hand, who would then take her hand to the participants ear and thereby a play across the senses of hearing and touch, and potentially a personal emotional connection between participant and performer.
Text
Text on a display, placed around the wrist. When a participant gets close to a performer, it would trigger a text message in the wristband.

![Image of text display]

Light
The sleeve with LEDs, is a visual representation of the distance between participant and performer. When the participant gets close to performer it would trigger the blinking LEDs.

![Image of LED sleeve]

From the three simple outputs, I recognized the importance of the need for rhythm in the data, and a choreography of the way the data goes from input on one body to output on another. The output is too simple and fragmented, and there is a need to experience and choreograph the data as a flow - wireless in combination with an input, considering the form, the rhythm and the quality of the data. This will be further explored in the second round of exploration in chapter 8. Exploration & conceptualization.
7.4 Experiment four //pulse reader

**Goals:** Exploring a pulse reader as output.
**Location:** My living room turned into a workspace.
**Participants:** Me.
**Materials:** Pulse reader, Arduino board, Arduino sketches, computer, glove.
**Results:** Strong input.
**Next step:** Combine input/output.
**Contribution to program:** Alternative solution for future iterations.

Pulse is another potential input for sensitive intimate communication and expression. Breath, breathing and heartbeat is omnipresent in our being, and when amplified it possess the ability to create a sense of both intimate care and protection and invasiveness. I have been testing a pulse reader as input for both visual and sound as output attached to the ear, and different places on the body, ending up on the index finger inside a glove. Seeing a visualization, and even stronger hearing a representation of your own heartbeat or another persons heartbeat, makes you aware of your own breathing and being. It can calm you or get your heartbeat to increase. It is a very strong input. I ended up not using the pulse reader, but I have saved it as an alternative solution for future iteration using more advanced and natural expressive elements as input/output.

7.5 Experiment five //form and materials

**Goals:** Exploring comfortability, and form in materials.
**Location:** DD Lab, Connectivity Lab, Illutron, and my living room.
**Participants:** Me.
**Materials:** Leather, belts, fabric, electronics, sewing machine.
**Results:** Leather fabric has a live skin like-texture, and an interesting aesthetics.
**Next step:** Combine, input/output with form and materials.

**Contribution to program:** Materializing comfortability.

Exploring comfortability and form has been present throughout experiment one through four. I have been working with fabrics, soft bending materials like felt, yarn and leather combined with the hard metallic electronics. I find that an extra layer of fabric between electronics and skin is very pleasurable. The leather fabric has a live skin-like texture and an interesting aesthetics, both rough, and yet a soft gentle natural skin-like feeling to it. The comfortability will be further tested in the field exploration.

### 7.6 Different work labs

At the Digital Design Lab in Aarhus, I attended a three hour workshop lead by two girls. They presented LilyPads, conductive yarn - a more soft and girly side to electronics than I have experienced before. The prototype (experiment one), and my revelation of the use of soft materials, shows how the influence from the social, the pragmatics, and the materials at hand effect the outcome. This calls for a gender analysis of how electronics and wearables have germinated in different social circles. The girly soft side of electronics lead by Leah Buechley (designer and creator of LilyPads) represents the use of fabrics, yarn, paper, and washable electronic parts. Female and feminist hacker spaces make a point about girls and electronics (e.g. Miss Baltazar's Laboratory), by introducing new more girly materials, but at the same time simplifying the hardcore coding part of electronics and thereby add to the gender separation, maintaining the typical gender perception: boys programme and do electronics, while girls sew and knit, and when we do electronics, we prefer that they are made in girly colors (hence the purple color of the LilyPad Arduino kit vs. the blue Arduino board).

The connectivity Lab at Medea is socially and creatively inspiring. While I was working, a second year student was preparing a test of the accelerometer in a mobile phone placed on a body and turned to sound with performing acrobats, and a PhD student was building and testing a volcano reader. Illutron collaborative interactive art studio in Copenhagen is also socially and creative inspiring. Moreover it is very inspiring environment and material wise; it is situated on an old rusty barge with unpolished surfaces and creaking metal, and it is full of old electronics and old art installations. In my living room as a workspace, there is easy access to textile materials. I can find old fabrics in a drawer, I can cut off the top of a boot and re-use it as a sleeve, and I have quick access to my sewing machine. Socially it is just me and the material.
7.7 Reflection

My exploration of input/output solutions, and the form and comfortability of the wearables, so far makes me realize that it is too simple to have a simplified binary input/output approach. There has to be a rhythm in the data, some kind of collaborative pattern between the two bodies. The notion of one body being input and the other output is too simplistic. For the wearables to function as interesting mediums of expression between two bodies there must be a shared output and a progression in the movement between participant and performer.

Inspired by the term Data Choreography (Kozel 2007) I must treat the data as a choreographer. What is the data, who receives it, what is the form, the rhythm, and the quality of the data?
8. EXPLORATION & CONCEPTUALIZATION

In exploration round two, I have continued working with the light output, using IR remote technology as proximity, triggering input/output between the two bodies.

This round of exploration is based on the realization from the previous experiments that there has to be a rhythm in the data in order to treat the data as something that needs to be choreographed. The first step to make a rhythm in the data is to have two sets of the prototype to make a translation from one body to another. In the previous experiments my prototyping has been very fragmented as I have tested e.g. input without other output than a blinking LED, not being able to sense the flow and wear it wireless on my body. So the aim of this exploration round is to start making wireless prototypes to enable testing on bodies. Experiment six to eleven was executed between the 29th of April and the 24th of May 2013:

Experiment six //rhythm in the data
Experiment seven //exploring movement and form
Experiment eight //vibration
Experiment nine //re-conceptualization
Experiment ten //feedback loop
Experiment eleven //re-conceptualization

8.1 Experiment six //rhythm in the data

Goals: Make a wireless, testable set of wearables.
Location: My living room turned into a working space.
Participants: Me.
Materials: Batteries, electronics, IR sender & receiver, LEDs, two Arduino boards, leather, belts, sewing machine, & computer.
Results: A functioning simple working wireless prototype.
Next step: Testing the prototype on bodies.
Contribution to program: Materialization of a prototype.

In order to make a rhythm in the data, I needed to make a wireless prototype to test on bodies, without being hooked up to the computer. I used the IR sensor technology as proximity, and the light output from experiment two and three to create two sets of sleeves with light output and IR receiver, and two sets of belts with IR senders. And I realized that in order to use both sleeves as output I would have to place both a receiver and a sender on each body/wearable (more on this in experiment ten). This experiment resulted in a simple working prototype, with the next logical step being trying it out, placing it on bodies.
8.2 Experiment seven //exploring movement and form

**Goals:** Explore movement and form.
**Location:** My living room turned into a workspace.
**Participants:** Me, friends, and family.
**Materials:** The prototype; two sets of belts, and sleeves.
**Results:** Restricted movement when placed on an arm, whole body movement when placed on hip.
**Next step:** Develop prototype for hips.
**Contribution to program:** Prototypes lead to testing & conceptualization.

This experiment's goal was to explore movement and form, but it resulted in a re-conceptualization of the prototype as I realized in my testing, that there is very little movement in the whole body when the wearable is placed on an arm. This was not intended as a test, but what started as a playful approach to finally having a wireless acting prototype: I wore the belt with the sender, and a sleeve with receiver and light output myself, dancing around in my living room, testing the trigger function, the movement and the experience, and I placed the sleeve on friends and family, wearing the sender belt myself. And I realized that when placed on a leg or an arm the movements are very restricted whereas, when I strapped it around the hip, the whole body was engaged in movement. This experiment furthermore illustrates a shift in the second round of exploration; from sketching to prototyping. The making of working prototypes lead to testing and conceptualization, whereas the first round (experiment one to six) had more of a sketching/mock up sense to it.

8.3 Experiment eight //vibration

**Goals:** Implement haptics as output.
**Location:** My living room turned into workspace.
**Participants:** Me.
**Materials:** Coin vibration motors, electronics, Arduino board, Arduino sketches, computer.
**Results:** More interesting data to the output.
**Next step:** Implement vibration in the prototype.
**Contribution to program:** The feeling of being touched through movement.
Getting back to the choreography of the data, I wanted the quality of the data to have a more interesting form than the obvious visual: light. What is the data, who receives it, what is the form, the rhythm, and the quality of the data? Vibration was meant as an alternative outcome to light. There is an interesting scope around haptics in wearables, and combined with IR remote technology used as proximity between two bodies, there is a possibility to create the experience of being touched - to transmit physical stimuli from one body to the other - touch without touching. I used coin vibration motors similar to the ones making vibration in smart phones.

There is a great magical effect in creating tactile perception between two bodies through movement. A combination of embodied experience, haptics, and the phenomenological - being touched - physically. In everyday life, it happens all the time, tactile perception when touching the smartphone, and by movement from another person e.g. texting from a distance, the object vibrates.

The result of the experiment was an interesting alternative to visual output - vibration. The next step is to implement vibration in the prototype.

8.4 Experiment nine //re-conceptualization

**Goals:** Transform sleeves into belts.
**Location:** My living room.
**Participants:** Me + a friend.
**Materials:** The sleeve prototype, an old leather skirt, and a sewing machine.
**Results:** A functioning prototype; an sender and receiver belt.
**Next step:** Feedback loop.
**Contribution to program:** A new iteration of a functioning prototype.

To complete the realization of the connection between the hips and movement, I have transformed the two sleeves into two belts worn around the hip, and implemented vibration from the previous example. The making of the belt took place while a friend of mine was staying for the weekend at my apartment, and it turned into a collaboration, where we designed and constructed the belts from materials at hand - an old leather skirt and the sleeve prototype - while measuring and wearing the fabric on our bodies. The idea is that the sender part (input) is placed on one body, and the receiver (the output) on another body. The sender belt has two IR senders placed on the belt, and a pattern of LEDs. The receiver belt has two IR receive sensors placed on the belt and a light and vibration output that is triggered when the IR sender and IR receiver is within a distance of ten centimeter to each other. The next step is to make a feedback loop, so that both belts can both receive and send.
8.5 Experiment ten //feedback loop

**Goals:** Make a feedback loop between the two belts.
**Location:** My living room turned into a workspace.
**Participants:** Me.
**Materials:** Two sets of IR senders and receivers, Arduino boards, Arduino sketches, computer.
**Results:** Failed (/not finished).
**Next step:** Rhythm in the visual output.
**Contribution to program:** Time restraints & priorities.

One of the challenges of using IR remote technology is that it is one directionally. It goes from sender to receiver, but in order for it to be an interesting experience between two bodies there has to be a feedback loop, to enable a shared output and a progression in the movement between participant and performer. This can be solved by placing both sender and receiver on both belts and make a parallel programming called master-slave, where master start the slave computation, and the slave computation then returns the results to the master. After testing having both a IR sender and a receiver on one Arduino board, and recognizing, that it will never be able to do the two things at the same time, and a day spent with Google searching: work on master/slave computation, I realized that in order to keep up with my time frame, I would prioritize to concentrate on making a rhythm in the visual output, and on the testing of the prototype.

8.6 Experiment eleven //re-conceptualization

**Goals:** Make a rhythm in the visual part.
**Location:** My living room turned into a working space.
**Participants:** Me (+ friends, and family).
**Materials:** The two belts, wire, soldering, Arduino boards, Arduino sketches, batteries, and computer.
**Results:** An interesting light (& vibration) pattern.
**Next step:** Testing in the field.
**Contribution to program:** A prototype to bring to the field.
To compensate for not having a feedback loop, I spend some time making a better rhythm to the data at hand. This part of the experiments is entwined with testing and placing the prototypes on bodies, from the testing of the two sleeves, where I strapped it on people dropping by my lab, to the making and arranged testing of the two belts (further described in 9.3 testing part two and 9.4 testing part three). In retro perspective the rhythm can be compared to bioluminescence, where living organism produce and emission light, e.g. deep sea fishes and fireflies releases light energy - bioluminescence - to lure and attract prey and mates (Bioluminescence 2013), the sender belts light pattern of LEDs constantly blink in a changing beaming tempting rhythm, as if alluring the other belt to come closer. When the receiver belt does come closer it trickers a bouquet of LEDs one by one and finally the vibration.

8.7 Reflection

Where the first round of lab experiments (experiment one to six) was structured around technical and material possibilities, this round of experiments has been less structured: merging technical experiments with testing, turning prototyping into concept development, and re-conceptualization. The process has been dominated by action, pragmatism, time limits, and my embodied experience with the materials, and visceral choices. It can be described as a methodological shift from sketching with the digital material in the lab to making prototypes in the lab.

Furthermore my investigation of different lab environments was limited to my living room as my borrowed and bought tools multiplied and my lab wasn’t mobile anymore. Moreover it shows that the notion of the generic lab can be questioned. The different lab environments differ from each other socially and with respect to materials. The social, the materials, and the context all influence the process.
8.8 Prototype

The acting prototype is now two sets of belts; an input part, and an output part. The input has two IR senders and a constantly blinking set of LEDs in a beaming alluring rhythm. The LEDs on the input part are connected in series of six (see marked numbers on the model below). A line of LEDs is turned on constantly (marked 1 on the model) while the remaining five series of LEDs blink one by one (repeating 2-6 again and again). The output part, the receiver belt with two IR receivers and a set of LEDs in four bouquets - connected in series of four followed by vibration from two coin motors (repeating 1-5, market on the model, again and again) is triggered when the IR sender and receiver is within ten centimeters from each other. The belts are made in leather and have a double layer of fabric that hides the electronics. Both belts have an Arduino board and a nine volt battery inside, which is accessible from a zipper in the top of the belt.
9. EXPLORATION IN THE FIELD

Exploration in the field is divided into three parts: 9.1 Performer & participant, in which I will be describing the idea of an interaction between performer and participant, in 9.2 Performance & the experience I will be sketching the goal of the performance experience, and finally the testing will be described in 9.3 testing part one, 9.5 testing part two and 9.5 testing part three.

The goal of the performance experience, and the idea of the interaction between performer and participant, are both closely connected to the program: wearables designed as a collaborative expression between audience and performer in a participatory performative installation. This is the perspective on the program, and it is with the experiments and the testing - the process from the lab to the field - the materialization in program/experiment dialectics unfolds, as program and experiments influence, challenge and transform each other.

Parts of the testing has been done in earlier stages of the experiments in the lab, e.g. the sleeve prototype, and my own embodied experience of the process. In relation to program/experiment, I have divided the experiments into two areas: lab exploration and field exploration, and in this part of the exploration I refer to experiments as testing, in an attempt to separate lab from field.

9.1 Performer & participant

A performance situation, where performer and participant interact, highlights audience as participants or co-creators in the performance. And this creates several observation levels. From the observation of the performance to the observation of one’s own co-creative role, where identity and self-reflection plays a major role. Furthermore, digital material communicates several layers that cannot be (verbally) communicated in the sense of digital material - performance and art in general - can communicate or cause emotional subjective experiences. Experiencing a performance is both an individual experience, and an opportunity for cohesion, and the feeling of community between participant and performer, context and artifact.

Wearables could be described as the work of art - an intermediary object, to which both the artist and viewer can relate (Bishop 2012). The use of technology can both enhance and diminish the relationship between audience and performer. The interaction with technology can turn the audience from passive spectators to active co-creators - where the audience participate and contribute to the experience by interacting with the work, creating a unique experience each time, or audience-as-artist, where the outcome depends on the participant. The use of technology in wearables placed on the body can merge with the bodies ‘natural’ movement and make the audience go through the spectrum of different levels of audience involvement from from interpretive engagement to inventive engagement (Brown & Novak-Leonard 2011).
9.2 Performance & the experience

The aim is to make wearables as a collaborative expression between two bodies, and between body and technology within a performative participatory installation. Instead of the reductive binary notion of either passive or active, I want to use technology as medium of expression, supporting the shared experience between two bodies. Jacques Rancière’s *The Emancipated Spectator* challenges the idea that the spectator is passive, and sums up the paradox, that there is no theatre without spectators, that the theatre is a place where an action is actually performed by living bodies:

“It calls for spectators who are active as interpreters, who try to invent their own translation in order to appropriate the story for themselves and make their own story out of it. An emancipated community is in fact a community of storytellers and translators.” (Rancière 2004, p. 280).

Performance is constituted by participants, as they translate, and produce meaning while the performance is experienced. In my testing, it is a conscious choice that there is no specific instruction manual for the use and function of the wearables, as alternative use and own context and meaning may provide new perspectives and allow ambiguity in the interpretation and perception of the experience.

According to German theater researcher Erika Fischer-Lichte the semiotic distinction between subject and object, performer and recipient, is blurred in performance art. The audience is encouraged to create their own context and meaning rather than decoding the performance text (Jalving 2011).

In IxD, Gaver, Beaver & Benford (2002) argue that ambiguity is a resource for design. Ambiguity is perceived as an opportunity, as opposed to traditional HCI where it is considered a problem if the user do not get the clear meaning of the interface. Further ambiguity can encourage personal engagement with systems, freeing users to make individual interpretations, as the designer only suggests perspectives without imposing solutions.

By bringing performance to IxD, there is an opportunity to go beyond freeing users to make individual interpretations; the action of the participants create the performative situation, and offer a creative space for transformation where emotions and the embodied experience of the integration of bodies and technology are dominant.

Furthermore the intended use situation calls for an understanding of the context, and the way artifact, users and context influence each other. Where the word performative represents what is performance-like, the concept of performativity is used both generally and specifically - as a general description of the construction-related substantive form of performative, and according to art critic Dorethea von Hantelmann as a situational understanding, a functional tool by which to approach an objects doing. A spectators experience of a work from a situational dimension, is the way a work produces meaning (Jalving 2011).
9.3 Testing part one

Goals: Testing through lived experience.
Location: DD Lab, Connectivity Lab, Illutron, and my home.
Participants: Me.
Materials: All from the previous experiments.
Results: Lived experience with the material.
Next step: Testing with participants.
Contribution to program: Use of theoretical scope.

Testing part one was executed between the 9th of April until the end of the project, June 2013. This part of the testing has been my constantly trying out and wearing the prototypes during the different experiments and constant concept development. It has been my own phenomenological investigation, my own lived experience of wearing the devices.

This lived experience has been dominated by action and body in a phenomenological embodied interaction where cognitive thinking and knowing has ranked second. And it makes it difficult to explicitly explain all the choices, the process, and steps, that lead to the final prototype. Am I using leather as material because it is a personal preference, the material at hand, that it resembles skin, or that it has a performative dramatic costume sense to it? Maybe it just felt right, and touched me back. And as such my use of program/experiment dialectics and embodied experience with the material merge with an artistic approach.

There’s a great satisfaction in materializing ideas, some of my experiments are very simple and in theory they could have been sketched on a piece of paper in five minutes, but the process of soldering for hours, and wearing it on your body, gives you a different relationship with the material, it becomes a lived, embodied experience as oppose to an abstract sketch of what it could be.
Goals: Observation of expression and understanding of input/output.
Location: At my upstairs neighbors apartment, my sisters place, and my home.
Participants: Me as the performer and five test persons.
Materials: The two sets of sleeves and belts, and the two sets of belts (including Arduino boards and batteries).
Results: Collaborative movement as expression, but not enough sense of the experience.
Next step: Tests followed by conversation/interviews.
Contribution to program: A full body movement enabling prototype.

In this part of the testing I have been the performer and friends and people around me have been the participant. This testing started with the prototype of the two sets of sleeves, and continued as it was developed into belts. The testing is twofold: video recording and observation of body expression. Testing part two was executed between the 6th of May and the 24th of May 2013.

Difference between sleeve and belt:
Both sleeve and belt uses IR for proximity as input and the sleeve has a simple light output, whereas the belt has a light output in a beaming rhythm combined with the vibration. The overall result of the transition from sleeve to belt is related to the full body movement when the prototype is placed on the hip. Furthermore the belts create more playful collaborative movements, whereas the sleeve was a personal experience for the participants, e.g. focussing on her own arm, and the visual output, with a movement as if checking the time on a wristwatch. Furthermore the sensed vibration brings an addition to the visual and gestural - an awareness related to haptics.

Technical issues and adjustments:
Besides the adjustment of the rhythm in the LEDs and vibration, I have adjusted the resistor on the sender belt, and the amount of senders and receivers sensors on the belts. Using IR remote technology as proximity has pros and cons. The beam of the IR sender is directional and since I have restricted the distance by placing resistors on the sender, the beam is highly directional, meaning that the sender and receiver area is very narrow and has to be directly towards each other to make contact and trigger the output. This became very clear in a testing where the height difference between me and the participant was too big. I have now placed two respectively, senders and receivers on each belt, one pointing slightly upward, the other down. Temporarily solving the issue, a better solution would be to place several senders...
and receivers, also accommodating trigger of input/output, not only two places on the belt, but all around the hip.

In testing different proximity boarders of the trigger point for the output, I have chosen the very intimate and close ten centimeters, as it has the sense of an energetic aura field to it, and a kinaesthetic awareness of experiencing our own movements in combination with the other persons’ aura and body movement.

The prototype is fragile. It is soft and pleasurable, but I have done soldering in between tests - this screams for the need to consider more robust materials, e.g. bendable LED strips and finalize the wires with a shield to the Arduino board, at the moment these are just loosely attached and pop out occasionally.

**Behavior and comments:**
There is a constant change in behavior when I place the belt on people. People start swaying their hips, and some start humming. One instantly opened the zipper to the electronics: “What’s down here?”.
As I act as the performer, they automatically mimic my behavior and movement. Kinaesthetics play a role in how we move our bodies in the meeting with another body in a way that supports shared movement.

The vibration course the biggest spontaneous reactions, from a scared “No” to a ticklish “uh what’s that!” The reaction to moving close together courses reactions like “It’s very intimate”, laughs and “This is weird”.

**Understanding of input/output:**
Regarding my choice not to have an instruction manual for the use and function of the belt, some participants seek meaning in the interaction. For some it is a playful wonder and they explore possibilities: “I'm trying to shake it to make it light up”. For others a slightly annoyed and embarrassed: “It’s funny, I can’t determine how it works…”, whereas other just state: “It looks cool”.

**Reflection:**
The expression between the two bodies is very much related to movement. Just wearing the belt invites full body movement, and when two bodies are wearing the belts simultaneously, a collaborative movement occurs. In order to get a deeper sense of the experience of the participants I have to combine observation with interviews.
9.5 Testing part three

**Goals:** Insight in participants’ experience.

**Location:** In my yard and my home.

**Date:** Was executed between 25th of May and the 1st of June 2013.

**Participants:** Me as the performer and three test persons.

**Materials:** The two belts (including Arduino boards and batteries).

**Results:** Intimate and erotic collaborative expression.

**Next step:** Further field testing, specific context, and further prototyping.

**Contribution to program:** Need for further iterations.

The set up of testing part three is one participant wearing the receiver belt while I am wearing the sender belt, followed by an open interview/conversation about the experience. The acting prototype is two sets of belts, the input part, with two IR senders and a constantly blinking set of LEDs in a beaming alluring rhythm. And the output part, the receiver belt with two IR receivers and a set of LEDs in four bouquets, that trigger one by one is followed by a vibration from two coin motors, when receiver and sender belts are approximately ten centimeter from each other (as described in the model in 8.8 Prototype). The data obtained from testing is threefold: video recording, observation of body expression, followed by conversation; interview of the experience.

I have formulated a short set of question, intended to make participants describe the experience of wearing the belt. The questions are inspired by Dunne and Raby’s (2001) *The placebo objects* - project, where they elicit stories about the “...secret life of electronic objects” by placing electronic design objects in peoples homes for an amount of time, followed by interviews, where they ask sneaky questions like: "If you had to give the object to somebody else, who would you give it to and why?".

**Questions:**

**Experience**
- What was it like wearing the belt?
- How are you connected to the other person?
- How would you describe the belt as an object?
- What would you tell the next person wearing the belt?

**Re-conceptualization**
- What would make you wear it for more than an hour?
- If I was making a new one - how would you re-design it?

**Context**
- How would you use it in everyday life?
- If you could pass it on - who would you give it too?

The questions gave a broad range of different individual experiences. The most interesting responses was from (two) participants also part of testing part two (test interview one and three). Maybe because it was their second time around, they had a preconceived perception of the embodied experience. Furthermore a
test in the dark had a completely different unrestrained sense to it, where the collaborative movement turned into the participant transforming into the performer, insisting on trying on the other belt as well, as it had more light, dancing around with the belt experimenting with using it as headgear, pants, and as a bra: “[What was it like wearing the belt?] It was great fun, I instantly engaged in movement and had a laugh playing with possibilities of the belt.” (Test interview three, see p. 62).

One participant experienced the connection to the other body as an extension of everyday human expressions:

  [How are you connected to the other person?] I think - it is an extension of interaction like facial expressions and movements. I cannot put lights in my body, but it feels like an extension of communication with the other person. (Test interview one, see p. 60).

For another it was a new experience - physical contact by presence:

  I feel connected to the other person in a completely new way, I have never tried this before, it is physical contact by presence, just by being close. (Test interview two, see p. 61).

Others experienced it as a lustful communication:

  [How are you connected to the other person?] It is a lustful communication, it makes you smile, and if I was dancing with a man it would be very erotic... (Test interview one, p. 60).

  [If I made a new belt - how would you re-design it?] ...maybe re-make it as a hairband, but there is something erotic about the hip, it is naughty movements. (Test interview two, p. 61).

One participant made a comparison between the inside of the wearables electronics to the inside of her own body:

  [How would you describe the belt as an object] It is funny - realizing that there must be electronical wires inside the belt makes me aware of my own bodies' inside. How amazing it is that our bodies are linked by cords and wires... It makes me think of my body as an instrument. (Test interview one, p. 60).

On the question about what to tell the next person wearing the belt. Participants reflected on their own embodied experience, once again moving the hips:

  I would say “enjoy it”. Perhaps “it suits you”. A belt with light around the hips, [laugh and starts to sway the hip] look at me! I get the urge to dance and move my body... (Test interview one, p. 60).

Regarding re-conceptualization, and the time matter [What would make you wear it for more than an hour?] Participants responded everything from “…much more has to happen for me to wear it for a long time” (stated during testing part two) to “… on stage or at a party, dancing” (Test interview three, p. 62). and “I would just wear it [as it is] and spin around, alone or with a friend, or at a party - that would be fun.” (Test interview two, p. 61).

The party context gets mentioned a couple of times:

  [How would you use it in everyday life?] …I would wear it at a party as a plain accessory, I would want to make it more narrow to resemble something I would usually wear, and then, when it would suddenly start blinking, that would be a great surprise element. (Test interview one, p. 60).

Also art and performance is mentioned as contexts [...]describe the belt as an object] “…an artistic sensory object.” (Test interview two, p. 61). [How would you use it in everyday life] “I wouldn’t! It belongs in a
performance, maybe one where the audience could get to try it afterwards.” (Test interview two, p. 61). And finally as a festival gadget and a dating concept:

[How would you use it in everyday life?] If it was running on solar energy, I would wear it as a fanny pack for Roskilde Festival and then wait eagerly for it to light up during the night. But I guess that doesn’t really count as everyday life... Oh, and if other people had it too it would turn into a dating concept, we could buzz each other. (Test interview three, p. 62).

9.6 Summary

The expression between two bodies is more than movement; it has a intimate and sensual erotic collaborative expression to it. Furthermore the testing in the dark shows how context can influence the expression and the role of the participant transform to performer.

The experience can be divided in a tangible choice via action (movement) and a more unconscious perceptual experience. So there is both a conscious and an unconscious act in relation to being a wearer. And thereby the perceived experience is in the layer between cognition and action - thinking and doing, hence the phenomenological pre-reflective experience that doesn’t detach the subject from the world it experiences. The participants become performers and is thus prerequisite for the existence of the performance.

From the testing I identify a need for further development of the prototype in order to extend the experience over a longer time, and accommodate more data choreography, e.g by creating a loop so that both performer and participant can influence the interaction back and forth. There is also a need for a clear context, and thereby the need to re-formulate the program and do new rounds of iteration between program/experiments, and between lab and field.
10. DISCUSSION

10.1 The prototype
The prototype is at a stage where it serves as an example of expression between two bodies, and it is an obvious choice to continue the process: the iteration between experiments in the lab with exploration in the field. And reformulate a new program with the results from my work so far.

The three identified next steps are: the prototype needs further development, further testing, and a clear context. In order to deeply investigate expression between two bodies, there is a need for the interaction to have a feedback loop, this would also call for a new round of testing, where the performer and the participant could be replaced by the movement of two participants during a longer amount of time. Furthermore there is a need for a more clear context. My use of performative participatory installation has functioned as a context to set the participants free to make their own interpretation, but it has merely been a test that was performance-like, as I have not set up a specific performance situation with an audience. It would be beneficial to arrange an actual performance, or take the exploration to a specific social space, and do social context experiments, e.g. give a belt to two strangers in a public space and see if they will find each other.

The experience of wearing the belt is not only reduced to the digital material, but is a continual interplay between bodies and technology where thinking and doing intertwine. User, artifact, and context affect each other.

10.2 Research question
My goal was to explore a collaborative expression between performer and participant, and between body and computer within a performative participatory installation:

1. How can material exploration, through prototyping and experiments, lead to wearables designed as a collaborative expression between performer and participant in a performative participatory installation?

The research question has first and foremost been answered by the making and testing of the prototype. The process, the time in the lab, experiments and prototyping, lead to testing in the field and through iterations this process can lead to technology ready to wear. The prototype is not an exemplary notion of a collaborative expressive wearable but a suggestion. This is closely connected to the use of method and theory: the use of program/experiment dialectics (further described in 11.1 Methodological contribution), and the phenomenological approach.

The context as a performance situation require the use of materials to be flexible for body movement, pleasurable, and expressive, and this refer to the use of both digital and non-digital materials, and the relationship between (the non-digital material) body and (digital) technology (this will be further described in 11.2 Digital materials in field and lab and 11.3 Exploration of non-digital material).
11. CONTRIBUTION TO KNOWLEDGE

I have gained and produced knowledge in all three areas of investigation: user, artifact, and context. It is not general knowledge in the sense of universal theories and framework, that lead to one specific end product, but rather generalizations of the design procedure, that doesn't limit the design to one particular situation (Obrenović 2011). The most interesting knowledge is in relation to my choice of method: program/experiment dialectics, and the phenomenological aspect in the process with the digital and non-digital material.

11.1 Methodological contribution

The use of program/experiment dialectics has allowed my process to be more intuitive and performative. The workflow has made room for creative inspiration, expression, and reflection.

As such it resembles features from experience-based approach and participatory design where the researcher and/or the stakeholders are an active part of the process. From an objectivist approach this would be viewed as a source of error, that researcher and stakeholders actively engage and participate in the process - but this has provided in adding more layers to my exploration and has given a new knowledge base. As such program/experiment dialectics have had the function of a generous space, allowing elements from several other methods, non linearity, and intuition, to be part of the process. This results in exemplary experiments and prototypes in the sense that they enable both critical dissemination through examples of what could be done and how, that can express the possibilities of the program, and more general suggestions about design practice: “...it is in the relation between program and experiments the most important knowledge is gained” (Brandt et al. 2011, p. 22).

A noticeable difference in my use of program/experiment and e.g participatory design or other form of collaborations in design, is that I have been a solo researcher/designer. The social has not been a constant synergy of different people with different competences, but an interesting phenomenological approach to working with design processes that resembles an artistic approach. In the different lab environments, and the testing in the field, the social has been of great importance. In the testing the participants’ embodied interaction with the materials and the context, and furthermore the inter-corporal perception and lived experience between two bodies, has all influenced the performance experience and the process of creating the prototype.

Phenomenology in IxD methods is an attribution to IxD to allow room for active participation of the lived body in different stages of the design process; a development of the notion of embodiment beyond situatedness - acknowledging the interplay between bodies and technology, that users, artifacts, and contexts affect each other. Furthermore it represents a new field within research through design; phenomenological research through design, where the researcher acknowledges her own sensory perceptive presence, not just by handling materials and materiality, but also through her own subjective sensory materiality.
11.2 Digital materials in field and lab

Prototyping is both a part of my method and an object of research. Through the digital material exploration in my experiments and prototypes, the decisions made in the lab become a frame for what to try out in the field. In program/experiment dialectics, the separation between lab and field can be difficult to distinguish, as the iteration between experiments and tests is constant and further happens simultaneously with reflection, re-conceptualization, and analysis.

The strength of combining experimental design in the lab with explorative design in the field lies in the interaction between the social and the digital material. Materiality of digital interaction design is not only the digital material, but also a constant interaction between concept, perception, and context.

There is a great satisfaction in materializing ideas, some of my experiments are very simple, and as mentioned, they could have been sketched on a piece of paper in five minutes. But the process of soldering for hours and wearing it on your body gives you a different relationship with the material, it becomes a lived, embodied experience as oppose to an abstract sketch of what it could be. It is still sketching - just an embodied form of sketching in digital material. There is a great scalability in sketching with electronics, I can make a LED blink, and I know that I can upscale the interaction to a huge amount of LEDs or light, and moreover by materializing it I can actively participate with, be touched by, and touch the material.

Bill Buxton (2007) makes a distinction between sketching and prototypes, even though they are both instantiations of the design concept, they serve different purposes: sketches dominate the early stages, and prototypes the later when things are converging, as a transition from ideation to usability testing. From exploration to refinement, from propose to test, from suggestion to description. This is easily transferred to my process in the lab, where the first early part was centered around sketching different solutions, to the second later part focused on transforming into a usable prototype.

As a design process field and lab constitute each other. I have only scratched the surface regarding exploration in the field, the social is mainly represented by me and my test persons, and the majority of my work has been done in the lab, bringing the field to the lab.

11.3 Exploration of non-digital material

As the prototype is taking from the lab to the field, the exploration switches from a focus on the digital material to a focus on the non-digital material (the bodies). Wearables full spectrum of action is from the laboratory context where they are produced, to the change in the field when placed on a body. Lamontagne (2012) describes this change as a collaboration between the technical potential of the materials and the artistic potential for the wearable to transform the body, she argues that both the technical and the body come into performative action as “Wearables as a technology co-habitate with the body and perform in such a way that gives agency, materiality and meaning to both the organic (the body, organism) and the technological (electronics, sensors)” (Lamontagne 2010, p. 3).

This also applies to my phenomenological perception of the material in my time in the lab, which is why it could be stated that the lab also functions as field as it also here is placed on a body performing with
agency to both human and non-human material.

The agency of both human and non-human material moves beyond Steve Mann’s Humanistic Intelligence theory and acknowledge the more sophisticated approach from Science and Technology Studies by Bruno Latour. Computers are typically described as a media and software as a tool, but with a constructivist Actor–Network Theory (ANT)-view on technology; computer and software can be viewed as acting actors with agency. ANT is very much an approach focusing on the importance of materiality in the design process, equally with people. The author of the design solution is in constructivist thinking both human and non-human actors. In the lab both software and technology become part of an artistic intuitive creative process where materials (in a phenomenological term) touch back or (with an ANT term) have agency.

Embodiment, phenomenology, and kinaesthetics are omnipresent in the investigation of wearables, bodies, and technology. And it has influenced the process in the lab, the testing, and the participants’ perception in the field. Both as a solo designers phenomenological approach with the design process, and in the addition of the social and the context, in the performance situation where the two bodies are experienced as one inter-corporeality. The embodied experience makes the researcher/designer/participant a phenomenologist as interaction with the material, own body and memory influences the process, and embodied experience with the artifact and the other body both constitute and is constituting perception.
12. REFLECTION

12.1 New questions & suggestions for further research

Besides the identified areas of problematization - that the prototype needs further development, further testing, and a clear context - there is a deeper investigation area in the notion of expression in the non-digital materials that can be explored: is it important to our perception of touching and being touched that the material is digital or non-digital? Do the body translate, interpret, and sense the same?

The focus on embodied interaction and a phenomenological approach in the process of making interaction design call for further observation of ourselves and investigation of what criteria we have to experience and observe. I have merely reached the point where I acknowledge my own sensory perspective presence and tie it to IxD - the next step could be a broader investigation of the how we experience.

Bodies translate, interpret, and sense across non-digital materials. Digital processes and representations have been incorporated into everyday life, in a manner that we no longer experience the split into categories such as digital vs. non-digital. But when we explain the experience verbally, we still use negations and extremities to describe the world around us, in the absence of a new language, we use words like digital and non-digital.

Regarding my prototype, there is a need for a closer investigation and exploration of the choreography of the data, besides the identified feedback loop. Data Choreography includes a set of invitations that a device can offer: physical gestures, ergonomics, and the communicated codes across social groups (Kozel 2007). This relates to the artifact, the way it effects the bodies, and the use in a context, I touched all three, and I would like the next step to be centered around moving the prototype from a simplistic example to an orchestrated piece with greater awareness on the relationship between artifact and body. E.g. by incorporating pulse and heartbeat to escape the visual simplistic output and enhance the intercorporeal perception. Furthermore, as earlier mentioned, a deeper investigation of a specific social field would be interesting to execute.

There is an interesting scope in the field that occurs in the explicit use of software and computation in IxD and in the arts. Software is available, but technical skills are needed, excluding researchers and designers without technical skills from the lived experience? This is also seen in the paradox that open source communities are declared open to all, but restricted to what could be called the programming elite - those who understand the codes. Open source is changing the way we think and talk about software and computation. This also refer to the earlier mentioned need for a gender analysis of how electronics germinates in different social circles.
13. CONCLUSION

In their relatively short history, wearables have evolved from cyborg-like extensions to poetic representations and experiences (Wilde 2009). Wearables are not only the machine or technology they perish, but consist of both construction, operation, and equipment as well as the interpretation and embodied interaction intertwining both technology and body.

The use of program/experiment dialectics has allowed room for creative inspiration, intuition, expression, and reflection, and the addition of a phenomenological approach has been a great resource in the iterative process of creating the prototype, where the lived experience of the researcher and the participants has influenced the performance experience and the process of creating the prototype.

Creative practices can contribute to new knowledge, and thus the opportunity for reflection and evaluation occurs. In a practical design process the need to twist and turn methods and theory is essential, and this is the strength in research through design - that it is a flexible interaction triangulating between practice, conceptual theory, and analytic grounding.

In my prototype, the participant and the performer express collaborative intimate erotic movements, and the performance is constituted by both technology and human agency - both wearable and bodies act - in the interaction between interpretation, body, and experience on the one side, and concept, wearable, and technology on the other side. The synergy between interpretation and experience, concept and technique can not be separated.

Phenomenology in IxD is an attribution to research through design as a method that allows room for active participation of the lived body in different stages of the design process - a development of the notion of embodiment beyond situatedness - acknowledging the interplay between bodies and technology, that users, artifacts, and contexts influence, touch, and touch back each other.
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Experience:

What is it like wearing the belt?

It is wonderful - it feels very comfortable.

How are you connected to the other person?

I think... it is an extension of interaction like facial expressions and movements. I cannot put lights in my body, but it feels like an extension of communication with the other person. It is a lustful communication, it makes you smile, and if I was dancing with a man it would be very erotic...

How would you describe the belt as an object?

Very aesthetic, very beautiful, I like the colors, the blue and the black is beautiful. I could wear it like an accessory, it is not vulgar more elegant. It is funny - realizing that there must be electronical wires inside the belt makes me aware of my own bodies’ inside. How amazing it is that our bodies are linked by cords and wires...It makes me think of my body as an instrument. It's also fun that it evokes smiles, I do not think you can wear it without smiling.

What would you tell the next person wearing the belt?

I would say, enjoy it! Perhaps - it suits you! A belt with light around the hips, [laughing] look at me! I get the urge to dance and move my body...

Re-conceptualization:

What would make you wear it for more than an hour?

Well, anything, I would just wear it and spin around, alone or with a friend, or at a party - that would be fun.

If I made a new belt - how would you re-design it?

It's hard, I really like the black and blue. If I would wear it at a party as a plain accessory, I would want to make it more narrow to resemble something I would usually wear, and then, when it would suddenly start blinking, that would be a great surprise element. Or maybe make it as a hairband, but there is something erotic about the hip, it’s naughty movements.

Context:

How would you use it in everyday life?

[skipped the question, since already answered]

If you were to pass it on - who would you give it?

I would give it to friends... I would enjoy giving it to someone who would care about it.
15.2 Test interview two

Experience:

What is it like wearing the belt?

It is incredible comfortable to wear your belt. It is soft and fits the body without being too tight or uncomfortable.

How are you connected to the other person?

I feel connected to the other person in a completely new way, I have never tried this before, it is physical contact by presence, just by being close. And also, there is light so it is visible to others who may be nearby.

How would you describe the belt as an object?

As an artistic sense object.

What would you tell the next person wearing the belt?

"Try this out. It's crazy!"

Re-conceptualization:

What would make you wear it for more than an hour?

It would clearly be someone I was very familiar with that would carry the second belt, then I could easily wear the belt for a very long time and have the fun seeing how I could effect and be affected by each other person.

If I made a new belt - how would you re-design it?

I wouldn’t necessarily. It is in the right place, both in terms of general comfort, and in terms of stimulation. The fact that it is placed on the hip gives the last dimension of something sensual and challenging. Also the light has an attractive pattern.

Context:

How would you use it in everyday life?

I wouldn’t! It belongs in a performance, maybe one where the audience could get to try it afterwards.

If you were to give it to anyone - who would you give it to?

A good old friend.
15.3 Test interview three

**Experience:**

What was it like wearing the belt?

It was great fun, I instantly engaged in movement and had a laugh playing with possibilities of the belt.

How are you connected to the other person?

Through the movement of our bodies and through the technology also, I guess. But for me mostly the fact that we in order to get the pay off from the belt (to light up each other), we had to share our intimate space.

How would you describe the belt as an object?

As a belt with lights in it - and as a play thing. A toy for grown ups. :-)

What would you tell the next person wearing the belt?

To go crazy, have fun, and to be sure to move closely in order to get the kick of lighting up the other person.

**Re-conceptualization:**

What would make you wear it for more than an hour?

If I was on stage or at a party, dancing.

If I was making a new one - how would you re-design it?

I would make it able to change forms so it wasn’t restricted for hip-wearing, maybe do a whole suit! Or just a pair of pants. Also the tickling effect could be enhanced.

**Context:**

How would you use it in everyday life?

If it was running on solar energy, I would wear it as a fanny pack for Roskilde Festival and then wait eagerly for it to light up during the night. But I guess that doesn’t really count as everyday life... Oh, and if other people had it too it would turn into a dating concept, we could buzz each other.

If you could pass it on - who would you give it too?

Definitely a performer, maybe Oh Land [Danish singer, previous dancer].