PHANTOM PHYSICALIZATIONS

Reinterpreting dreams through physical representation

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ABSTRACT

This thesis begins with a philosophical question: What if we could amplify our waking experience with the aesthetic qualities of dreams? Through a discourse on experiential dream related aspects in philosophy, design and daily life it examines what it means, and has meant, to dream, and how these qualities already permeate the physical world. I hypothesize that objects capable of representing dream related physiological data as physical output have the potential to amplify our waking experience. To formulate a set of considerations for the design of such objects, an ethnographic study of dream experience, comprising a survey, a cultural probe study and interviews, has been conducted. The text concludes by exploring how dream elements like ambiguity, synesthetic sensibility, and affective self-exploration may benefit interaction design, raising questions about how digital media can facilitate personal, meaningful experiences.

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INTRODUCTION
1. INTRODUCTION

“Our revels now are ended. These our actors,
As I foretold you, were all spirits, and
Are melted into air, into thin air:
And like the baseless fabric of this vision,
The cloud-capp’d tow’rs, the gorgeous palaces,
The solemn temples, the great globe itself;
Yea, all which it inherit, shall dissolve,
And, like this insubstantial pageant faded,
Leave not a rack tbehind. We are such stuff
As dreams are made on; and our little life
Is rounded with a sleep.”

— Prospero in Shakespeare’s The Tempest Act 4, scene 1, 148–158

The Merriam Webster English dictionary defines the word ‘phantom’ as:
a) something apparent to sense but with no substantial existence,
b) something elusive or visionary
c) a representation of something abstract, ideal, or incorporeal.

There are few things more enticing and enigmatic than dreams. Dreams have incited many scientific studies and influenced countless works of art. They shape our everyday perception and evoke our affect and conscious thought. Moreover, they spark a sense of wonder and mystery and present us with experiential qualities lacking in waking existence. They are eloquent, ambiguous and ephemeral, a kind of mental apparition, an obscure product of our own mind.

This text discusses how these dream elements extend to interaction design; the design of “interactive products to support the way people communicate and interact in their everyday lives” (Preece, Rogers & Sharp, 2007, p8) It explores how ambiguity and abstraction, qualities also inherent in interaction design, can be used as strategies to create engaging and thought provoking experiences. An extensive theoretical and empirical study of dream experience explores how aspects of dreams can be physically represented during wakefulness to assess how dreams might inspire both individuals and design practice. Finally, two concepts that embody different experiential dream aspects are evaluated to investigate in which ways design can create affective, meaningful experiences that amplify our waking experience with dreamlike qualities.
FRAMING THE DESIGN SPACE
2. FRAMING THE DESIGN SPACE

The experiential tension between the corporeality of waking life and the ephemerality of dreams fascinates me. As a designer I am interested in exploring how dreams affect people and in evaluating how dreams can be represented in a meaningful way during wakefulness. This text investigates how everyday waking experience can be amplified with the rich aesthetics qualities of dreams and explores in which physical forms they can influence our conscious and subconscious waking routines in an attempt to challenge the ways in which we respect, perceive, interpret and remember them. The following questions serve to shape the scope of this research:

Which aspects of human physiology correlate to the dream state and what provokes them?

How can representation of dream related physiological events facilitate a person to establish meaningful dream interpretations?

These goals define a framework of design challenges which give rise to broader set of considerations:

In which ways can the aesthetic qualities of dreams be abstracted, materialized and represented using digital tools?

(How) can the physical manifestation of these qualities enable a personal, affective and meaningful connection with the dreams they represent?

(How) may dreams benefit interaction design and might interaction design contribute to the scientific study of dreams?

These design challenges have shaped the following thesis:

Objects capable of representing dream related physiological data as physical output can create a personal, meaningful user experience.

My aim has been to explore this theory through a user centered process leading to two prototypes which investigate how users interpret, remember and respect their dreams to understand how dreams may benefit interaction design practice.
3 METHODOLOGY: DESIGNING FOR EXPERIENCE
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Experience as interaction design methodology

Interaction design is inherently concerned with the intersection of the physical world and the virtual world. Bill Verplank, one of the first pioneers of interaction design, said in interview that “a lot of our emotions about the world come from the sensory qualities of [the] media we present things with.” (Moggridge, 2007, p 127) Yet the way those media present us with information has changed little about our physical perception of and engagement with the world.1 Takeshi Ishii elaborates that “rendering bits into human-readable form has been restricted mostly to displays and keyboards—sensory deprived and physically limited.” (Moggridge, 2007, p 515) Technological developments like digital projections, computer vision, augmented reality, virtualization, social media and speech/voice recognition increasingly permeate our lives and put us at a remove of our direct physical experience.2 Buchanan (2001, p 11) points out “a common misunderstanding that interaction design is concerned fundamentally with the digital medium” and ponders its concern with the creation of a “concrete form of experience.” In the Poetics of Augmented Space Lev Manovich postulates that “while from the phenomenological perspective of the human subject, the ‘old’ geometric dimensions may still have the priority, from the perspective of technology and its social, political, and economic uses, they are no longer more important than any other dimension.” The tension between the physical and the virtual found in both interaction design and dreams serves as the premise for an investigation of how either may benefit the other. Dunne and Raby argue that “there is a place for a form of design that pushes the cultural and aesthetic potential and role of electronic products and services to its limits “and that “questions must be asked about [...] the way poetic moments can be intertwined with the everyday and not separated from it.”(2001, p 58) If these poetic everyday experiences are to be created, design needs to go beyond designing for the user to instead empower the user to contribute to the design process. (Saffer, 2007, pp. 33-34)

User centered design

Henry Dreyfuss, one of the founders of industrial design, advocates using user centered fieldwork to design products that are not only helpful but also delightful. (Laurel, B and Lunenfeld, 2003, p 36) The design work described in this text is grounded in such a user-centered approach. In user-centered design practice end-users are considered knowledgeable resources (Kuuti, 2009, 67), they are actively involved in the design process so their needs can be translated by the designer into design proposals. (Saffer, 2007, pp.31-32) User centered design (UCD) is concerned with the use qualities of objects. Jonas Löwgren defines use qualities as “properties of digital designs that are experienced in use”. (2006, p 384) When concerned with aesthetics, UCD can be rephrased as “a holistic approach wherein the person with feelings, emotions, and thoughts is the focus of design”. (McCarthy, et al., 2008 p 1). User empathy facilitates the design of artifacts that allow their users to engage in a playful dialog with their environment. (Norman, 2003, p 11-13)

Ludic design

Ludic design is a design practice which values the creation of meaningful experiences through an explorative process of reflection on and engagement with design iterations. The design work in this text is ludic; it relies on “ambiguity, defamiliarization, and an overall anti-utilitarian stance to create open, exploratory and fulfilling experiences.” (Carroll & Hassenzahl, 2010, p67) It is involved with empirically investigating the behavior and values of users. Ludic design derives its name from “Homo Ludens”, a term coined by the Dutch cultural historian Johan Huizinga who describes humans as playful creatures. Huizinga reasons: “in play there is something ‘at play’ which transcends the immediate needs of life and imparts meaning to the action. All play means something. If we call the active principle that makes up the essence of play, ‘instinct’, we explain nothing; if we call it ‘mind’ or ‘will’ we say too much. However
we may regard it, the very fact that play has a meaning implies a non-materialistic quality in the nature of the thing itself.” (Huizinga, 1949, p1)

Prayer Companion (Gaver, 2010) exemplifies the spirit of ludic design by questioning and transgressing spatial rules and conventions. The project has brought forth a communication instrument that informs Roman Catholic nuns in a monastery in York (who have taken a vow of silence) of worldly issues that necessitate their prayer. The device, a small wall mounted ticker tape display, aggregates news and emotive blog posts of anonymous authors into the space of benediction. The nuns expressed that “Goldie” (the device) “has been valuable in keeping [their] prayers pertinent.” (MoMA, 2010) Prayer Companion manages to lay bare contextual routines and traditions at play and to reflect on and to empathize with deeply rooted beliefs, evoking a sense of respectful wonder. “As the Prayer Companion project shows, active listening and imaginative suggestion entail the act of moving over into the life of the other person who is to be designed for. Ludic design takes into account their uniqueness, trying to envision the other party’s involvement in the relationship, in order to imagine quite concretely what he or she is feeling and thinking. But, in such listening, moving over is done without taking over or projecting oneself into what the other is saying.” (McCarthy & Wright, 2010, p57)

**Critical design**

Similar to ludic design, critical design sees its mission in the design of artifacts that provoke stories and provide a critique on contemporary culture. Its aim is to reinterpret established mental models and provide new ways of looking at the world. It values fiction and promotes the extraordinary using irony, humor and subtlety to provoke intimate connections with its audience and to tell compelling stories that force us to reflect on our identity. Critical design lies at the intersection of art and design. It belongs to the realm of the para-functional and the poetic; the conceptual rather than the functional. Sculptor and photographer Philippe Ramette’s imaginative trans-disciplinary projects explore thought provoking aesthetic dimensions. His creations challenge our ways of seeing through their hyper-functionality by focusing “the viewer’s attention on the space between the experience of looking at the work and the prospect of using it.” (Dunne, 2008, p56) Object with Which to See the World in Detail mediates the space between the user and his surroundings, estranging him from the environment.”[...] Devices like an Object with Which to See the World in Detail do not attempt to escape the dictates of functionalism but instead work from within, extending it to include the poetic and playfully subversive.”3 (Dunne, 2008, p56) Similarly, the design work described in this text uses subversive playful strategies, like cultural probes and a high fidelity prototype, to make users reflect on their dreams.

**Designing for the para-functional and post-optimal**

The notion of extending the functional beyond conventional definitions of usefulness and pragmatism is what Dunne refers to as para-functionality. In para-functional design work “[...] function is used to encourage reflection on the way electronic products condition our behavior. The prefix “para-” suggests that such design is within the realms of utility but attempts to go beyond conventional definitions of functionalism to include the poetic.” (Dunne, 2008, p43) Jack Kevorkian’s Suicide Machines, contraptions that allow the user, typically terminally ill, to end their life in a dignified, painless manner, are an example of such work.
extreme example of critical design. In naming his machines Thanatron (death machine) and Mercitron (mercy machine) Kevorkian provokes a discourse on the morality of euthanasia and questions the ways in which technologies affect our lives. Dunne continues: “Para-functionality [...] investigates the design of function (rather than form) to provide new types of aesthetic experience.” (Dunne, 2008, p.XVIII)

Dunne’s concept of the post-optimal, subverting an object’s use to achieve new insights and explore new meanings, complements his notion of the para-functional. “To provide conditions where users can be provoked to reflect on their everyday experience [...] it is necessary to go beyond forms of estrangement grounded in the visual and instead explore the aesthetics of use grounded in functionality, turning to a form of strangeness that lends the object a purposefulness.” (Dunne, 2008, p 41-42) Critical designer Noam Toram has developed such objects. ‘Accessories for lonely men’, a collection of eight objects that “propose that the physicality of most forms of human intimacy is crude enough to be replicated by electronic objects. These objects question what we miss in a relationship; the individual or the generic traces they leave behind.” (Toran, 2001) Devices like the Sheet Thief, Heavy Breather and Hair Alarm Clock make us aware of the “incidental pleasures of shared existence” by mechanically replicating familiar but exasperating behavior.4 (Dunne and Raby, 2001, p 64)

**Ambiguity as design strategy**

Ludic design and critical design employ the para-functional and the post-optimal as oblique strategies to create ambiguous, thought provoking objects that offer rich cognitive and sensory affordances: they provide design features that help us rethink how we feel and what we know about something. (Hartson, 2003, pp. 319-322) Ambiguity is an experiential quality engrained in the fabric of design work, as Löwgren (2007, p 116) puts it: “The meaning of a product is never straightforward and unambiguous; it can never be obtained by the use of some objective scale of measurement.” Benford, Beaver and Gaver (2003, p 233) see ambiguity as a design strategy to “engage users with issues without constraining how they respond, [...] enabling users of different sociocultural backgrounds to find their own interpretations” and to make “a virtue out of technical limitations by providing the grounds for peoples’ interpretations to supplement them.” Ambiguity facilitates the “exploration of [...] conditions for serendipitous discoveries”6, a use quality dubbed ‘pliability’ by Löwgren. (2007, p 92) Pliability empowers imagination and agency, entailing that “during the interaction, the user might learn things he/she didn’t look for and didn’t know he/she was interested in learning.” (ibid., 2007, p 92) Hallnäs and Redström (2002) call the expressive qualities of ambiguity ‘presence’ in their dialectic on meaningful aesthetics. ‘Presence’ is what makes objects meaningful to us, it “refers to existential definitions of a thing based on how we invite and accept it as a part of our lifeworld.” (p 219)

In Design Noir Anthony Dunne and Fiona Raby argue for “a form of design that pushes the cultural and the aesthetic potential and role of electronic products and services to its limits” by asking question about “what we actually need [and] about the way poetic moments can be intertwined with the everyday and not separated from it.” (2001, p 58) Their Placebo Objects belong to a dimension in which ambivalence and friction are treated as poetic strategies that scrutinize the way people are affected by technology. Many works at the intersection of art and design critically reflect on the poetic ambiguity of the convergence of technology and the human body. Elio Caccavale explores issues of identity in the
fabric of everyday life. Caccavale’s Future Families “investigates new reproductive techniques and the effect they might have on our notions of identity, self, and the family” in a world where “a baby can have up to five people responsible for its birth – a sperm donor, egg donor, a surrogate mother, and a couple of any gender combination (or a single mother or father) who will raise the child,” (Antonelli, et al., 2008 32) Alexandra Daisy Ginsberg uses microscopic organisms to shape her projects. By blending art, design and synthetic biology she raises questions of control, authority and the ownership of our bodies. These works contain cognitive and sensory affordances that explore how personal aesthetic moments can be used to reimagine embodied experience.
THE PHENOMENOLOGY OF DREAM EXPERIENCE
4. THE PHENOMENOLOGY OF DREAM EXPERIENCE

“Our life is twofold; Sleep hath its own world...
And dreams in their development have breath
And tears, and torture and the touch of joy;
They leave a weight upon our waking thoughts,
They take a weight from off our waking toils.”

Excerpted from the first strophe of The Dream by Lord Byron, 1816

Interaction design, experience and dreams
Jon Kolko describes interaction design as “a process that connects people, technology, and the emotional qualities of sensory data, generally pertaining to aesthetics” (2007, p42) Löwgren (2006, p3) goes as far to argue that “aesthetic experiences answer to our needs for a sense of meaning and wholeness, and push us over the threshold of doing something for its own sake” claiming that “aesthetic experience [...] spans the analytical mind and the bodily experience.” Aesthetic in this sense means more than mere sensation, but is used in a philosophical sense in Baumgarten’s tradition, who delineated aesthetics as “the science of sensual cognition”. (Hammermeister, 2002, p 7) In the context of this text aesthetics refers to events or properties (of designed artifacts) that evoke a sense of experiential beauty. The dream world, amplified with elevated modes of sensory operation, presents such existential aesthetic qualities that are valuable to design for experience. It is thus necessary to assess the aesthetic qualities present in dreams from the perspective of phenomenology.

Phenomenology may be understood as the study of “the essence of perception. [...] It tries to give a direct description of our experience as it is, without taking account of its psychological origin and the causal explanations which the scientist, the historian or the sociologist may be able to provide.” (Merleau-Ponty, 1962, p VII). Stenslie (2010, p 181) observes that “from a physiological point of view we are constantly immersed in an ocean of physical impressions” and contemplates “how we consciously process these impressions and –in turn– how we use them to form and give meaning to the world”. Phenomenology proposes a philosophy of the self that relies on experience, “if ever any kind of history has suggested the interpretations which should be put on it, it is the history of philosophy. We shall find in ourselves, and nowhere else, the unity and true meaning of phenomenology.” (Merleau-Ponty, 1962, p viii). This chapter examines dreams from the perspective of experience.

Contextualized meaning
Paul Dourish’s notion of embodiment explains how things derive their meaning from the way we interact with them: “Embodiment is the property of our engagement with the world that allows us to make it meaningful. [...] Embodied Interaction is the creation, manipulation, and sharing of meaning through engaged interaction with artifacts.” (Dourish, 2001, p 126). Embodiment denotes how “interaction is intimately connected with the situations in which it occurs”. (Dourish, 2001, p 19). Dourish continues: ‘embodiment is about the fact that things are embedded in the world, and the ways in which their reality depends on being embedded.’ (2001, pp.18–19) ‘Embodied phenomena [...] gain their meaning through participative status as objects in felt experience.’(McCarthy and Wright, 2004 pp. 17)
John Berger writes that “every image embodies a way of seeing. [...] The photographer’s way of seeing is reflected in his choice of subject.” Berger elaborates that “the painter’s way of seeing is reconstituted by the marks he makes on the canvas or paper. Yet although every image embodies a way of seeing, our perception or appreciation of an image depends also on our own way of seeing.” (1972, p 10) While our dreams are products of our own unconscious mind, our waking reflection on the experience is equally subjective.

Figure 4: Gerhard Nordström’s Vietnam critical painting “Sommaren 1970” tries to literally refra... its audiences focus

Waking experience is governed by the spatiotemporal constraints of physical reality and is limited to what we can see, hear, feel, smell and taste. In contrast, dreams mark the threshold of what is real and what feels real. Gaston Bachelard ascribes spatial elements similar imaginative qualities. His writing interprets architectural forms as “edges of the imagination, recesses of the psyche, [and] hallways of the mind” ([1958],1994: vii) and emphasizes the importance of the experiential potential embodied by lived environments. Some of these environments (i.e. the Sydney Opera House or the Malmö based Turning Torso) are in their appearance much like dreamscapes.

Raw and processed experience

Kant’s approximation of experience is twofold. One kind is the raw uninterpreted sensation; the experience itself, the other is experience subjected to rationalization; the ‘thought’ of the experience. “The experience with which all our knowledge is said to begin is the raw material of the sensible impressions; experience in this sense is then said to be worked up by the understanding into that knowledge of objects which is entitled experience” (Van Cleve, 2003, p 73) Dreams not only evoke experience during sleep, but also during our wakeful reflection on them, we rationalize them when trying to understand them. At the same time dreams seem to embody essential properties of Kant’s conception of both phenomena (objects which appear in some form to the senses) and noumena (objects which in themselves are inaccessible to experience). (Van Cleve, 2003, pp. 34-136) Dreams have a direct effect on human anatomy (e.g. being covered in sweat while waking from a nightmare) but since consciousness is lacking when they emerge, it is hard to evaluate how we experience them. Yet, everybody knows that dreams are fundamentally experiential. This means waking dream interpretation faces a challenge; the fleetingness and fragmented nature of wakeful dream memories makes interpreting them in physical reality problematic.

Being there

Heidegger’s notion of Dasein, roughly understood as ‘our being in the world’, can in a way be used to describe the existential encounters that are often found in dreams. While inside the dream we are really ‘there’, yet the moment we wake up we are reminded of the fact that our wakeful presence is of a different kind entirely. Yet Dasein can be seen as a form of existential self-awareness present in both sleep and wakefulness. It relies on our subjective understanding of the environment and our place in it; “[it] is particular by being neither conventionally nor objectively individuated but by having ‘mineness’ (Jemeinigkeit), that is, by always having a reflexive understanding of itself, however unthematic, in its understandings of the world.” (Carman, 2003, p 36)
Mihaly Czikszentmihalyi’s (1997, p 29) definition of ‘flow’ which relates the momentary sense of effortless action felt when fully immersed in waking experience describes a detachment from embodied experience. Flow demarks a sense of timelessness; a disconnect between the feeling of being ‘in the moment’ and external temporal reality also present in dreams. Like dreams, flow envelops us in the ecstatic feeling of being outside everyday reality. “Being involved into a completely engaging process of experiencing something new, [one] doesn’t have enough attention left to feel his problems, even his identity disappears from his consciousness. Existence is temporarily suspended.” (Czikszentmihalyi, 2008)

The realness of dreams

This brings into question the ‘realness’ of dreams; do they actually exist at all as subconscious mental entities, or are they mere hallucinations; imaginative projections made by the mind as it transgresses from sleep into wakefulness. The concept of the ‘simulacrum’, explored from different perspectives in the work of Jean Baudrillard and Gilles Deleuze, may help explore the issue. Baudrillard defines simulacra as a hierarchy of symbolic simulations of reality leading to a state of ‘hyperreality’.  

“[...] The first level is an obvious copy of reality and the second level is a copy so good that it blurs the boundaries between reality and representation. The third level is one which produces a reality of its own without being based upon any particular bit of the real world. [...] It is this third level of simulation, where the model comes before the constructed world, that Baudrillard calls the hyperreal.”  

(Lane, 2000, p.30) While dreams are probably influenced by our waking experience, the events portrayed in them are surreal. One might argue that, in a sense, dreams exist at the level of the hyperreal. Representing dream physiology in physical form would thus, in a way, give substance to a realm of hyperreal meaning and allow us to experience and reinterpret the dream through our waking senses. “The simulacrum”, Deleuze delineates, “is not a degraded copy. It harbors a positive power (puissance positive) which denies the original and the copy, the model and the reproduction [...] It is the simulacra which enables both the notion of the copy and the model

to be challenged. (1969:302; 1990:262).” (Ansell-Pearson, 1999, pp. 17-18) The notion of transcendental meaning was epitomized by one of the cultural probe informants who imagined a device that would allow its user to “wake up from the dream we call reality”. (I5)

Intrapersonal value

Dream interpretation is inherently subjective, implying that personal meaning can only come from the dreamer himself. Like art, it is only relevant to a select audience. If dreams are to provide new inspiration, perhaps we need only look at them from a different perspective. Most artists do not create paint or canvas in order to use it as a tool for creative self-expression; similarly interaction design cannot interpret dreams for people, but may instead offer tools for exploring dream interpretation in a way that is meaningful to them.
5 EXPERIENTIAL DREAM-LIKE QUALITIES IN DESIGN
Dreams embody virtual, corporeal, immersive and synesthetic qualities also present in interactive works of art. This chapter explores these experiential aspects and looks at how art and design can be used to make visible the virtual and ephemeral and to transgress the physical. The ‘virtual’ is used here in the broadest sense, it extends the artificial; screen-based or other digitally mediated experiences. with the immanent; the enigmatic potential and mysterious appeal of unfathomed experience in general. As Brian Massumi puts it: the virtual is the “‘real but abstract’ incorporeality of the body”. (2002, p 21)

It tries to classify these experiential aspects under two inspirational patterns. Inspirational patterns are “abstractions of core ideas and essential elements from a class of coherent examples, pointing to promising regions in the design space.” (Löwgren, 2007, p 1)

Abstraction is inherent to interaction design. Generalized abstractions of user groups (known as personas) are often used to quantify user experience. In the object oriented programming paradigm abstraction is a strategy to make code more robust. But perhaps more importantly, interaction design makes use of our ability to use ambiguous visual and verbal metaphors to create and communicate meaning. The works discussed in this chapter embody these expressive qualities. Some of them are relevant because they regard the body as interface, others induce dream-like sensory experiences and yet others critique how we experience everyday life or bring to our attention hidden connections and meanings.

**Revealing enigmatic phenomena**

Don Norman calls for the use of technology to make visible what would otherwise be invisible to “supplement our perceptual abilities”. (1988, p 193) Norman argues that “[…] the microscope and telescope, television set, camera, microphone, and loudspeaker all provide ways of getting information about a remote object, making visible (or audible) what is happening, making possible tasks and pursuits that would otherwise not be possible.” (1988, p 192) Andrew Friend’s Device for Experiencing the Invisible (2010) and Device for Experiencing Lightning Strike can be regarded as para-functional objects for witnessing even more elusive experiences.
The former is a parabolic dish which should be used near sources of radio, paranormal or electrical activity to “uncover new, previously unseen landscapes and instances” (Friend, 2010), the latter is a mechanical appendage that allows its user to embody the experience of being struck by lightning in the purest sense. By converting energy from a lightning strike into heat, the user is left with a scar to remember the event.

Similarly, The Sigh Collector (2012) by Michael Kontopoulos visualizes the bad karma in the air by giving physical volume to our emotions of discontent.14 The project features a belt connected to a post-optimal device which inflates a balloon shaped bag little by little each time the wearer of the belt sighs, over time spatially visualizing the user’s discomfort.

The Morpheus Tree, conceived at the Copenhagen Institute of Interaction Design by Kristjana Guðjónsdóttir, Mette René Lyckegaard and Hyeona Yang, is a lamp which visualizes the user’s sleep pattern. Beads hanging from the lamp visualize the amount of light and in deep sleep. The device receives input from the user’s smartphone which, when placed in bed, detects the user’s movements and informs the system wirelessly of the user’s sleep behavior.

**Synesthetic embodied experience**

Synesthesia is a chronic mental condition which affects the sensory perception of the world. The senses transgress their normal boundaries and bleed over into each other. Synesthetics experience the world in a different manner, and are for example able to ‘see the colour of sound’. (Cytowic, 2002, p xii) Similarly, some post-optimal objects allow sensory modalities to be substituted, so that sight, sound, smell, taste and touch can be experienced in new ways.

Some works explore what happens when the human body is exposed to an exuberance of stimuli. Sitraka Rakotoniaina’s strange contraptions directly affect the body. Beam me down! (2010), one of his ‘Hyper Normal’ installations, explores the aesthetic qualities of short term memory loss. An air pump hidden behind a trapdoor quickly pushes air in and out of the user’s lungs to induce hyperventilation and fainting, ultimately leading to temporary disorientation.
Zee (2009) by Kurt Hentschläger consisted of a room filled with strobe lights, smoke and humming sound. Visitors who enter the space are deprived of their ability to see, communicate and navigate, bringing about a sense of claustrophobic weightlessness and inducing vivid visual hallucinations.

Other objects allow the body and the senses to be reinterpreted. Music for Bodies, a research initiative that explores other haptic sensory modalities to experience sound created Sonic Bench Malmö, an outdoor bench which uses transducers to allow the user to feel sound vibrations as kinesthetic output. Drawdio, a device which can be attached to a pencil, replaces touch with sound by turning the graphite trails left by the pencil tip into haptic ‘circuit bendable’ sound sources which can be played back through touch.

Yet other objects deprive the users of their senses in order to experience the world in a different manner. Mattia Casalegno’s The Open is a mask which covers the user’s face with a strip of grass, forcing the wearer to smell the turf and listen to his own breathing. Casalegno describes the tension between stimuli and perception as a strategy to divert the user’s perception towards an inner space.
DREAMS MATERIALIZED AS WORKS OF ART AND SCIENCE
Throughout human history dreams have been a source of inspiration and insight. In Antiquity unconscious inspiration was personified as the Muses, beautiful women who were said to visit artists in their dreams and motivate them to turn their thoughts into fresco’s and sculptures and works of prose and poetry. (Devereux, 1975, p xxvii) Dreams have profoundly influenced both artistic and scientific work, from Shakespeare’s plays to Dali’s Surrealist paintings, from Bohr’s discovery of the atom to Mendeleev’s invention of the periodic table of elements. This chapter examines how dreams have shaped works of art and scientific innovations.

**Dreams as the subject of the work**

In Alice in Wonderland (1865), published by English deacon, mathematician and author Charles Lutwidge Dodgson under the pseudonym Lewis Caroll, a small girl’s adventures in a magical place are revealed to be a series of dreams. Kubla Khan (1797), a poem by Samuel Taylor Coleridge, narrates an exotic and surrealistic dream the author had while under the influence of an opiate.

Moritz Ludwig von Schwind’s painting ‘The Dream of a Prisoner’ (1836) shows an incarcerated man sleeping on the floor of his cell, while his dream-self hovers over his body and escapes through the metal bars, free from physical imprisonment. Graphic artist M.C. Escher draws from his own dreams in his mathematically inspired works of art which depict impossible worlds wound in warped perspectives. ‘Dream (Mantis Religiosa)’ (1935), one of Escher’s woodcuts, depicts a praying mantis hovering over a sleeping bishop, inviting the viewer to ponder if the bishop is dreaming about the mantis or if the entire scene has been reconstructed in the image of the artist’s dream. An amalgamation of the dream world and physical reality serves as the premise of countless movies, among which Waking Life (2001), The Science of Sleep (2006), The Good Night (2007) and Inception (2010).

**Work inspired by dreams**

Mary Shelley’s novel Frankenstein (1818) was in part inspired by a dream and was conceived under the influence of laudanum, an opium infused alcoholic beverage. (Packer, 2002, p143) Similarly Edgar Allen Poe’s A Dream Within A Dream (1849) was inspired by a dream. Novelist Robert Louis Stevenson is said to have trained himself to ‘dream up’ the plots of his books. The premise of his classic ‘The Strange Case of Dr. Jekyll and Mr. Hyde’ (1886), was conceived by remembering a dream.¹⁸

Dreams are an equal source of inspiration to pictographic works. Peter Paul Ruben’s Decius Mus Addressing the Legions (1616) and The Death of Decius Mus in Battle (1618) depict the eponymous Roman consul addressing his troops and sacrificing himself in battle to spur his men to defeat their enemies after having dreamt about defeat. Perseverance (1982) by Francesco Clemente was made after the artist had a dream in which he was walking through New York naked while it was raining excrement. Dreams are said to have inspired Salvador Dalí and his colleagues to start the Surrealist art movement.¹⁹ Dalí’s Temptation of St. Anthony (1946) and The Persistence of Memory (1931) feature an array of strange objects and dream creatures.

“I believe it to be true that dreams are the true interpreters of our inclinations; but there is art required to sort and understand them.”

— Michel de Montaigne in Gardner, Skeptical, 10
Work containing dream-like qualities


Dreams leading to revelations

Dreams are said to have inspired several scientists to make Nobel Prize winning discoveries in a variety of scientific fields. Guided by insights from a dream, The German physiologist Otto Loewi devised a series of experiments to prove that nerve impulses are transmitted chemically rather than electrically, while Danish physician Niels Bohr discovered the structure of the atom by seeing a nucleus surrounded with spinning electrons in a dream. August Kekulé von Stadonitz dreamt about a snake seizing its own tail, leading him to find the circular structure of the Benzene molecule and Russian chemist Dmitri Mendeleev is said to have been inspired by a dream when inventing the periodic table of elements. American inventor Elias Howe claimed to have gotten the idea of using hollow needless for his sewing machine after having dreamt about being attacked by cannibals with hollow tipped spears.

Hollywood cinema, commonly referred to as the “dream factory” (Bulkeley, 2003, p.50) draws in many ways from the ambiguity and mystery of dreams. Alfred Hitchcock’s Spellbound (1945) features an absurd, seemingly meaningless dream which ends up containing important clues about the main character’s involvement in a mysterious death, while in Hitchcock’s Family Plot (1976), bad dreams are recounted as memories tormenting one of the main characters. In anything, Hollywood epitomizes the “American dream”; America’s nation-wide belief that wakeful desires can be realized through freedom and hard work. “The American dream tells us that we can achieve what others elsewhere only imagine and that we can turn the ethereal into the material. [...] For both Freud and the dreamers of the American dream, the dream is a place where fantasies are fulfilled.” (Packer, 2002, pp. 14-15)

Figure 9: Neo sees inside the fabric of the virtual world that is the Matrix

Figure 10: August Kekulé von Stadonitz dream about an Ouroboros; a snake eating its own tail. The cyclical shape of the animal is said to have led him to the discovery of the chemical makeup of Benzene.
7 A CULTURAL HISTORY OF DREAM INTERPRETATION
 Dreams in Antiquity: Anthropomorphic omens

In ancient Greece dreams belonged to the realm of the divine. Dreams were perceived to be a communication conduit between the gods and men and were even attributed healing qualities. Pilgrims would sleep in designated ‘dream’ temples called Asclepeions to ‘incubate’, believing that dreams could cure their ailments. (Walde, 1999, p 121) In Greek mythology, the ‘Oneroi’, children of Hypnos (Somnus in Roman mythology), the god of sleep are the embodiment of dreams. In modern times they lend their name to the scientific study of dreams (oneirology). The Oneroi are said to have guarded two enormous gates representing both prophetic and meaningless dreams in the underworld, depicted in verse by Latin poet Virgil as a source of both revelation and deception.  

At this time the significance of dreams had already become problematic, they were ascribed a multitude of ambiguous origins and interpretations: “[..] dreams had their origin in exterior reality, or were caused by divine influence, or by the dreamer’s psyche, or the functions of his or her body.” (Walde, 1999, p122) Artemidorus wrote an expansive discourse on the meaning and interpretation of dreams in Oneirocritica, envisioning incestuous dreams as having both positive and negative interpretations and as relating to a measure of future political power. In contrast Plato does not attribute any meaning to dreams of indulgence. (Walde, 1999, pp. 144-155), but sees the less lustful dreams as containing the valuable content and believes the mind “may in isolated purity examine and reach out toward and apprehend some of the things unknown to it, past, present or future” (572 A). Aristotle, adversely, believed that predictions made in dreams were mere coincidences and that they were conceived by the influence of external stimuli on the sensory system during sleep. (Walde, 1999, pp. 123-144)

Dreams in China: Causal entities

In Chinese cultural heritage dreams are also rich in equivocality. The Zuo zhuan, an ancient work of prose chronicling the earliest written historical narrative of China, treats dreams as objects of causality. Meaning is deduced from the interpretation of dream signs and their contained advice or warnings. In the Zuo Zhuan two motifs take center stage: choice and morality— and the enigmatic and mystical beyond human comprehension. (Li, 1999, p 17) In the Zuo Zhuan dream experiences invoke an awareness of responsibility and human agency while also deterministic and formative of destiny. The interpretation of dreams is seen as restoring the equilibrium between the physical and the metaphysical world. (Li, 1999, p18) The text places dream interpretation in a social context, and considers dreams in many instances as objective

Reflection takes place on another level. The idea that the dreamer might be dreamed by another is the theme one of the most significant dreams discussed in the text; Zhuang Zhou's butterfly dream. "Zhuang Zhou once dreamed he was a butterfly – joyous and carefree in being a butterfly. His heart's desires were fulfilled, and he did not know about [Zhuang] Zhou. He did not know whether he was [Zhuang] Zhou dreaming of a butterfly, or a butterfly dreaming of being [Zhuang] Zhou. Between being [Zhuang] Zhou and being a butterfly there must be a difference." (ZhZ 2/23 in Li, 1999, p 31) In a way the Zuo zhuan questions the fabric of reality, in the butterfly dream one cannot exist without the other, but which can exist without the other, and which cannot, is unclear. This is related to one of the predominant themes in the text: death, and in particular the death of the dreamer, which is viewed as an augury void of morality.

**Dreams in Amerindian culture: Communicative tools**

Death is also a predominant theme in Amerindian dream tradition. Dreams serve as a space for contacting deceased ancestors. Members of the Zuni and Navajo tribes induce dream-like trace states by ingesting hallucinogenic cacti (peyote) to actively seek contact with dead. Dreams are expressed in and explained through communal folklore and mythology. There exist numerous theories on dream meaning and origin in Amerindian culture, each differing from tribe to tribe. One theory tells of a part of the self, travelling outside the body to visit foreign locations and experience past and future events. Another theory dictates that dreams are a gateway to communicate with the multiplicity of souls that the dreamer embodies. Yet another revolves around gods or ancestors approaching the dreamer with cosmic visions and messages from other places and times, a dream state which shamans call the ‘lightning-soul’.

Memory plays an important role in dream interpretation. Tedlock (1999, p 91) elucidates how a member of the K’iche’ Maya tribe in Guatemala thinks of dreams as auguries that need to be 'conquered' in order to be fully understood, hidden messages have to be revealed through ritual means and are interpreted through the communal wisdom of the tribe. (1999, pp. 87-92) Meaning evolves from the ever changing collective memory of the tribe.

**Dreams in India: Philosophical riddles**

Memory is also an instrument for the discovery of meaning (or lack thereof) in Indian dream culture. The Manimekalai is the first Tamil dream book in Buddhist tradition. It tells the story of the eponymous heroine Manimekalai who revisits dreams from past lives in her journey down the path of Buddhism in search of spiritual enlightenment. (Shulman, 1999, pp. 43-48) Indian philosophers Vasubandhu and Adi Śankara held conflicting opinions on experience in dreams. Vasubandhu posed that dreams prove that there can be experience without the presence of external, physical objects, while Adi Śankara disputes this notion by arguing that dreams cannot be understood without accounting for an external reality that makes them possible. (Ram-Prasad, 1995, p 226)

**Dreams in contemporary culture**

The multitude of interpretations discussed in this chapter attest to the importance of dream interpretation in the past. In recent times Hoffman, et al., and other sleep researchers have attested that stressful events prior or during sleep impact people’s dreams: “elements of the experience can be incorporated directly into the dream narrative, the emotionality of dreams can be modified, activity in the dreams can be changed and the types of interactions in the dream can be altered.” (Hoffman, et al., 1993, p 322) This implies that although in modern times we may not give our dreams much thought, they still affect our wakeful condition. For instance, it is debated that “dreams serve an adaptive function in dealing with contemporary stress” providing “an opportunity for the dreamer to integrate affectively charged material with the past, similar material that has already reached a successful resolution.” (Hoffman, et al., 1993, p 322) The next chapter elaborates contemporary perspectives on dreams.
8 DREAMS: ENIGMATA OF THE COGNITIVE SCIENCES
While dreams have inspired many individuals, science has yet to agree on the function of dreams and the subconscious mind. The aim here is to understand and correlate psychological and physiological theories on dreams and to discuss where they overlap and contradict each other, to explore different ways in which dreams are valued and interpreted.

**Dreams in psychoanalysis**

**Dreams embodying unconscious desires**

Sigmund Freud, an Austrian neurologist and pioneer of modern psychoanalysis, was a prolific writer on the subject of dreams. Freud’s study of the contents of dreams led him to think of dreams as tools for understanding the workings of human cognition and behavior, claiming that “it possible to interpret dreams, and that [...] every dream reveals itself as a psychical structure which has a meaning and which can be inserted at an assignable point in the mental activities of waking life”. (Freud, 1980, p 35) In his lectures and essays he speaks exhaustively about the psychological significance of dreams. Freud perceives dreams as fulfilling unconscious wishes and desires.25 His dream theory comprises two definitions of ‘unconsciousness’: that what is latent at the moment (escaping our attention) and that which is an unconscious wishful impulse (a desire) making dreams possible: “[...] the unconscious is a particular realm of the mind with its own wishful impulses, its own modes of expression and its peculiar mental mechanisms which are not in force elsewhere”.

(Lecture 13, pp.211-212)

Freud makes a clear distinction between the unrefined contents of the dream and their rationalized interpretation. The subconscious thoughts of the dream are classified as latent dream-thoughts, described by Freud as “[...] the concealed material, which we hope to reach by pursuing the ideas that occur to the dreamer.” (Lecture 7, p. 120) “The manifest dream content”, the interpretation and rationalization of the dream, is described by Freud as “what the dream actually tells us” (Lecture 7, p. 120) and used to theorize how dreams get constituted; his concept of ‘the day’s residues’, described as “something that is derived from our conscious life and shares its characteristics” (Lecture 13, p. 212) describes the complex psychic process of dream construction known as ‘the dream-work’. The dream-work encompasses “that what makes a dream seem strange and intelligible to us.”26 (Lecture 9, p 136)

**Dreams as reflections of conscious behavior**

Interpretation of dream content is also a central in Carl Jung’s work. Originally a student of Freud, Jung valued the actual dream content instead of the associations resulting from their analysis. (Packer, 2002, p 37) Believing dream symbols to be unambiguous representations of the unconscious mind, he argued that dream imagery could remedy traumas and emotional distress, “Dreams . . . are natural phenomena which are nothing other than what they pretend to be. They do not deceive, they do not lie, they do not distort or disguise, but naively announce what they are and what they mean.”27 (Jung, 1974, cited in Packer, 2002, pp. 7-8).

Jung argued that “self-subsistent meaning is suggested in dreams” (Jung, 1973, p 87), which would later constitute his definition of synchronicity; unrelated events which are experienced meaningfully together. Jung believed dreams are as real as reality to the one having experienced
Dreams as a functionless evolutionary residue

There also exists a minimalist theory of dreams that claims that dreams are devoid of meaning and function. Owen Flanagan, professor of philosophy and neurobiology at Duke University in North Carolina has written extensively on consciousness. His theory is grounded in evolutionism and ascribes dreams no biological function, viewing sleep and sleep cycling as a by-products of Darwinian adaptationism (natural selection based development). He does not regard dreaming as a by-product of the process of adaptation but sees dreams as a side-effect of a system designed for aware cognition and sleep. (Barcaro, 2010, pp. 1-2) Flanagan goes on to argue that dreaming is a result of functions performed during wakefulness and sleep and suggests that dreams have never been exposed to the pressure of biological selection. (Barcaro, 2010, pp. 2-3) However while lacking a clear function he does not regard them as being void of meaning. He argues that dreams, while lacking functionality, still have significance for psychological science, therapy and self-knowledge. (Flanagan, 1999, p 25)

Dream theories

Dreams resulting from psychic interferences

Numerous conflicting cognitive theories exist on the function and purpose of dreams. John Allan Hobson and Robert McCarley (1977) claimed the mind is subconsciously affected by ‘noise’ (electrical impulses) during the dream state, a process they called activation-synthesis. Activation-synthesis theory proposes that “dreams are caused by random signals arising from the pontine brainstem during REM sleep; the forebrain then synthesizes the dream and tries its best to make sense (i.e., dream images) out of the nonsense (i.e., random impulses) it is presented with.” (Zhang, 2009, p 92) Seligman and Yellen (1987, p 1) hold that “what we experience as a dream consists of a cognitive attempt to integrate a series of internally generated visual hallucinations, which are unrelated to one another, with internally generated emotional episodes.”
Dreams as part of memory consolidation

Neuroscientist Jeff Hawkins disputes this claim by arguing that a well-defined theory on how the brain works is still lacking. Hawkins explains how memory sequences are “auto-associatively” recalled and require no conscious thought. According to Hawkins the neo cortex, the part of the brain that takes care of sensory perception, is in charge of memorizing information and “playing it back” next time in a similar situation effectively enabling us to “predict the future” and “to make intelligent decisions”. Bloch, Hennevinm, and Leconte correlate REM (rapid eye movement) sleep and the waking learning process, and suggest that dream sleep may be important for memory consolidation. Sara Mednick, et al. “propose that REM sleep is important for assimilating new information into past experience to create a richer network of associations for future use” and for “the forming of associative elements into new combinations which either meet specified requirements or are in some way useful’. According to Mednick dreams “manifest intense creativity but escape the control of individual reason or collective authority”. “Schmitt, J.C., 1999, p 274”

Dreams as defense mechanism

Finnish sleep researcher Antti Revonsuo argues that dreaming is an evolutionary mechanism that prepares us for day-time hazards, something he refers to as ‘threat-simulation theory’. Revonsuo believes that dreaming is biologically programmed into the brain. He argues that nightmares “[…] force us to go through those simulated threatening events, in order that when in the waking world we encounter similar or different kinds of threatening events, we are more prepared to survive those when we have been training for them in our dreams.” By being exposed to threats, he states that we can condition our subconscious behavior during wakefulness. He exemplifies his theory by making mention of parents dreaming their children are in danger and young women dreaming about involuntary pregnancy.
Dreams, memory and perception

Dreams have also demonstrated relation to memory, leading to the creation of “rich associative networks, mapping our past and predicting our future” (Walker, M.P. and Stickgold, R. 2010, p 114). From Cay, et al.’s theory may even be deduced that dreams might positively affect our waking perception of the world: “Compared with quiet rest and non-REM sleep, REM enhances the [...] the integration of unassociated information. [...] for creative problem solving, a process, we hypothesize, that is facilitated [...] during REM sleep.” (2009).

Our wakeful experience is also affected by our ‘body clock’, known as the sleep-wake circadian rhythm. The circadian rhythm is “synchronized to environmental cues. [...] In most mammals and humans, the light-dark cycle is the most potent stimulus.” (Goldman and Markov, 2006, p 6) Scientific journalist Jessa Gamble describes how our sleeping and waking rhythms are affected by our urbanized lifestyle. When people live without artificial light, they typically sleep twice per night; they go to sleep around 8 p.m. until mid-night and again from 2 a.m. until sun rise. In between sleeping they tend to stay in bed in a restful state. In this restful state the body produces prolactin, which has been shown to increase wakeful awareness. (Gamble, 2010) Test subjects, who live urban lifestyles, report feeling more awake than ever before when adopting said sleep pattern. Gamble argues that jet lag, shift work and 24 hour business in an ever more globalized world further impact body chemistry in unforeseen ways and impact our wakeful perception. (Gamble, 2010)

Rapid eye movement

The relationship between rapid eye movement (REM) sleep stages and dreams has been speculated as early as 1892 by George Trumball Ladd who believed that eyes move during dream episodes.  

(Dement, et al. 1962 p. 235) Over half a century ago the correlation between dreams and the Rapid Eye Movement (REM) sleep state was formally established. Barrett elaborates: “In the 1950’s researchers discovered that human sleep has 90 minute cycles, each one containing a period of rapid eye movement sleep or REM sleep, and that each period of REM is accompanied by a dream. If researchers work a subject right at the end of a REM period, they got 5 dreams a night, even though most of these would be lost by morning.” (Barrett, 2011) Around the same time the relationship between REM sleep and physiological impulses was discovered, impulses that were indicative of events in the dreamers sensory perception. Roffwarg described that the “support for existence of a biological relationship between mind and body events during the REM state is contributed by the finding of heightened vividness of imagery at moments of greatest physiological variation” and that “there can no longer be any doubt that a dream, far from being merely a diaphanous and elusive creature of mind, is the sensate expression of a fundamental and rhythmically repetitive, and enormously active neurophysiological state.” (Roffwarg et al., 1966, p 606) Hori, et al. (2008, p 128) attest to the correlation between REM, dreams and their recollection: “During rapid eye movement (REM) sleep, the rate of dream recall is higher, with more vivid and clearer recall, than during non-REM sleep.”
CONSUMER AND SCIENTIFIC SLEEP TECHNOLOGIES
9. CONSUMER AND SCIENTIFIC SLEEP TECHNOLOGIES

Sleep related products

To contextualize my design process I have made an analysis of sleep and dream related products, and body area network technology. A multitude of products and services endeavor to improve sleep efficiency. The WakeMate, by the eponymous company, is a wrist-worn motion sensor which detects when the wearer enters a light sleep cycle to wake him up to reduce sleep inertia. Zeo Personal Sleep coach features an EEG headband, smart alarm clock and online sleep journal. SleepTracker Elite, a wristwatch equipped with an integrated accelerometer offers similar functionalities. LightSleeper is a lamp which projects a circular moving light on the user’s ceiling, intending to lull him asleep. Marpac produces a line of ‘sound conditioners’; white noise generators that aim to induce sleepiness. Remee is a crowd sourced lucid dreaming eye mask produced by Bitbanger Labs that purportedly allows its user to become aware that he is dreaming by pulsating a preconditioned pattern of lights integrated in the mask intended to remind the user of the preconditioned waking routine during slumber. Jukusuri-Kun, a Japanese invention, is a robotic bear that aims to reduce sleep apnea (breathing complications due to snoring). The bear reads the users blood oxygen levels through a wrist worn sensor to detect when the user is snoring and gently wakes the user up by tickling his face. There are also countless mobile apps that relate to sleep and dreams. Some of them are quite straightforward in their use, involving tools to improve or manage sleep, to track sleep and to record sleep talking. Other, more esoteric ones claim to be useful for interpreting dreams or for learning how to induce ‘lucid’ dreams (dreams in which the dreamer is aware of the dream experience).

While tapping into the dream experience may still lie beyond the reach of science, the relationship between our dreams and our physiology can be quantified. The following section examines which physiological signs are affected by sleep and which technologies can be used to monitor them.

Recording sleep physiology

Polysomnography (PSG) is the established method for the scientific study of sleep and dreams. (James D.Geyer, Paul R.Carney, Troy A.Payne, 2010) Polysomnographic practice combines multiple techniques including actigraphy (motion sensing), spirometry (respiration monitoring), electroencephalography (measuring of brain activity) to detect the multiplicity of ways in which the physiology of the research subject affects and is affected by sleep. This methodology favors reliability over comfort of use in order to maximize scientific validity. While offering certain advantages, polysomnography was neither achievable, nor appropriate for accomplishing of my design goals.

Electroencephalography (EEG), one of the measurement techniques used in polysomnography, is the recording of electrical activity along the scalp. EEG equipment used in laboratory settings is highly intrusive compared to the measurement of other physiological metrics. Conductive gels, electrodes and sensors applied to the head of the research subject increase the accuracy of the readings but inherently influence the dream experience. The electric potential measured using EEG is not only influenced by the dream but by various other environmental and bodily influences and comprises a wide frequency spectrum that depends can only be thoughtfully analyzed by a neuroscientist. Professional EEG equipment is also costly, although consumer hardware is making its introduction.

My attempts to establish contacts with Emotiv and Neurosky, two manufacturers of consumer EEG equipment, did not amount in collaboration, pushing the technology beyond my budget and out of the scope of my research.
Actigraphy comprises the recording of bodily movements during sleep and can be used to “approximate sleep versus wake state during 24 hours and [...] has been used for monitoring insomnia, circadian sleep/wake disturbances, and periodic limb movement disorder.” Changes in movement during the night are indicative of cycling through the different phases of sleep. (Ancoli-Israel, 2003, p342) For instance, during REM the tongue almost ceases to move. (Sauerland and Harper, 1976, pp.160-170) Actigraphy provides a less invasive alternative to polysomnography, “when compared to PSG, actigraphy was found to be valid and reliable for detecting sleep in normal, healthy adult populations.” (Ancoli-Israel, 2003, p345)

**Human physiology during dream sleep**

<table>
<thead>
<tr>
<th>Body movements</th>
<th>Almost absent</th>
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<tbody>
<tr>
<td>Body temperature</td>
<td>Irregular and poikilothermic (cold blooded)</td>
</tr>
<tr>
<td>Heart rate</td>
<td>Decreased and irregular</td>
</tr>
<tr>
<td>Respiration rate</td>
<td>Decreased and irregular</td>
</tr>
</tbody>
</table>

Figure: The effect of REM sleep on human physiology

Several other body functions are affected by the REM state. The “[...] respiratory rhythm, heart rate and blood pressure tend to [...] display greater activity and greater variability during REM phases.” (Roffwarg et al., 1966, p605) Smyth et al (1969, pp.476-485) had at first reported a reduction of heart rate and arterial pressure during sleep and argued that blood pressure would drop during REM sleep (1969, pp.109-121). This has later been disputed by Zemaityte et al. (1984, p 21) who discovered that heart rate and heart rate variability (the time between consecutive beats) drops during non-REM sleep but increases during REM sleep to an even higher level than during wakefulness. A fourth physiological aspect affected by REM sleep is body temperature. During non-REM sleep the body uses less energy and regulates its temperature to a lower set-point than in wakefulness. During REM sleep the human body turns “poikilothermic”; it (temporarily) loses the ability to self-regulate temperature, similar to cold blooded animals. (Goldman, M. and Markov, D, 2006, p 4)

Many other physiological aspects like the neurological and digestive systems, the skin and the body’s biochemistry are affected by sleep, but their relationship to REM sleep is disputed and their parameters are hard to monitor and interpret which moves them out of the scope of this research.
EMPIRICAL RESEARCH
“Exploratory experiment is the probing, playful activity by which we get a feel for things. It succeeds when it leads to the discovery of something there.”

— Donald Schö̈n in Educating the Reflective Practitioner, 1987, p 70

In a design study as concerned with experience theoretical research can only go so far.

Since dreams are experiential and intrapersonal their existential qualities can only be assessed through extensive qualitative research.

The empirical research carried out in this project included a self-assessment of sleep behavior, a survey on sleep behavior and dream attitude, a cultural probe study followed by debriefing interviews and a user evaluated prototype that was informed by these resources.

Sleep self-study

To better understand the dream experience I first studied my own sleep behavior. Over the course of one week I filmed myself sleeping throughout the night and reviewed the footage. From the footage I learned that I talk in my sleep and that I tend to move and turn approximately every five minutes, which made me consider to include motion as part of the dream representation.36

I also experimented with a variety of alarm sounds configured to play at different volume levels and time intervals to discover when I would wake up. Additionally I tried to assess my sleep experience while objects were attached to parts of my body, from which I learned that the head and neck need to remain uncovered to sleep comfortably.

These experiments made me aware of the fact that monitoring the vital signs of a sleeping person introduces a range of design challenges and restrictions. Firstly, sensors applied to the body have to be unobtrusive so as not to alter the dream experience. They need to be compact and light enough in order not to restrict mobility or exert an uncomfortable level of pressure on the body. I found that (incidental) sounds produced by the data collection system are likely to wake the sleeping person and should be avoided. Secondly, the sensors also need to be firmly attached to the body to prevent the user from (accidently) disconnecting them.

Reviewing the recordings I noticed how my eyes would open and blink sporadically over the course of the night. This gave me the idea of using an image processing algorithm and Kinect motion sensor to translate my body and eye movements into motion data, which was later abandoned for practical reasons.
The larger survey was conducted over the course of four days at three locations (at two Malmö University buildings (Kranen and Orkanen) and during a conference on information architecture in the Turning Torso building) yielding a total of 143 responses. The sample group contained 80 female and 63 male respondents with a modal age 23.

The survey contained nineteen questions (of which 15 in closed form and 6 in open form). 3% of the respondent's sleepwalked (5 people), more people talk in their sleep (64, 43%) than snore (50, 34%) and most people (102, 61%) have pleasant dreams. Half of the people do not get up during the night (75), the most common reasons for getting up are going to the bathroom (43), drinking something (18). The modal amount of time spent sleeping is 8 hours per night, while going to bed at 23:00 and waking up at 08:00. 82 respondents (60%) voiced their interest to become a test user by leaving their email address and 42 respondents (43%) drew a sketch of a dream representation device.
The structured questions which dealt with affective topics were stipulated using a Likert-type scale which allowed respondents to specify their level of agreement or disagreement with the topic. The decision was made to use a 7 point Likert-type scale to prevent prevarication, to accommodate for the abstract nature of the questions and to allow the respondents to nuance their opinions. As Anderson, et al. note: “[...] most people may be able to differentiate feeling slightly favorable, moderately favorable, and extremely favorable towards objects, in which case a 7-point scale would be more desirable than a 5-point scale” (1985, p 295) 44 people 91 respondents (65%) remember their dreams at least sometimes and 77 respondents (54%) get inspired by their dreams on occasion. 58 respondents (41%) said that dreams at least moderately affect their creativity and 44 (31%) expressed that dreams help them solve waking problems.

I made the conscious decision to conduct the survey on paper for several reasons. Firstly it allowed me to personally introduce myself, my ambitions and the context of the project, which I suspected would benefit the response rate and the quality of the responses. In addition, it served as a way for me to get to know my audience. I gained demographic insights on how often people remember their dreams and how often they get inspired by their dreams and learned more about the general sentiment towards dream integration in waking life. More importantly the survey allowed me to establish an atmosphere of confiding closeness with the people I sampled; the survey worked as an ice breaker leading into a conversation about the somewhat abstract and private topic of dreams. It also served to introduce them to my project, to gain their trust and to pave the way for further cooperation in the research. Lastly, the survey worked as a way to screen respondents for their willingness to cooperate and contribute in the next phase of the project. Based on the propitiousness of my conversations with the participants during the execution of the survey and the participant’s ability to remember their dreams (from the survey data) I was able to compile a list of eligible future Cultural Probe informants.

**Survey insights**

The survey results indicated that dreams affect people’s lives in several ways. The variety of dream themes and answers to the unstructured questions pointed out that the way in which dreams are experienced differs vastly from person to person. The most common dream themes were sex (69 responses), adventure (68 responses), past events (66 responses), romance (61 responses) and future events (55 responses). People suggested additional themes which included death (8 responses), every day events (5 responses) and work (4 responses).

![Graphed survey data](image)

Figure 15: The graphed survey data shows that dreams do play a significant role for the respondents
connected to the head and write annotations mentioning cables, sensors and other technical equipment connected to the body.

Figure 16: Diagram showing the most frequently mentioned dream themes (size corresponds to frequency)

In addition, people almost unanimously drew helmets, heads and electrodes and other things connected to the head. The objects they envisioned for representing the dream were almost all visual screen-based devices or to a lesser extent audio recording or playback devices.

Reflecting on the survey

In hindsight the survey suffered to an extent from ‘question threat’, questions that “[…] threaten respondents in a way that either influences their willingness to give answers at all or determines the nature of the answers that they do give.” (Foddy, 1994, p112) in the way it was designed. The way in which the questions were phrased limited the respondent’s capacity for imaginative thinking. For example, Question 17 stated: “If you could record and playback your dreams using a fantasy device, how would the device work and what would it look like?” implying that a solution for revisiting dreams would be technically deterministic and that the device should register the dream in the form of a (magnetic) ‘recording’. This led to suggestions of ‘dream VCR recorders’ and ‘dream DVD players’. Moreover, the words ‘record’ and ‘playback’ suggested long term storage capacity and user interface elements like buttons and switches. It set a science-fictionesque tone that influenced the respondents to draw hats, helmets and other devices which were

Figure 17: Dream devices drawn by the survey respondents

Cultural Probes

Cultural probes are an ethnographic research technique first employed in the Presence Project (Dunne, Gaver and Pacenti, 1995) as a means to gain a better understanding of the social needs of elderly people in three countries. Cultural probes are collections of artifacts designed by the researcher and used by informants to inspire the design process. The probes are not used to quantify or validate data but to “provoke inspirational responses” (Dunne, Gaver and Pacenti, 1999, p2).

There are several notable characteristics that distinguish cultural probes from other ethnographic methods, like contextual inquiry for example. Firstly, they stimulate the informant to actively participate in the design process by facilitating self-documentation. When using cultural probes
Dreams are a conversational topic shrouded in privacy. Moreover, the episodic nature of dreams makes them difficult to recall and discuss in detail. Cultural probes are particularly useful when conducting research on sensitive topics. I chose to employ cultural probes because of their flexibility, their empathic power and their ability to provide a narrative backdrop for in depth dream discussion. My intention was to discuss the probe returns with the informants in an open conversation and debrief them in a semi-structured interview. Cultural probes, when designed well, can be used at any time in any way the informant sees fit, allowing rich documentation of dream related recollections.99

Selecting the participants

The potential probe participants were drawn from the pool of survey respondents and were selected on several criteria. Firstly, the informant’s ability to remember dreams on a regular basis was a prerequisite. Secondly, their attitude towards dreams and their willingness and enthusiasm to contribute to the research played part in making them eligible for participation. Another factor for the selection of the probe informants was my estimate of the candidate’s willingness to divulge valuable (and hence highly personal) information about their dream experiences. Furthermore the participants which were selected represented varying opinions on the meaning and effect of dreams, to ensure a diversity of probe returns. Five women and three men from different walks of life participated, ages ranging from to 25 to 65, (modal age = 28) were chosen to participate. Informants were students (6) or employed (2) and were all in good health, on average sleeping 7.5 hours per night. The informants agreed to use the cultural probe kit over the course of one week where after the returns were collected and evaluated in a debriefing interview.

Considerations regarding the cultural probes.

The richness of the material that cultural probes are able to yield allows reviewing of the data from different perspectives. Revisiting the returns allows the discovery of material that previously might have been filtered out or discounted. This makes the process time consuming yet also rewarding. For instance, by analyzing the object card returns I learned that the cultural probe informants were interested in both ambient and attentional properties. E.g. informant 1 imagined a bed which would gently rock to the movements she made in her dreams to amplify the dream experience while informant 3 conceived of a wristwatch which would run backwards to trick other people that they are dreaming with the purpose to help them remember dreams.

During the design process I tried to envision how my informants would use the probes and which difficulties they might face when trying to use them. When evaluating the design iterations with other designers I discovered that the aesthetics of the probes were far more important than I had at first imagined. I wanted to prevent the informants from being intimidated while still making the kit look professional and genuine. At times it was hard to strike a balance in regards to the communication around the probes. A too formal tone might make the kit boring and create too much distance between the informants and myself making it hard to engage in an emphatic conversation with them.

the data is collected by the subjects themselves, which is unconventional from a traditional ethnographic perspective. In other ethnographic research methods the data is collected by the practitioner, which means there is always a filter being applied to what’s collected and what is considered to be relevant, decreasing the possibility to be inspired by unexpected discoveries.

Secondly, cultural probes are designed to explore the socio-cultural environment and personal perceptions of the informant. They are open-ended and explorative by nature, intended to “explore new opportunities rather than solve problems that are known already. (Mattelmäki, 2006, p40). Cultural probes rely on ludic and critical design elements to spark light-hearted conversations about the research topic and to engage the informant in the design process through a framework for experimentation that favors exploration over a solution oriented approach. To achieve such an empathic, trustful relationship with the informant it is of utmost importance to that the informants are “seen and understood from where they stand, not as test subjects but as persons with feelings.” (Mattelmäki and Battarbee, 2002, p1)

Dreams are a conversational topic shrouded in privacy. Moreover, the episodic nature of dreams makes them difficult to recall and discuss in detail. Cultural probes are particularly useful when conducting research on sensitive topics. I chose to employ cultural probes because of their flexibility, their empathic power and their ability to provide a narrative backdrop for in depth dream discussion. My intention was to discuss the probe returns with the informants in an open conversation and debrief them in a semi-structured interview. Cultural probes, when designed well, can be used at any time in any way the informant sees fit, allowing rich documentation of dream related recollections.
while a too informal tone might make the context of my process look unprofessional.

**Designing the probes**

The cultural probe kit comprised four probes. Among the contents were a Morpholog (a repurposed, preconfigured smart phone used to record sleep data and dream recollections), a dream diorama construction kit, a deck of card containing objects that were to be related to dreams and a set of bags which were to be used to store objects which texture, scent or taste related to a dream. My aim was to make the kit engaging and inviting by not making it overly esoteric or scientific. I wanted to enable the informants to entrust their feelings towards dreams while using the probes.
The Morpholog

The Morpholog (a portmanteau of Morpheus, the Greek god of dreams and the word catalog) comprised a repurposed Android smart phone and was inspired by Gaver, et al.’s Dream Recorder which was a a cheap digital memo-taker [...] repackaged with instructions to use upon awakening from a vivid dream”. (2010, p 4) In order to prevent the informants from being subconsciously influenced by the device’s inherent telecommunication affordances I removed most of its features. I wanted to make the probe easier to use, keep the informant focused on the task and prevent tampering with the device and its data.

The Morpholog was distributed in an envelope decorated with a pictorial user manual. The informants were also provided with an additional visual step-by-step instruction sheet on how to use the device. The Morpholog contained four applications that were to be used by the informant: SleepStat (Sleep as Android) for recording of the circadian rhythm, SleepTalk (Sleep Talk Recorder) for recording spoken dialogue while asleep, VoiceDiary (the default android voice recorder) for keeping a spoken diary of remembered dreams and TakePhoto (Photo Effects) to visually document dream associations during wakefulness. The corresponding apps were renamed to their respective names to offer a more coherent and intuitive use experience.

Figure 21: Top left: overview of the artifacts included in the Morpholog probe, top center: excerpt from the Morpholog instruction manual on the back of the envelope. Bottom left: the Morpholog interface, including shortcuts to the four apps and a preconfigured calendar that reminded the informants periodically to perform tasks. Bottom right: detailed step-by-step instruction chart included with the Morpholog.
The Dream Object Cards

The dream object cards comprised a deck of illustrated cards containing images of various domestic or portable objects. Below each illustration was a ruled area where the informants could leave their comments. The first two cards contained playful instructions on how to use the deck. The cards served a similar purpose as the penultimate survey question: If you could record and playback your dreams using a fantasy device, how would the device work and what would it look like?, but provided a specific set of use contexts and were less technological deterministic (e.g. the cards included depictions of objects like pillows, chairs, duvets and lamps). The morpholog periodically reminded the informant to draw a random card from the deck, to analyze it and to write down how the object depicted on the card could be used related to dreams during sleep or in the waking life of the informant.

The Dream Diorama

The dream diorama box contained a number of materials intended to invite the informant to spatially reconstruct his most captivating dream experience. Included in the box were a note which explained the assignment, various craft materials (colored cardboard, plastic film and paper, color pens, poster adhesive, stickers, etc.). To encourage the informants to reconstruct one of their dreams and to set a serious tone for the assignment, I first assembled a diorama of a recurring dream I have had in the past and added a picture and description of the diorama to the instruction sheet that was provided with the probe. During the assembly of the diorama I came to the realization that this probe might be problematic for the informants since it required a high level of user engagement, a share of creative confidence and at least fifteen minutes of labor and attention. For this reason this probe was scheduled to be used on the Saturday afternoon in the morpholog and on the probe container so there would be a higher likelihood that the informant would have the time and commitment to use it.
Interpreting the probe returns

The use of cultural probes is not grounded in scientific research practice. Instead it is a serendipitous ethnographic tool for gaining deeper, more intimate understanding of the subject’s mode of thinking and his milieu. Evaluation of the probe returns is, more than anything else, an emphatic activity. “The word analysis applied to probes may refer to a more scientific procedure than is usually necessary. More appropriate words would be making sense, outlining or interpretation.” (Mattelmäki, 2006, p88) The material recorded in the cultural probes was astoundingly personal and insightful and captured direct emotions, concerns and design suggestions.

Analyzing the morpholog returns

Some informants chose to write down their dreams in the paper dream diary, while others preferred to dictate and record them using the morpholog’s VoiceDiary application. I5 mentioned waking up early in the morning and silently dictating his memories to the morpholog in order not to have to turn on the light and wake up his partner, while I3 and I6 used the paper diary because they did not want to hear her own voice. From reading and listening to the dream documentation, the most important thing I’ve come to realize is that Freud is probably right about one thing: if dreams can at all be interpreted meaningfully, it should probably be done by the person who had them. The documented dreams are often cryptic, making reference to associations and contextual...

The Sense Bags

The sense bags comprised a set of three zip-lock bags that were provided with usage instructions. Included were a ‘feel bag’, ‘scent bag’ and ‘taste bag’, to be used during the week to store materials or substances with textures, smell, or tastes that related to elements in a dream. The bags attempted to evoke reflection on any sensory experiences the informants might have had in their dreams. Additionally I wanted to explore which senses are predominant while dreaming, and which senses triggered memories of dream events during wakefulness.

Figure 23: The sense bags consisted of labeled zip-lock bags

Figure 24: Overview chart showing the morpholog response rate per informant
The informants used the Morpholog to make several pictures of objects or places which reminded them of dream events, the pictures intended to give me a different perspective on the informants' dreams and were used to evaluate if the informants reflect on their dreams during the day. Informant 2 made a picture of a painting she made of an open mouth; the picture represented a game-like dream in which she needed to shoot crocodiles. In the interview she explained that she was developing a game and rationalized that the dream had adopted elements of her waking affairs. Informant 1 made a picture of his office, explaining that a lot of his dreams take place in places he visits frequently. In the week he used to cultural probe kit he experienced a stressful dream in which he was late for work. Informant 3 was reminded of a dream coincidentally when visiting a friend: “This week I dreamt I met a woman at the bus stop. Later, when I was on my way to my friend's house I went past the bus stop and then I remembered the dream and took the picture.”

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Analyzing the sense bags

The sense bags did not lead to a lot of direct input, but confirmed Foulkes, et al.'s findings that touch, smell and taste do not play a big part in dream experience. Only three informants used the bags (I2, I3 and I5). Several informants stated that they did not remember tasting or smelling anything in their dreams but expressed their interest to have the dream represented as an aroma or flavor. Informants 3 and 5 filled their feel bags with sea related items. I5 included a piece of rubber which texture
would come to the rescue in dangerous situations. I6 pictured his slippers as “anti-gravity shoes that would help reach elusive and unreachable things” and ear plugs as “pause buttons” to the dream, allowing him to analyze his dreams from within. I6 also described turning off a lamp, instantly interchanging day with night in a past dream.

Other informants imagined the objects to augment the dream experience. I2 imagined several devices to alter her dreams, she envisioned that “movements in the dream could be supported by small movements in the bed”, “earplugs [which] could adapt and let in sound when you are supposed to wake up” and experimenting “with what kinds of dreams certain smells could evoke”. I4 described the alarm clock as “an appreciated devise to wake me up on time, but I really don’t like it when I hear it [...] I look for other solutions to wake me up”, indicating her love-hate relationship with the device and a potential design opportunity. I8 relates the narrative capacity of books to dreams: “Books I love and dreams I enjoy have the same qualities. They make me escape and give me energy; they make me experience strong emotions”.

Analyzing the dream object cards

It was interesting to observe that the ambiguity of this probe led to different thoughts on how the objects depicted on the cards could be of value.

Some informants pictured them as tools to amplify or alter sleep or the dream experience, some saw them as a means to document and access their dreams during wakefulness, and others used the cards to describe what the objects could mean or how they could be used inside the dream. For example, informants 1 and 4 noted never having seen themselves in a mirror in a dream, I1 described dreaming as “watching a TV”. Later, during the debriefing session I1 concluded that he experiences his dreams from different perspectives (first person, third person and bird perspective) and that his dreams vary in their experiential engagement. I5 imagined using a mirror in the dream to become another entity, a book containing ‘in-dream’ advice and a ‘dream carpet’ which

reminded him of the boom on a wind surfboard and mentioned feeling “the texture of things, for example I was windsurfing in a dream and I felt having the wind in the sail.” I3 explained during the interview that the screws and nails in her feel bag represented sea shells from a dream.

Figure 26: Informant 5’s scent bag and feel bag submissions, the items in the bags relate to events that transpired in his dreams: a dream about a alcohol fueled car chase and a dream about surfing

Figure 27: Left: informant 6’s dream pausing ear plugs, Right: informant 2’s dream supporting bed
Difficulties and deficiencies concerning the cultural probes

In retrospect I suspect that the amount of tasks in the probe kit might have overwhelmed some of the informants. The probes required clear instructions, which were mainly provided in textual form, but the surplus of text might have appeared intimidating. Some informants contacted me by themselves, allowing me to explain how to proceed. Yet, most respondents expressed that they did not perceive the cultural probe experiment as a chore and even described it as being a fun experience in the interview.

The Morpholog’s applications were problematic, SleepStat had too many buttons and was confusing to use. SleepTalk deactivated after navigating to a different window which was a limitation of the app. TakePhoto was configured in a way that didn’t allow the informant to review the photos that were taken. My expectations were that the

Analyzing the dream dioramas

The dream dioramas were a tool for the informants to actively recall a dream which had left a lasting impression on them and to later discuss why they had chosen this dream and to assess which elements this dream embodied. The diorama kits attempted to be a fun and engaging way to make the informant more aware of his dreams during the process. They served to remind the informants of the details of the dreams they represented and facilitated discussion of sensitive subjects relating to the dream during the debriefing interview.

The objects were also repurposed to revisit dreams during wakefulness. I3 pictured the objects as meditative tools. The mirror would be used to reflect on her (waking) feelings and decision taking. “I’ve had periods in my life when a soul mirror would have saved me time and heartache” and the book would be used to recognize emergent dream themes “I’ve realized when writing down my dreams that similar things return. Like the sea, and the issue of eating meat.” She also envisioned abstracting her dreams. “I would like for the PJs (pajamas) to visualize last night’s dream, not like a movie but rather show colors and mood.” About the picture frame I4 expressed her preference for “pictures that don’t contain people or pets”, not to be reminded of unfortunate past events before going to sleep. She also described her need for a sense of home; pajamas, a bedroom lamp and an antique chair create a comfortable atmosphere and her pillow is her most important bedroom item. I1 and I4 also noted that temperature affect the content of their dreams, I1: “I dream more pleasant when I feel warm”, I4: “feeling warm and relaxed creates a sense of security”.

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Debriefing the informants

At the outset the debriefing session reiterated the purpose of the cultural probe study and the intents of the project and mentioned that the research material would be referenced anonymously. This was followed by an interview that covered the informants’ dream recollection, their sensory and spatiotemporal perception in dreams, emergent dream themes and sharing and physically representing parts of their dreams during wakefulness. The interviews were an attempt to awaken memories of the previous week’s dreams and experiences and insights the informants had while using the kit to try to identify aspects of the dreams which could inspire the design process. After the semi-structured interview the probe contents were discussed in an open conversation. Later I received additional responses from the informants by text message and email, elucidating new insights they had regarding their dreams and expressing their interest in continued involvement in the project.

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Dream Diorama kit would yield the lowest response rate, but it were the Sense Bags and that turned out to be particularly problematic and the Dream Object cards which yielded unexpected results. The task description on the Dream Object instruction cards were intentionally framed in a way which was quite open for interpretation to prevent setting a technologically deterministic context to the assignment which might hold back the informants’ imagination. Rather than wanting to get suggestions on which technology could be used to capture and revisit dreams, I wanted to get a deeper understanding of the experiential underpinnings of their dreams and how they could imagine dreams to be part of their waking lives. From the survey I had learned that it is generally a bad idea to assess user needs in a direct way, since, particularly in the context of my research, they can’t be expected to know. Yet the cultural probes led to confusion, one of the informants mentioned that the morpholog helped to stay engaged with the probe kit, but that it was invasive and time-consuming. However, it turned out that most respondents actively engaged with it, making it an important part of the debriefing session.
Understanding dreams

The survey indicated that dreams are experienced and interpreted differently from person to person. Some of the cultural probe informants claimed that the cultural probes had shed new light on how their dreams affect their waking life. Informant 1 did not attribute a particular meaning to his dreams: “I think they are just this kind of random thing that happens in the brain, and that they don’t have any consequences, well consequences they have because we talk about them, but what happens in the dream itself is just random.” I6 uses books to explore what his dreams mean and “I have read some stuff [...] that did actually affect the way I think and [...] my perception of reality.” I4 stated that her dreams alert her of waking life problems and influence her relationships. She described a dream “[...] in which [a friend of mine] was so big and I was very little [...] and where ever I went she was invading the space”, and her relation towards the dream: “I really like her, so when I was thinking about the dream I couldn’t put it together because she is a very nice person. [...] But when we were in this situation the next time [...] the dream came to me and then I understood that I have to distance myself [from her], I cannot be in her company so much anymore.” Interestingly, informants 2, 3 and 4, all female, mentioned having dreams in which they fall in love with people they either dislike or are only vaguely acquainted with. They also mentioned that after having such dreams, they think about the person involved a lot more during the day and feel they might act differently towards that person.

Nightmares are perceived differently by the informants. I5 thinks they are just as necessary as pleasant dreams, while I1, I4 and I5 could live without them. The effect of nightmares is also different. I8 is happy when waking up from a nightmare realizing that it is just a dream, while I3 stated mostly having uncomfortable dreams which remind her of bad things and leave her with an unpleasant reminiscent feeling.

When asked what they would like to change about the way they currently experience and remember their dreams the informants held different opinions. I4 voiced her desire for a way to pause the dream and step back for a moment to examine what was happening in the dream scene. I2 would like to remember more details about her dreams and to be able to “have a bit more control of dreams so that you could actually change some things”, but also stated not wanting to alter the experience too much: “[Dreams] are a product of what I’ve been doing the day before and what I’ve been thinking about and what I am processing right now, so whatever content they have I think it’s probably important in some way.” As Bachelard indicated dreams contain interesting spatiotemporal aspects. Most informants dream about their direct environment or places where they spent time during their childhood or surreal landscapes containing elements of those places. I3 and I5 dream a lot about the sea and the place they grew up. Both of them mentioned having dreams in which they were younger. The informants’ dreams described both ordinary and surrealistic environments.

Experiential affordances of the dream state

When asked about their sensory perception in dreams, most informants expressed that their dream experiences are mainly visual. I6 recounted: “Sight is the most prominent [sense] of all. [...] Often I have really vivid pictures that really influence the mood of the dream. [They] have a cinematic quality to them.” I5 mentioned dreaming in color and in black and white. “The happier the dreams are, the stronger colors they have”, he elaborated. None of the informants recalled having a strong sense of smell or taste in their dreams. Informant 6 mentioned eating blue ice cream in a dream, but could not remember its taste. Sound did play a role, mostly in the form of dialogue. Most informants reported remembering fragments of spoken narrative. The accounts of the sensory experiences in the dreams of the cultural probe participants are in line with the discoveries made in several studies which showing that dreams (recollections thereof) are almost unanimously visual, 60% of them contain auditory elements, 15% contain tactility and less than 5% of them contain sensations of smell or taste. (Schwartz and Maquet, 2002, p24.), (Foulkes, D., Meier, B. and Strauch, I., 1996 pp. 78-80)

The mood and setting of the dream seemed equally important as the actual sensory experience. I2: “Everything seems to be shifting shape and meaning. Sometimes one person can become another person and then transform again into another person. Sometimes it’s purely visual
and sometimes it’s just a feeling.” Dreams affected the emotional states of informants in varying extents, I8 said “it feels like the emotions I have in my dreams influence what I feel like in the morning more than the emotions I have in this time of life influence my dreams”.

Dreams also seem to embody a different kind of agency and causality than the physical world. Informant 8 stated: “Sometimes I’m able to experience things in my dreams, which I’m not able to experience while I’m awake.” Informant 5 had a dream in which he was David Bowie and another dream about Bryan Adams after visiting one of his concerts. Informant 1 recounted how one of his dreams was influenced by something he had seen during wakefulness and reflected on its meaning: “I was watching on TV this new Three Musketeers movie [...] there is one scene somewhere in Venice where there was a room that was structured similar to my granddaughter’s room. So somehow I’ve translated this visual impression I got from the movie into the dream. I was not surprised in the dream; I was surprised when I woke up.” Informant 5 described the lack of self-awareness in dreams as a quality. “If I knew that someone was watching all the time I wouldn’t feel so free in some of the dreams I guess.” Informants 6 and 8 recounted experimenting with lucid dreaming (becoming aware of the act of dreaming) to varying degrees of success. Informant 8 described her strategy as writing notes on pieces of paper and periodically checked if she could still discern the writing to check if she was awake or asleep.

**Perceptual metaphors**

Mutability seemed to be a recurring theme for the informants. The informants mentioned malleable or impalpable substances when they were asked to describe their dreams in terms of a perceptual metaphor or sensation, Informant 4 described them as being fluid and having a life of their own. Informant 2 compared them to clay. Informants 3 and 5 compared them to (ocean) water. Informant 8 compared his dreams to shape shifting clouds. Informant 8 could not name a metaphor able to capture the essence of her dreams. Informant 5 emphasized the existential qualities of dream experiences, his description of the lamp object card imaged being able to “wake up from this dream we call reality and wake up in the real world”.

**Dream themes and contents**

For some informants their daily affairs strongly influenced the content of their dreams. Informant 2 recalled: “I noticed that my dreams actually revolve a lot around what I’m doing at the time. So at the time I was prototyping a game and there were some elements in my dreams that were game like or they felt like a game in the end.” Informant 1 often dreams about his work and social interactions with relatives. Other informants dreamt about the past or surrealistic environments. Excerpted from the dream diary of informant 6: “March 9th [...] There was a war between some different species in the galaxy. Things managed to settle down in the end. We used our houses as spaceships [...], The experiment had influenced the content of the dreams of two informants (4 and 8) who mentioned having dreamt about being involved in a research project on dreams. I received a text message from informant 8 in which she recounted a recursive dream, dreaming that she was not dreaming anything. Similarly, informant 4 sent me an email in which she elaborated a dream about dream research.

**Accessibility and sharing**

Sharing dreams turned out to be a controversial conversational topic. Several informants stated that they did not want to share (parts of) their dreams because of privacy reasons, not wanting to reveal everything about oneself, fear of hurting loved ones by recounting bad dream experiences and not wanting other people to form opinions based on the dream representation. I4 described that she does not share sensitive dreams to avoid getting hurt and to maintain a level of privacy. “Those parts where I feel vulnerable I don’t like to share them. [...] I like to keep those to trusted people.” Dream sharing seemed to require a certain level of discretion. I2 described that she considers “people who share too much of themselves on social media [...] in a negative way” and pondered how for dream representation “it would be the same thing”. Most informants felt that if another person would interpret their dreams he
would be biased. I8 voiced her fear of a person assessing her solely on her dreams, she stated: “I don’t feel that I am my dreams”. I2 was cautious of spiritual or religious interpretative agendas. Yet I8 sees meaning in using dreams as a conversation piece: “the only way that I think we can do them justice is by talking about them.”

Revisiting dreams

Some informants expressed their desire to harness the dream as a tool for self-exploration or as a recreational activity. I6 reflected on the nature of dreams: “I’ve learned eventually that dreams hold a lot of things [...] they have one shape in your head when you sleep, but they are actually representing something completely different, and I’ve gotten interested in what that is.” I2: “I think you have so many dreams during one night that, if you collected all those dreams, you could get really inspired for the next month or so. They could inspire me to create mood boards, concepts or even graphical details and interesting textures.”

The informants expressed a need for a kind of representation of the dream that leaves enough room for interpretation. I5 noted that “something really abstract [...] could easily fit into your daily life without feeling constrained to it. Informant 2 defined dreams as an abstract diary that, over time, helps her become aware of valuable moments of her life: “often when I write down dreams and read them afterwards they define a period of my life. [...] they help me see which parts were important and which part were not.” I6 wanted to experience his dreams in different form entirely: “It would be interesting for me to see this convergence of one thing into another. [...] I think it would be interesting to see how the object would understand my dream and how it would translate it into something else. [...]It allows you to make different connections between things and associate them in a different way.” I8 stated that “making a visual representation of my dream would never do it justice. I’ve tried [...] to draw my dreams when I woke up but felt like I didn’t have respect for my dreams”, instead wanted to explore different senses. I7 suggested stimulating senses which are dormant during dreams: “sometimes things don’t have a feel or scent in a dream because it’s not important for the dream content [...] in those cases it would be more interesting to have the whole spectrum of senses working together, she also expressed an interest to revisit her dreams through smell and taste.

Dream representation was also pictured as a momentary and a long term process. I7 stated that “you’d want it to be very time consuming if that is what you want to do with four hours of your day, but I think you should also just be able to watch it for a couple of minutes.” The informants were also asked where they would wear a device to monitor dream activity on the body. Suggestions were made to wear it on the arms, legs, waist and hands. Informants 4 and 7 clearly stated not to want anything connected to their head.

Figure 29: Top: contents of one of the returned probe kits, bottom: categorizing the 8 kits after retrieval
11 DREAMS PHYSICALIZED
11. DREAMS PHYSICALIZED

Specifying design requirements

Through the cultural probe returns I learned that a measure of ambiguity is required to make dream representations engaging and to allow space for personal interpretation. Physical abstraction allowed the dream to retain its mystery and the user to reinterpret dream in a social context. The para-functional devices suggested by the informants have inspired the design process to address the senses. Visualizing abstract physiological data as synesthetic output became central in the prototype ideation process. The inspirational patterns identified in the evaluation of the interactive works have further defined the use qualities of the prototypes.

Dourish and Bachelard argue that meaningful experience relies on our interaction with and perception of the world around us. One may argue that the more senses are involved, the more embodied the experience becomes. Dreams are inherently physically embodied and experiential, yet lack some sensory aspects like smell, taste and touch. By giving the dream substance in a way that it could not only be seen and heard, but also smelled and tasted, I aimed to trigger the waking senses to complement the latent dream experience, in order to spark new insights. Physical representations embody sensory modalities like smell, taste and touch, which screen-based media can never reproduce. Additionally, physicalized dream representations are able to draw the poetic ambiguity of dreams into three dimensional space, while a virtual representation cannot encompass the rich complexity of human experience found in the dream.

While the virtual world lacks some of the rich sensory modalities of the physical world, digital representation of the dream content does also offer benefits. Digital media enable maximum dissemination (and monetization) of the recorded material and allow users to easily share and compare their experiences with other people. Yet, since my cultural probe research has suggested that a personal, unique embodied experience is more engaging and aesthetically pleasing than a screen-based representation, I have decided not to proceed in this direction. The fragmented episodic nature of dreams makes each of them unique in the way we perceive them. This sense of uniqueness is another quality that is inherent in physical objects and lost in digital media. While digital media might be able to provide a unique graphical representation of the dream, the way we experience them is perhaps less durable and thus less memorable. If, instead, the output can be tasted, smelled or otherwise subjected to our senses, the representation can become more lasting and engaging and perhaps more meaningful. One of the prototypes evaluated in this text allowed the user to sample a unique blend of coffee based on his dream. This device expanded the morning ritual of drinking coffee with the parafunctional of engaging serendipitous surprise.

When faced with the physical output of the machine they would either realize that the machine had done part of the interpreting for them, or they would accept the physical residue as a ‘truthful’ ground for the interpretation of their dream. Since I did not want the machine to be fully deterministic of its meaning, it was important that that the users understood that they were going to determine their own use of the device.

The sensor waistband

There are different ways to monitor the user’s physiological condition, some more invasive than others. Most of them require sensors to be attached to the body. From my sleep experiments and the cultural probe study I learned that the sensors could not be applied on the head or the neck. Body temperature, movement, respiration and motion have been correlated to REM sleep episodes in interesting ways and proved to be relatively non-intrusive to measure. The electronic components capable of measuring these signals were small enough to integrate in a single garment. When watching the footage from the sleep experiments I notice that I never sleep on my stomach, but that I flail my arms and legs on occasion. This is when the idea emerged to integrate the sensors in a waistband. When designing the waistband I kept in mind that it should be
non-invasive and easy to use, so as not to confuse the user or negatively influence his dreams.\textsuperscript{42} The waistband integrated all data sources into one object, minimizing the physical strain put on the body.\textsuperscript{43}

The custom-made sensor waistband contains four sensors which monitor heart rate, respiration rate, body motion and body temperature during REM sleep. The recorded data is then wirelessly sent to the actuating prototypes which turn the readings into physical output. The waistband is powered by two 9 volt batteries and contains a series of pockets on the front which hold the sensors and the microcontroller. The closing strap is provided with two small and one larger buttons which are backlit with a small LED. These buttons are used to communicate the
The coffee grinder evolved from the observation that the cultural probe informants suggested that dreams could be represented as scents or tastes. The respondents also pictured using an object for dream representation in the domestic context of their homes and some informants specifically mentioned wanting to use it in their kitchen. Initially this gave me the idea to make a blender which would process different kinds of edibles like fruit, nuts and vitamin pills, but later this idea was abandoned in favor of coffee since this suited the context best. Making and drinking coffee is for many people part of breakfast routine, the energizing properties of caffeine mark a mental and physiological transition from sleep to wakefulness.

status of the device to the user. The pictogram of the person wearing the waistband is used to indicate to the user which side is up, so the device is worn in the correct fashion to prevent the accelerometer from picking up reversed values. The LED behind the waistband in the pictogram softly fades in and out as long as the device is active to indicate that the device is activated. A piece of conductive Velcro on the inside of the strap of the waistband is pulled loose as the wearer takes it off in the morning. This triggers the automatic broadcasting of the recorded data indicated by the antenna pictogram pulsating in bursts which signals to the user that the waistband should not be turned off until the data was sent.

**Generating physical output**

The actuating prototypes were developed through iterative brainstorming and sketching. The informants were not directly involved in the design process since the cultural probe research had already demanded much of their time. Instead the concept ideas emerged from conversations with colleague interaction designers at Malmö University and Fabriken, a Malmö based fablab. Several ideas emerged over time. One idea intended to allow dreams to influence themselves recursively, by using the physiological data to generate a narrative that the user would read before going to sleep the next night, in the hopes that elements from the narrative would appear in his dreams. This recursive influence was also part of another idea which features a device that would record the users sleep talking and play back previous sleep talk recording after a new recording was made, to provoke the dreamer to engage in a dialogue with himself. These ideas were not further pursued since I felt they did not leave sufficient space for personal interpretation and did not address the social considerations raised in the cultural probe studies. Instead I wanted to evaluate all the sensory modalities and relate them to the waking modalities. After several design iterations the ideas crystalized into two proposals, each embodying different qualities of dreams and different senses. The coffee grinder integrates smell, taste and touch in its physical output, while the phantoliquefier addresses sight and sound through audiovisual abstractions. Both devices produce their output based on the data recorded and transmitted by the sensor waistband.

**The coffee grinder**

The coffee grinder evolved from the observation that the cultural probe informants suggested that dreams could be represented as scents or tastes. The respondents also pictured using an object for dream representation in the domestic context of their homes and some informants specifically mentioned wanting to use it in their kitchen. Initially this gave me the idea to make a blender which would process different kinds of edibles like fruit, nuts and vitamin pills, but later this idea was abandoned in favor of coffee since this suited the context best. Making and drinking coffee is for many people part of breakfast routine, the energizing properties of caffeine mark a mental and physiological transition from sleep to wakefulness.
The coffee grinder produces a unique blend of ground coffee that changes each time the user uses the waistband. The device features four separate cylindrical storage containers, each holding a different flavor of unground coffee beans and other ingredients. It automatically dispenses a variable amount of each type of beans into the grinding chamber and then grinds the beans to a finer or coarser powder depending on which data it received from the waistband. The user can then take it out to make coffee.

The device intends to evoke thought on the dream by producing output with a unique and distinct smell and taste, which the user might over time associate with dream elements. To make the flavor and scent of each storage compartment more distinguishable, the semitransparent plastic containers obfuscated their contents. The containers were not labeled in order not to impose a particular meaning, but to imbue the device with the potential to create conditions for imagination. The four physiological signals read from the body are mapped to four storage containers, each container representing one aspect, heart rate, respiration rate, motion and body temperature. It is not shown to the user which parameter corresponds to which flavor of coffee, allowing the user to discover personal patterns over time. The device has two buttons. One bears the pictogram of a coffee cup, pressing this button will produce just enough ground coffee for one cup. The other, showing a storage container, can be pressed to grind more of the same mixture to store away for later use or to make a full pot of coffee to share with friends. This way the device allows the user to ‘store’ a particular meaningful dream allowing the user to revisit it in a social setting or at a later time. However, just as dream memories fade over time, the recipe for the dream is lost the next time the sensor waistband is used.
The **phantoliquefier**

The second proposal was inspired by Phantasos, one of the oneroi featured in Greek dream mythology. Phantasos appears in dreams in the form of inanimate things like water. (Metamorphoses, XI, 633-649) The phantoliquefier allows you to see and hear a physical abstraction of your dreams. It consists of a cylindrical glass jar containing a milky viscous liquid which moves and changes color based on data recorded by the sensors of the waistband during sleep. A subwoofer produced oscillations that set the liquid in motion and make it change shape and density and shape. Light sources under the liquid’s surface color it in swirling, constantly changing patterns. In addition the object transforms the sensor readings into an (abstract) sound scheme, played by a second speaker. The liquid in the device is ‘non-Newtonian’, under the percussive action of the speaker the liquid acts like a solid. Depending on the frequency of the vibrations it becomes gel-like and adopts different abstract shapes.

The device offers different use qualities than the coffee grinder. It embodies sight and sound and does not allow the user to embody the experience but instead changes its own appearance. The device works autonomously, much like a lava lamp, but unlike lava lamps the shapes it produces are not completely random. The audiovisual output ‘loops’ in a pattern based on the data from the last dream recording until new input is received from the sensor waistband. The only user interaction it affords is a small turning knob to set the volume at which the sound scheme is played. The device automatically turns on when the belt is removed from the body, and disables again when the user goes to sleep and dons the belt. When turned on the shapes and colors it produces are fleeting and ever changing, when disabled the liquid becomes an inanimate, flat surface again. Recognizing shapes in it is somewhat akin to suddenly recognizing a face in a cloud; it happens in the periphery of your attention.

The phantoliquefier contains ambient qualities embodied by some of the object envisioned informants, like I3’s lamp and pajamas which would show colors and moods and I5’s to make an audiovisual ‘sound track’ of her dreams. Other devices described by the informant were only to be used incidentally, like the I7’s ‘dream pause button’ earplugs and the air refresher that made him wake up from the dream.

**Physiological variables**

The physiological signals measured by the sensor waistband were not visibly related to the output produced by the prototypes to further open up the possibility for subjective patterns and meanings to emerge. In the coffee grinder each coffee bean compartment was controlled by a different signal, since the contents in the semi-transparent containers looked similar the user could not directly tell which flavor would correspond to which signal. In the phantoliquefier the signals which fluctuated the most (motion, heart rate and respiration rate) would control the behavior and color of the liquid and while body temperature which changes more gradually affected the sound scheme.
The actuating prototypes are in a way ‘simulacra machines’, because the output they produce is not directly representing the content of a dream they encourage reinterpretation of the dream experience through the waking senses.

Qualities embodied by the concepts
The concepts show similarities and differences. Both comprise ludic qualities by presenting an open, whimsical, outlook on dream interpretation and are situated at a level of abstraction that allows the dream to be shared in a social context. The devices have been designed for use within the domestic context. Where the devices differ is in the aesthetic use. Though neither of the devices allows the user to directly manipulate its output, their interaction modalities differ. While the phantoliquefier lives a life of its own, the coffee grinder requires active user interaction. It is interesting to explore which experience is more engaging. Also contrasting are the device’s contexts of use. The coffee grinder can be integrated in everyday routine to make dream interpretation accessible, but the phantoliquefier works better in social contexts or in moments the user specifically chooses to reflect. The phantoliquefier is also more ambient in the sense that it blends into the background of the owner’s interior and in the sense that it is exteroceptive, the sensations it provides are not as potent as taste or smell. The coffee grinder has the ability to produce lasting physical output, which can be stored for later use, in the phantoliquefier reflection is momentary; over time patterns can be compared but not re-experienced.

I wanted to refrain as much as possible from letting my own experience of dreams determine the prototypes, yet there were multiple levels of interpretation inherently present in the output they produced. Firstly, the choice I made to measure bodily metrics instead...
of brain potentials (or other metrics) affected the shape and output of the prototypes. On the level of the microcontroller the waistband registered analog and digital values (like impedance and logic sequences) abstracted from the user’s sleeping body and on the algorithmic level this data was interpreted and mutated into a different format. On the level of the actuating device interpretation occurred through the type and amount of physical output the device delivered (and was capable of delivering).

**Putting the ideas in practice**

The first design iteration of the prototype was executed using an Arduino Uno equipped with a Wireless (XBEE/Micro SD) shield. This choice was made to have ‘out of the box’ compatibility with the Arduino integrated development environment (IDE) and to make debugging and detecting hardware connection errors easier. A mini breadboard was mounted on top of the Arduino Uno so the sensors could be easily connected, tested and calibrated without having to permanently solder them in place, additional breadboards were used to connect the remaining sensors (heart rate sensor, digital thermometer, and stretch sensor) to the circuit.
The final design of the sensor waistband prototype comprised a Teensy 2.0 board, four sensors for measuring heart rate, body temperature, respiration rate and motion, and other peripherals.

Considerations and limitations
Initially I wanted to test both concepts, but due to limited time and resources the realization of both devices was unattainable. After careful consideration I decided to prototype the coffee grinder for several reasons. Firstly, on a practical level my estimate was that this concept was easier to realize and thus could be tested more quickly. Secondly, when I consulted other designers they predicted that the coffee grinder would be easier to evaluate since it provided a direct user experience: the act of making and drinking coffee. From start to finish the development of the device took two months. A lot work went into the 40 laser-cut parts that comprise the top compartment containing the coffee bean dispensers. This section was custom manufactured to fit an off-the-shelf coffee grinder. The coffee grinder and the sensor waistband were met with several setbacks. Keeping both items powered was another major concern. These technical limitations were time consuming and severely impacted the development process which meant that ultimately there was too little time to adequately test the device.

The prototype was to be evaluated by the cultural probe informants, since they had already been actively engaged in the process of dream documentation. It needed to be fully functional. I could not simulate the experience since the device was to be used in a context where my presence would not be appropriate. Moreover the subconscious experiences that were to be evoked by the device could have never been elicited by a low fidelity design. Through the cultural probe research it became clear that one week of dream documentation was not nearly enough time to empirically assess dream interpretation. The informants had kept a diary, but there was too little material to reflect on how the dreams might relate to each other or to the informants waking cognition. This meant that in order to have any effect, the user needed to be intimate involved with the prototype for at least a month (if not longer), so the sensor waistband and the coffee grinder could be integrated in his daily routines. Moreover the artifacts would only start to become meaningful as time progressed. Personal associations would only be made as newly physicalized dreams were subconsciously compared to older ones and meaningful patterns would only emerge as those associations were compared and internalized by the informant over time. Since the informants had widely varying attitudes towards dreams it was necessary to thoroughly assess the potential value of the device, which required it to be evaluated by multiple users. My aim is to finalize the prototype and evaluate it with at least two cultural probe informants to reflect on if and how their experiences using the device were meaningful and how the aesthetics use of the device may inform ludic design practice. The discussion of the interview and cultural probe material and the informants’ first reflection on the devices has provided some preliminary conclusions about the prototypes.

Prototype evaluation
Several weeks after the cultural probe research completed the informants were presented with the two concept proposals and were asked to reflect on which device they would prefer, which qualities in it appealed to them, and how they would integrate the device in their waking routines. The opinions were divided; several informants expressed their interest in the phantoliquefier, because it was more stimulating and socially engaging, while other informants were keener on the coffee grinder for practical reasons and because it directly evoked their senses.

Appearance seemed to be an important selection criterion. Informant 1 saw the phantoliquefier as a “kitch” item, which would not suit his interior, while I2 perceived it as “an artifact I would like to be associated with, and that I can relate to in another way.” I6 preferred the coffee grinder, seeing it as a “good abstract piece and a great decoration”. Several informants preferred the coffee grinder for pragmatic reasons: I7 predicted its target group; “one that isn’t willing to spend hour after hour on analyzing their dreams but maybe 10 minutes in the morning before getting to work.” Informants 5 and 8 related it to their habits: “I drink coffee every morning and I like that this grinder would
add a special element to that ‘ritual’. [...] I like that the grinder has a practical use and that it merges with my daily routine.”

The device’s aesthetic use qualities were also important. Some informants preferred the phantoliquefer because they were “very visually oriented” (I2) and felt “sounds, color and shapes are easier to understand” (I5) and I7: “I want to see my dreams to analyze them and to be inspired. That takes more than a cup of coffee.”

Informant 2 also mentioned wanting to use it in a social context, liking “the fact that other people that visit me could see my dreams represented.” Informant 6 did not like coffee but still preferred the coffee grinder because it “gives the chance to have a more tangible experience” of the dream. I6 would use it with different ingredients, like fruit, to associate emotions with flavors: “If I don’t remember what I’ve dreamed, I would try to guess what the emotions in the dream were by trying to figure out what tastes are mixed in the smoothie.”

Figure 42:
Bottom left: The first iteration of the grinder concept comprised a blender which would make a smoothie from fresh fruit, however this idea was abandoned since it was not realistic to build a device which could evenly dispense different sized fruits and keep its contents refrigerated.

Bottom right: A later design iterator showing a rough version of the device’s user interface and the method to operate the grinder blade, by using an Arduino controlled relay which toggled the motor on and off.
Figure 43: Design work of the coffee grinder and sensor waistband
Figure 44: Electronics of the coffee grinder & sensor waistband
“A waistband for recording dream related body signals”

1. Concept sketch
2. Technical diagrams
3. Final prototype

“A device which turns dreams into colorful, moving liquid.”

1. Concept sketch
2. Technical diagrams
3. Final prototype

“A machine which makes coffee from your dreams.”


12. DISCUSSION

**Reinterpreting dreams through physical representation**

The focus of this text has been to evaluate how our waking experience can be amplified with the aesthetic qualities of dreams, in order to assess if objects capable of representing dream related physiological data as physical output can create a personal, meaningful user experience. An extensive literature and empirical study of dream experience has unveiled several dream-like design strategies which are able to evoke such intimate connections. Ludic and critical design methods use ambiguity as a tool to create interpretative fulfilling experiences. Like dreams they not only reinterpret the way we perceive objects but also how we use them. They design for presence, producing objects that are not merely functional, but explore new ways in which we can value ourselves. These objects are post-optimal and para-functional, going beyond the conventions of traditional aesthetics and interaction modalities to explore new cognitive and sensory affordances. The objects described in the design process embody these elements and attempt to empower their users to find new meaningful associations and patterns in their dreams by making dreams sensible. While ultimately it was not feasible to test the devices in action, the informants were still able to reflect on their use qualities. Their sentiments were diverse but generally positive, yield insights on the devices aesthetic (appearance), functional and para-functional qualities.

**Continuation of the research**

While the informants were keen on adopting both devices, they raised concerns on their appearance and their use qualities. While the prototype was just a proof of concept and was not designed with commercial viability in mind, it did point out some practical limitations. Although the finalized circuitry integrated in the waistband was still relatively small and tolerably comfortable it would be too bulky and intrusive for everyday use. With additional funding and more time one could develop a reusable Band-Aid or a ring containing an integrated circuit that could broadcast the data to other peripherals wirelessly. Another option could be to record ambient sound (including sleep talking) or motion through the user’s smartphone during the night and use it to generate physical output. This option has the advantage that no direct skin contact is necessary, but the recorded data is susceptible to noise and can thus be less clearly related to sleep. In the end I have attempted to simulate the physiological signals to test the prototype before submission of the thesis document, but I was not convinced a simulation would demonstrate its functionality in a way that would evoke the user to reflect on its output.

**Practical constraints**

The research focus has shifted from using dreams to inspire wakeful creativity to a broader scope of dream valorization because the theoretical and empirical research uncovered various other existential dream qualities Analysis of brain activity using EEG equipment is the closest one can get at ‘reading’ the dream experience. My initial aim was to apply this method to extract data from the dreamer’s mind, but over the course of the project it became clear that this technology had several practical limitations, e.g. the final design needed to be non-intrusive to the use and able to continuously monitor the user’s physiological signals during sleep. Another limitation, concerning the development cycle of the prototype, was the nature of the project. There were several practical concerns to the subject that slowed down the design process.

**Methodological concerns**

When listening to the interview recordings I was amazed at how open and willing the informants had been to share their stories and intimate parts of their lives. It made me realize that, in design research, and research of any kind, it is of utmost importance to be transparent about the projects intents and the way in which the data will be used. Only then it becomes possible to build a trust relationship needed to get at peoples
experiences, particularly in the context of this project. The employed methodologies have also raised questions of veracity and ethics. While the strength of cultural probes lies in their empathic qualities and their ability to bring into light deeply personal experiences and stories, their introspective focus also raises concerns. Since dreams present themselves to most people but are by nature highly personal and often abstruse and numinous, it should be contemplated who should be involved in the design conversation and what the ideal number of participants is to come to meaningful insights. It is also difficult to determine which elements of each informant’s returns should have more gravity in the design process since the returns are inherently subjective and unique.

During the interviews several informants mentioned that they found their dreams to be irrational and even perverse, which provokes thought on how (and if) dream content should be manifested. Here exists a concern in the final prototype; is it measuring and representing a construct at all related to dreaming, or something else entirely? On another level it should be considered that the possibility exists that, what we think of as dream recollections, might be a blend of latent memories and ad-hoc imaginations. This introduces a philosophical discourse: are we actually capable of accurately remembering, let alone interpreting, our dreams with or without the use of technology? And if we assume we are, then are the things we are reminded of representing aspects of our own identity or do they belong to a different realm of personal meaningfulness?

The significance of sleep

The sleeping mind is far from understood, pushing the discourse on the interpretation and meaning of dreams into the realms of philosophy. Moreover, dreams make evident that art, design and science intersect. Their ephemerality, unpredictable story like structure and interpretative elements add to their poetic appeal. In a way, one might argue, there is beauty to be found in their ambiguity. It is in the nature of dreams to be open-ended and open to interpretation since in any instance they are reflections of our waking selves. The ways in which we value them is consequently related to our identity and our outlook on the world. Whether biologically significant or not, the rich experiential qualities afforded by dreams serve many purposes like exploring dreams from a spiritual perspective, to gaining a deeper understanding of the self and the world, to valuing them as social currency. While there exists a significant body of work on dreams in the cognitive sciences, dreams do not play a prominent role in design literature. This text has evaluated these theories and perspectives to explore how dreams may benefit design.

Understandings from the project

The design process has led me to understand the socio-cultural fabric and scientific discourse that dreams reside in. Concepts from anthropology, cognitive science and philosophy have inspired my research and have led to a user centered approach that has been informed by real people, relating real experiences. Methodologies like ludic and critical design advocate dream-like aesthetics and have informed me of design strategies that transpose meaning (ambiguity, para-functionality) and can create compelling interpretative experiences (design for presence and post-optimality). I have examined several objects which offer new ways of experiencing the world by augmented our sensory modalities to a dreamlike state. From my investigation of ludic design and critical design I have come to realize that when objects are regarded as poetic statements instead of commodity, they may become extensions of our identity and may help us experience and express ourselves in new ways.

From the perspective of design a domain as experiential and subjective as dreams can only truly be understood when empirically investigated. The sleep study made me aware of behavioral aspects of sleep, which inspired the sensor waistband prototype. The survey pointed out the project relevance for a large demographic, and was a step stone for the cultural probe studies. Cultural probes and interviews fit well within the constraints of the design space and have proven to be powerful tools to get at heart of the user experience. Ludic elements have made the cultural probe artifacts engaging, making the returns
The cultural probes allowed me to evaluate personal accounts of dream experience so aesthetic qualities of dreams could be distinguished and turned into design criteria. Moreover, while cultural probes are a design centered method, they are able to uncover rich personal experiences that may be valuable to psychological and physiological research fields like sleep studies. Finally, while at the time of writing the prototype remains untested, it intends to embody these qualities so they can be evaluated. My intent is to test the prototypes over a longer extent of time to see if users establish a meaningful relationship with the artifacts’ output.

Over the course of a few months I have gained insights on the dynamics of sleep, the cultural impact of dreams and the body of knowledge that has been dedicated to their exploration and interpretation. During the project my research interest has shifted from a focus on the establishment of design requirements for a final design artifact to an increased engagement with the process and its methodological underpinnings. The empirical research, and in particular the cultural probe evaluation has furthered my enthusiasm for affective technology and design for experience. At times it was hard to combine the design work with the empirical research and the development of the theoretical framework. Since dreaming is still heavily debated by scientists, it is hard for designers to join the discussion.

Since the limitations of physical reality are temporarily suspended during dreams, the dreamer is able to experience hyper real experiences. Hence, dreaming may be regarded as para-functional and post-optimal; it has no proven (physiological) function but offers rich aesthetic qualities that benefit our waking individuality. Yet in dreams we are unconscious, making the memory of the dream experience ambiguous and enigmatic. Here lies an opportunity for interaction design. My aim has been to explore opportunities to draw aspects of the dream into waking life by employing design methodologies in the context of a theoretical backdrop. The resulting prototype aims to empower the owner to discover personal patterns and associations in the output it generates.

The eclipse of reason

The dream phenomenon warrants investigation on many levels. In this text I have demonstrated that dreams are a valuable resource to the cognitive sciences, but that they may also benefit design and that a deeper understanding might even benefit a larger audience. Dreams positively influence our waking cognition, creativity and memory. On an aesthetic level dreams offer rich interpretative experiences that lead to insights into the self. Beyond the aesthetics dreams may harness the potential to spark social and cultural change, yet it is hard to identify a general aesthetic paradigm that can be applied to interaction design since dreams are so highly individual. Instead dreams offer an elevated mode of being; they foster a locus of control and freedom not found in wakeful experience. Objects that are able to evoke such aesthetic qualities transcend their use and provide rich, subjective experiences that allow us to value them in new ways. In this paradigm the post-optimal and para-functional are no longer design strategies that subvert meaning but constitute their ‘presence’; the ways in which we choose to appreciate them.

While we are already the nocturnal architects of our own unconscious experiences, perhaps in the future we can tap into our dreams to become the designers of our waking experience. In this future not only the field of interaction design, but we ourselves will adopt a new identity so that concepts like experience and existence may be rethought. I think William Gaver (2007) described it well in an interview when he argued that “if we could find new ways, new perspectives on ideas and on the world around us, if we could sort of play around with the issues that surround us, we can find our own ways of leading meaningful lives.”
Appendix A: Notes

1. Chapman argues that the “aesthetic discourse between creative designers and researchers, consumers and marketing specialists” is dictated by limiting, conservative values: “A consensus is reached regarding the way things should look; a mug is a ceramic cylinder with one semicircular handle, and laptops are like plastic books with keys and a screen. In a world of constantly evolving social values, static design languages such as these are obscure, to say the least. Problems increasingly occur when contemporary design scenarios cannot be easily pigeonholed into any one predefined type, jamming both creative freedom and real opportunities for change.” (2005, p 16)

2. Arata Isozaki describes how “electronic devices of innumerable kinds have spread throughout society, transforming its systems and practices from within. Television, video recording, pocket-size audio devices and giant video displays, compact computer devices, like television screen hookup game equipment and personal computers, are irreversibly altering our ways of life. The images produced by these systems are displayed on screens but they are completely separated from the real things themselves processed, edited, and otherwise qualitatively changed, often into something completely different. That process can be manipulated, creating impressions of convincing simulation. The constant bombardment of such simulated images could cause those images to flow back into the real world, blurring the line between real and simulated. Perceptions may become completely reversed, producing the sensation that reality is only part of a world of simulation.” (Moggridge, p517)

3. In Digital Peacock Tails Magnus Torstenssen and Eric Sandelin explore how personal technologies can facilitate self-expression. By designing a series of social experiments featuring experimental provocative garments dubbed ‘post-optimal attire’ they illustrate how intimate and expressive objects affect our identity.

4. In Power Pilgrims (2003) David Cuartielles, Erik Sandelin, Magnus Torstenssen and Otto von Busch explore post-optimal attire that makes visible our dependence on technology “through sartorial submission and silent praise” (Sandelin and Torstensson, 2003). While wandering through Copenhagen barefoot, their ‘power relics’ forced them to find and plug into a wall socket every fifteen minutes, so the electromagnets holding together their bright red robes would not unpower. The charging ritual forced ad-hoc serendipitous social interaction and provokes a discourse on how we want technology to permeate our lives.

5. The process of exploring meaning is central in the work of Thomas Thwaites. Thwaites’s Toaster project criticizes technology in the domestic context by focusing attention on the forgotten value of everyday commodities and by highlighting the process of making in a prefabricated world. The project explores what it takes to produce a common and seemingly banal household object like a toaster from start to finish. In its execution lies a strong focus on the process over the end result, which could be easily substituted by an inexpensive corner shop replacement, by retrieving raw materials from the earth, refining them to make the necessitated components and assembling them into a working product. Thaites treats the mundane as the extraordinary, making visible our dependence on the globalized mass-market paradigm that underlies modern Western society.

6. “When we let things into our lifeworld and they receive a place in our life, they become meaningful to us. We can say that this act of acceptance is in a certain sense a matter of relating expression to meaning, or to give meaning to expressions. Sometimes this is an explicit act, as in gift-giving and rituals (consider for instance how the wedding ring is given its place
entails that, on a certain level, meaning is lost. Cook continues: “in doing, we wrongly substitute unity for diversity, simplicity for complexity, permanence for change, and identity for difference. Once particulars are effectively identified with universals, there is allegedly nothing more to be said about them. Identity thinking consists in the claim that diverse objects fall under concept “X”; it thereby obliterates the particularity of objects, their differences from one other, their individual development and histories, along with other unique traits.” (Cook, 2008, pp.9-10) Non-identity thinking “seeks to say what something is, while identitarian thinking says what something comes under, what it exemplifies or represents, and what accordingly it is not itself” (Adorno, 1979, p 149) This makes evident an inherent dilemma; by abstracting and physicalizing dream content, does one further open up or close down the possibility for a non-identitarian approach to dream valorization or can representing the ‘dream substance’ lead to a alternative, richer and more liberating experience of the dream? Moreover, it brings into question to which mode of interpretation the experiential aspect of the dream should be subjected in order to be meaningful to their owner.

This is exemplified in Thomas Pynchon’s Gravity’s Rainbow by one of the central characters realizing that memories of dreams are themselves abstractions of the dreams they represent: “I am meant to remember. Each clue that comes is supposed to have its own clarity, its fine chances for permanence. But then [Oedipa] wondered if the gemlike ‘clues’ were only some kind of compensation. To make up for her having lost the direct, epileptic Word, the cry that might abolish the night.” (Pynchon, pp. 117-118) So if dreams are to be made sense of at all, it may only be achieved on a personal level through indirect subsumption.

The First Order of Simulacrum made its debut during the Renaissance period when society first adapted “to a proliferation of signs according to demand” (Baudrillard, 1983, p 85). The Second Order
emerged at the advent of the Industrial Revolution when the sign became further abstracted by the introduction of mechanical (re)production. The Third Order came into existence in postmodern society where the notion of reality was suspended and “there are only simulacra.” (Baudrillard, 1994, p 21).

12.— E.g. the Matrix movies or the surrealistic environments of the cinema of David Lynch could be regarded containing their own universe of meaning that need to be interpreted to be understood.

13.— Jeroen Holthuis’s ‘Bitquid’ explores the convergence of the virtual and the actual by visualizing both dimensions in a display of sprawling neon tubes and physically warped and re-digitized images. An image on one computer is encoded as a stream of bubbles in a fluorescent liquid, which is pumped through a set of tubes to another computer, which in turn encodes the ‘analog bits’ of information to reconstruct a modified version of the image. As Holthuis elaborates: “in contradiction to digital information, which consists out of ones and zeros (which in fact are analogies for electrical or magnetic loads), and thus only exists in two states, a fluid behaves in such a complex way that its states could never be fully comprehended.”(Holthuis, 2009)

14.— Interactive artist Daniel Rozin’s also invites the viewer to become the subject of his pieces. Rozin elaborates: “I believe that the source and inspiration for designs should be, as it always has been, the emotions, expressions and aesthetics of people. The tools to bring these concepts to life have changed over the past centuries and are chasing now, designers need to be able to use and develop the new tools and language necessary for their expression.” (Cameron, 2004, p 42)

15.— “Deleuze and Guattari in “Thousand Plateaux” talk about the capacity of structured sounds, notably rhythm, to define a space: an example the birds who negotiate their interaction spaces with their refrains - which is the English word for “ritornell”, or the child who softly sings a song in the dark. The refrain is the first hint of a stable and quiet center, the primordial will to organize chaos. The idea of rhythm emerging from chaos belongs to any cosmogony, but what happens if, instead of externalizing such a process, we trace it from the inside, and thus define a kind of “inner cosmogony”? We could then define territories between our sensory system and our unconscious, libido, fears, etc. As we enter the mask, the refrain is our own breathing, but the territories thus delineated somehow don’t overlap, are slightly conflicting because of the delay, there’s an inconsistency between the act and the perception of it.” (Casalegno, 2010)

16.— Similarly, Alex Braidwood’s Listening Instruments limit auditory perception, his Noisolation Headphones (2011) is a device that covers the user’s ears and mediates environmental noise mechanically through a set of sound-prevention valves to create a personally composed listening experience.

17.— Stevenson described: “[…] on the second night I dreamed the scene at the window, and a scene afterward split in two, in which Hyde, pursued for some crime, took the powder and underwent the change in the presence of his pursuers.” (Terry, 1995, p117)

18.— Luis Buñuel and Dali’s Un Chien Andalou (1929) is a silent surrealist short film depicting a visual narrative of unrelated events void of plot or chronology and was inspired by a dream Buñuel had in which a cloud sliced the moon in half “like a razor blade slicing through an eye”.

19.— Possessed (1931) contains a scene resembling a dream experience. “[…] An ordinary working class girl living in a small provincial town, all of herself she finds herself in a situation where reality itself reproduces the magic cinematic experience. She approaches the rail, the train is passing and it is as if, what in reality is just a person standing near a slowly passing train, turns into a viewer observing the magic of the screen. We get a very real, ordinary scene, onto which the heroine’s inner fantasy space is projected so that, although reality is simply there, the train, the girl, part of reality in her perception and in our viewer’s perception is as
it were elevated to the magic level; becomes the screen of her dreams.” (Žižek, 2006)

20. The cinema of David Lynch is heavily influenced by dream elements like fantasy and tension. His work includes “[...] the use of dreaming as a narrative structuring device, the inclusion of scenes in which characters experience a dream, the inclusion of dialogue in which characters discuss dreams, and the use of Lynch’s own dream experience as an inspirational source for his creative work.” (Bulkeley, 2003, p50)

21. William Domhoff, research professor at the University of California, argues that not only dreams but also their conscious interpretation lead to valuable insights. “Many of the claims about great discoveries are very hard to document, but what we always have to remember is that these people were intensely thinking about these issues, so there may have been some discoveries based on reflecting on dreams”. (2011, in: What Are Dreams)

22. “Two gates the silent house of sleep adorn; Of polished ivory this, that of transparent horn; True visions through transparent horn arise; Through polished ivory pass deluding lies.” (Packer, 2002, p 12)

23. The Yogavasistha, a poetic Hindu treatise contains a dream similar to Zhuang Zhou’s butterfly dream. In the text a narrative unfolds of a recursive dream of a seer and a hunter, neither of them sure if they are the one dreaming the other. “As the tale progresses, we realize that our confusion is neither our own mistake nor the mistake of the author of the text; it is a device of the narrative, constructed to make us realize how impossible and, finally, how irrelevant it is to attempt to determine the precise level of consciousness at which we are existing. We cannot do it, and it does not matter.” (Doniger, 2001)

24. Freud thinks of dreams as vessels for hidden messages which meaning can be extracted from their content. His methodology for interpreting dreams is grounded in analysis of the dreamer’s account of the dream and associations provided by the dreamer. In the Freudian doctrine objects and events occurring in the dream are thought of as symbolic representations of unconscious thoughts. According to Freud the majority of symbols in dreams are sexual symbols. For example, hats, overcloaks, coats, umbrellas, cigars and the number “three” are believed to be abstractions of the male genitalia, though Freud points out that not every element of the dream should be regarded as a symbol. The recognition of symbols should be based solely on the usage of an associative technique which should be used to piece together a meaningful interpretation of the dream. Association happens by contextualizing the dream events in an analysis of the dreamer’s personal perspectives and mode of thinking. (Barcaro, 2010, p.4-10)

25. The dream work can be understood in the context of Freud’s theory of the Id, the Ego and the Superego. The Id is the unorganized part of the mind representing basic human drives and acts according to the “pleasure principle” (the psychoanalytic concept describing circumstantial reality compelling a person to defer instant gratification), seeking to avoid pain or displeasure aroused by increases in instinctual tension. (Rycroft, 1995) The ego acts according to the reality principle, it seeks to please the id’s drive in realistic ways that will benefit in the long term rather than bringing grief. (Garrison, et al. 1984, pp.189–194) The super-ego aims for perfection. “the super-ego also takes on the influence of those who have stepped into the place of parents — educators, teachers, people chosen as ideal models.” (Freud, 1933, p. 95-96) “It comprises that organized part of the personality structure, mainly but not entirely unconscious, that includes the individual’s ego ideals, spiritual goals, and the psychic agency (commonly called “conscience”) that criticizes and prohibits his or her drives, fantasies, feelings, and actions. “The Super-ego can be thought of as a type of conscience that punishes misbehavior with feelings of guilt. For example, for having extra-marital affairs.” (Reber, 1985)

26. Jung argued that dreams could be explored “in the hope of bringing
a more balanced attitude”, and harmonizing the conscious and unconscious: Jung argued that when interpreting a dream “it is always helpful to ask: What conscious attitude does it compensate?”. (1934, p 153)

27.— Hawkins proposes that the current predominant theory “that intelligence is defined by behavior” is false and mentions the Turing test as an example of this school of thought. (2004, p14) Hawkins continues by stating that “intelligence is instead defined by prediction” (Hawkins, 2007) in his argument on memory constituting intelligence.

28.— Ladd deliberates: “as we look down the street of a strange city, for example, in a dream we probably focus our eyes somewhat as we should do in making the same observation when awake” (Dement, et al. 1962 p. 235)

29.— There is also software available to help fall asleep. SimplyNoise.com offers white noise as streaming audio supposedly aiding the process of falling asleep, while Flux, a desktop application, reduces the amount of blue light emitted from the user's monitor during the night to make falling asleep easier.

30.— Sleep Cycle alarm clock (iOS), ElectricSleep (Android) and Sleep as Android (Android) implement the smart phone’s accelerometer to detect REM sleep body movements and wake the user when he enters a light sleep cycle around a preconfigured time in the morning. Sleep Talk Recorder (Android) is activated by ambient sound surpassing a pre-configured threshold and automatically starts and stops recording sound when a person talks (or makes sound) in his sleep. Sleep Bot Tracker Log (Android) keeps track of sleep duration, presents the data in graphs and tables, and makes the user aware of sleep deprivation by introducing the concept of ‘sleep debt’ which accumulates as the user sleeps too little over time. Other apps claim to positively alter the sleep. Snore no More (Android) is an app which offers statistics on when and how often the user snored during a night which recognizes snoring and plays an auditory alert to condition the person to stop. Sweet Dreams (Android) automatically turns off data connections and gsm functionality of the phone at night to avoid being woken by incoming calls or emails. Relax and Sleep (Android) is a mobile white noise and ambient sound scheme generator which intends to induce drowsiness and help combat insomnia.

31.— Some apps propose to offer tools to archive or interpret dreams. Dream Journal (Android) is a note-taking app for documenting and keeping track of dream events. Apps like Dream Dictionary (Android), Meaning of Dreams (Android), Interpret your Dreams (Android) and Dream Meanings Dictionary (Android) even go as far as to offer (often esoteric) ‘insights’ into the dream’s meaning. Dream:ON (iOS) uses the Iphone’s accelerometer to detect when the user is dreaming and play back preconfigured sound samples to evoke the dreamer to become aware of the dream state. Others try to achieve dream lucidity by playing back specific sound samples while sleeping (Lucid Dreaming App, Android) or remind the user periodically (during wakefulness) to do ‘reality checks’ (Lucid Dreaming Reality Check, Android) which condition the user to perform these checks during the dream and become aware that he is dreaming. Ludic Dreaming Guide (Android) makes claims on offering educative contextual information about dreaming.

32.— Firstly, the methodology requires the research subject to sleep within a controlled environment, generally for at least several nights. Secondly, it involves costly, bulky and invasive equipment which needs to be calibrated and operated by specially trained personnel. Moreover the retrieved data requires domain specific expertise to be interpreted knowledgably. With limited time and resources available, my aim has been to empower the user to self-monitor his dreams in a way which is as little invasive as necessary does not emphasize scientific validity, but instead explores and values abstract data retrieved from an equally abstract experience. While advancing rapidly, polysomnography is
Fitbit provides small bodyworn motion sensors, ‘smart’ scales and smart phone apps targeted at a health aware lifestyle. Nike produces the Nike+ FuelBand, a wrist-worn actigraph which allows its user to analyze the recorded data through a mobile app and web interface. ‘Neuromarketing’ company Innerscope has developed a waist worn biometric system for measuring consumer engagement with advertising which monitors skin conductivity, respiration, motion and heart rate.

35.— On one of the recordings I could clearly hear myself say “... and emotions...” before drifting back into the dream again.

36.— I made the fundamental design mistake of asking the respondents directly what they wanted. When asked impromptu, users are not aware of their intents and expectations and are often uncomfortable being introduced to experiences that differ from what they are already accustomed to. (Gladwell, 2005) As Thimbleby (1999, p 1) further illustrates: “few people claim to need the percent key on a calculator, many people claim they do not need to programme their video recorder, many people “prefer” to switch their mobile phone off than lock the keypad, and so on. Thus asking users what they want in design is fraught with problems.” This became even more problematic because of the fleeting nature of dreams which makes them hard to quantify within the rigid format of a survey. Limited space for writing forced condensed comments and often cryptic doodles that required missing contextualization to be interpreted as the author intended.

37.— Cultural probes allow designers to gain a deeper understanding how users “explore, wonder, love, worship, and waste time” and engage in other activities that are “meaningful and valuable” to them. (Gaver, 2001). Their taxonomy speaks to the imagination and refers to their explorative nature. Gaver explains how “…the name seemed right because it made multiple, simultaneous references:- to space probes returning data over time from far away- to medical probes poking into intimate nooks and crannies- to probes as devices to provoke reactions.” (Graham
43. The sensor waistband not only recorded data, it was also responsible for manipulating it to reduce file size so the data could be quickly transmitted wirelessly to the actuating prototype. The data collected by the sensor waistband over the course of the night was temporarily stored on a 2 Gigabyte microSD card. Since just a few bytes of data were read from the sensors the generated file containing the physiological measurements could easily fit on the microSD card to be accessed later by the program. When the user opened the waistband the data logging stopped and the file was sent, using an XBEE module, through a wireless connection to the actuating prototype.

44. This device would use the physiological data in an algorithm that would generative story by selecting three seemingly random selected lines from a series of digital books and assembling them into a surreal narrative which would grow each night.

45. For instance I wanted the device to automatically make a smoothie from the user’s dreams, but this led to a practical problem since fruit needs to be processed (cleaned and peeled) before consumption and fruit has different sizes, making it hard to dispense automatically without cutting and preserving it.

46. Admittedly the device is only suited to be used by a demographic of coffee drinkers.

47. When one informant (I5) expressed his concern that the taste would not be discernible extra ingredients were added to the coffee beans to provide a stronger contrast. A professional cook advised me which ingredients could be added. One container contained mildly roasted beans flavored with vanilla, another contained medium roasted beans flavored with dried orange peel, the third contained dark roasted beans with cinnamon, and the fourth espresso beans mixed with cacao beans.

...and Rouncefeld, 2008, p.194)
It also contained an amplifier, an active loudspeaker, an Arduino Uno prototyping board and several multicolored light sources (RGB LED's). The vibrations created by the subwoofer were amplified PWM signals coming from the Arduino's digital pins. The digital pins were also used to control each RGB LED's color individually.

The liquid is a suspension of corn starch and water commonly referred to as ‘obleck’.

At first I wanted to make a clear distinction between the various data sources (heart rate, temperature, motion and respiration rate) and how they would affect the output generated by the actuating prototype. My reasoning was that the signals which contained higher fluctuations (like motion) would be more predominantly presented in the output than metrics which showed little variation (temperature). However, later I decided that this extra layer of interpretation might limit the user’s own interpretation of the dream.

The Teensy board is a scaled-down version of the widespread Arduino Uno. It comes pre-fit with male headers allowing it to be connected to components without direct soldering. The sensors and the RTC were consequently soldered to female headers and modularly connected to the headers on the Teensy board, which allowed the individual sensors to be removed so the belt could be washed and the program running on the Teensy board could be easily debugged. A thin coating of hot glue and a layer of electrical tape ensured insulation and strengthened the connections to prevent the circuit from accidently becoming disconnected or short circuited.

The hardware components used in the final version of the sensor waistband are: a Teensy 2.0 input/output board modified with a MCP1825 voltage regulator to make it run on 3.3V and a microSD card reader module mounted on top, a 3-axis accelerometer (MMA7361L breakout board), a digital thermometer (DS18B20) with ±0.5°C accuracy, a heart rate monitor (open-source Pulse Sensor), a custom knitted stretch sensor made from interwoven flexible yarn and conductive thread which its impedance increased when stretched ever so slightly, a real time clock (DS1307) for time stamping the data, an XBEE breakout board for sensing the data wirelessly to the actuating prototype, two parallel connected 9V batteries, a 7805 voltage regulator to regulate the 9V batteries down to 5V, a conductive button used in the soft switch for turning on and off the sensor waistband, three Lilypad micro LED’s for indicating the status of the waistband and several resistors.

I was accustomed to most technology necessary to construct the coffee grinder, but the phantoliquefier required knowledge of audio synthesis, a field of electronics which I had no prior experience in. In addition to control the non-newtonian liquid in interesting ways I needed to have an advanced understanding of the physical properties of the liquid. Other limitations were that the corn-starch liquid I wanted to use settles to become a cement like substance after it is left unattended for a couple of hours, making it very labor intensive to use the device. On top of that a corn-starch emulsion starts to rot very quickly when exposed to oxygen, and as of yet I have not been able to find preservatives which do not affect the non-newtonian properties of the liquid.

The coffee grinder was also problematic. I chose to make the coffee grinder transparent to expose the inner workings of the device. I realized that by showing the electronics and wires inside it would only add to its mystery since it didn’t reveal how the device decided on what unique blend of coffee it would generate. Some problems arose with its design however, the button control panel on the grinder needed to be kept in place with bolts, which meant the buttons were hard to press and the clear acrylic parts were fragile and prone to scratches.

The sensors in the waistband were hard to integrate in the final prototype. The thermometer relied on a software library which was not compatible with the latest version of the Arduino integrated development environment, in which the rest of my program was developed and the
code necessary to use the heart rate monitor would disrupt the rest of the program.

56.— Since dreams emerge at different times throughout the night, the waistband needed to be able to constantly monitor the user over the course of at least 8 hours. In practice it was difficult to keep the prototype continuously powered for such a long time because of the inherent limitations of the Arduino prototyping platform. David Cuartielles explained in a tutoring session that “designing for low power consumption should not be the concern of designers [...] because the tools are not designed to design for low power consumption. They are designed to provide functionality.” There is a sense of irony to be found in the fact that in the context of this project functionality by itself did not cut it.

57.— To speed up the design process and sustain the dialogue the informants were not directly included in the conceptualization process, instead the prototype concepts were inspired by the cultural probe and interview material.

58.— Corventis, a biomedical company already produces smart band aids which can continuously monitor the wearer’s vital signs (measuring cardiac rhythm, temperature, respiration rate and oxygen levels) and connect wirelessly to his smart phone to send the recorded data wireless to a centralized server for analysis.

59.— The sensors comprising the waistband were tested individually on a prototyping ‘breadboard’ to confirm that they were operational in a controlled environment. To the sensors connectors were soldered so that they could be placed in and taken out of the waistband without the need to unsolder the circuit. Making the sensors work together proved to be a difficult task because of unexpected software and hardware incompatibility.

60.— Since sleeping is one of the most private rituals of the day, the only way to truly evaluate the dream experience is by giving the user the tools to self-monitor the dream, which means a functional, high-fidelity prototype needs to be developed. Since it’s hard to tell when someone is actually dreaming without waking the person up, I was constrained to one user test per night.

61.— On a personal level the project has affected me a great deal. Interestingly enough I started dreaming less frequently and less erratically as the project progressed, which might have been the result of my increasingly irregular sleeping pattern. The dreams that I’ve had fall into several categories that emerged over the course of the research. Some of them seemed too surrealistic to contain rational information, some have set me in the right state of mind to proceed with my work and others have led me to new insights about my writing and design work. My initial idea for doing my thesis project on the topic of dreams originated from the memory of a dream about doing my thesis project, although I do not remember dreaming that my thesis project was (or should be) on dreams.

62.— Specifically it was hard to switch between a focused analytical mindset needed to design, solder, assemble and program the prototypes and a holistic view needed for academic reflection and writing.
The material in Appendix B and C is provided in digital form due to its sensitivity and transmedial nature. For more information contact me through vincentolislagers.com. Following is an overview of the contents.

**Appendix B: Data Gathering**
- B-1 Sleep observation material (wmv, timelapse)
- B-2.1 Survey: Inquiry booklet template (pdf)
- B-2.2 Survey: Digitized inquiry returns: (respondent sketches)
- B-2.3 Survey: Data (pdf/xls)
- B-3.1 Cultural probes: Probe designs
- B-3.2 Cultural probes: Digitized returns
- B-3.3 Cultural probes: Informant debriefings (interviews)
- B-4.1 Correspondence with stakeholders: Cultural probe informants
- B-4.2 Correspondence with stakeholders: Sleep researchers
- B-4.3 Correspondence with stakeholders: Neuroscientist and EEG equipment manufacturers

**Appendix C: Design Process**
- C-1 Concept sketches
- C-2 Building the prototypes: (stills)
- C-3.1 Final Prototype: (stills)
- C-3.2 Final Prototype: Source code (pdf)
- C-3.3 Final Prototype: Electrical diagrams (pdf)
- C-3.4 50% Seminar Presentation and Critique (pdf + audio)
- C-3.5 80% Seminar Presentation and Critique (pdf + audio)
- C-3.6 Final thesis document (pdf)
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