

# How to design for well-being?

a methodology on design for well-being  
to embody well-being in ViSi Mobile

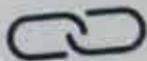
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Values that Matter



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Alterity  
relation

Technolo

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## ■ Summary.

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The term well-being is often used in the world of design. Design would, as frequently argued, improve users' well-being and thereby positively contribute to the world. One would then expect a large body of literature and methodologies on design for well-being. Yet, the opposite is true. There are only a few methodologies on designing for well-being, all mostly lacking well-developed frameworks.

This thesis will provide an answer to the research question: how to design for well-being? Chapter 1 will study well-being and its relation to design. At first, it will study the philosophical theories on well-being: hedonism, desire satisfactionism and objective list theories. Second, a light will be shed on the relation between well-being and healthcare, as that provides the settings for the case study of chapter 3. Third, on the basis of the theories on well-being, three heuristics will be derived. Those heuristics allow for applying well-being to design. They are pragmatic translations of the philosophical theories of well-being, without thereby doing injustice to the theories themselves. The heuristics are 1. A design for well-being methodology should anticipate on the effect of technology on well-being. 2. A design for well-being methodology should enable designers to define an objective list of well-being tailored to the context of the design project. 3. A design for well-being methodology should guide designers in developing designs that embody an objective well-being, whilst contributing to users' subjective well-being. Finally, chapter 1 will illustrate that existing design for well-being methodologies currently fail to take into consideration the three heuristics.

Chapter 2 will develop a new design for well-being methodology that takes into consideration the three heuristics. The methodology will revolve around human-technology relations by involving technological mediation and value sensitive design. It will grant an important

responsibility to designers to embody in design an objective well-being that concurrently meets users' subjective well-being. This results in the methodology *Values that Matter* that aims to guide designers in solving normal design problems with technologies that are not only feasible on a technological and economic level but that best embody well-being.

Chapter 3 will put into practice the newly developed methodology via the technology ViSi Mobile. ViSi Mobile is a device that will, from May 2018 on, be used in the Radboudumc hospital for continuous monitoring of patients. It will replace episodic measurements of nurses, thereby gaining better insight into patients' health and in the progression of diseases. ViSi Mobile may help to reshape healthcare. The device already meets its technological and economic feasibility. *Values that Matter* allows for gaining insight as well in technology's feasibility on well-being. Applying *Values that Matter* to ViSi Mobile does not only lead to a redesign of ViSi Mobile that is best for patients' and other stakeholders' well-being but simultaneously allows for improving the design methodology itself.

*Values that Matter* requires future research on balancing well-being with economic and technical requisites, what constitutes values of well-being and how they relate with each other, which scope of actors should be considered, how mediation theory could become better involved and how the theory could be brought into practice. Yet, for now, it provides designers with the tangible guidelines to make a positive contribution to the well-being of people in the world.



# Content.

Introduction 8.

## Part 1: Technology & Well-being 10.

### 1.1 The concept of well-being 12.

Well-being as the ultimate value of life 12.

Well-being in philosophy 13.

*Hedonism* 13.

*Desire satisfactionism* 14.

*Objective list theories* 14.

Well-being in healthcare 15.

### 1.2 Well-being in design 18.

Heuristics on design for well-being 18.

Existing design for well-being methodologies 20.

Conclusion on well-being 22.

## Part 2: Values that Matter 24.

### 2.1 Sources of inspiration 26.

1: Technological mediation 26.

2: Value sensitive design 29.

3: Designer as expert 29.

### 2.2 Values that Matter 30.

Step 1: What values matter 31.

Step 2: How values are affected 34.

Step 3: User and values 36.

Conclusion on *Values that Matter* 39.

|  |            |
|--|------------|
| <b>Part 3: Case study: ViSi Mobile</b>                 | <b>40.</b> |
| <b>3.1 The technology ViSi Mobile</b>                  | <b>42.</b> |
| Technology and the future of healthcare                | 42.        |
| ViSi Mobile and the future of healthcare               | 42.        |
| <b>3.2 <i>Values that Matter &amp; ViSi Mobile</i></b> | <b>46.</b> |
| Step 1: What values matter                             | 47.        |
| Step 2: How values are affected                        | 56.        |
| Step 3: User and values                                | 62.        |
| Conclusion on ViSi Mobile & well-being                 | 65.        |
| <b>Discussion &amp; Conclusion</b>                     | <b>66.</b> |
| Discussion   | 68.        |
| Conclusion   | 70.        |
| References   | 72.        |
| List of figures - tables - appendices                  | 76.        |

# ■ Introduction.

“

Well-being, or quality of life, is often a central value in the design of technological artifacts, especially in the design of consumer products. [...] Given the centrality of well-being in much of design, one would expect an extensive literature on design for well-being. This turns out not to be the case. Very few studies in the design literature focus on well-being and even less present a methodology or approach for designing for well-being

**(Brey, 2015, p.1)**

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This quote is the start of philosopher Philip Brey's paper reviewing the few design approaches that aim to improve well-being by design. Whereas Brey only reviews the design approaches, this thesis aims to develop a new approach that in the future would render this quote into only a reflection of the past.

The world of design is in need of awareness on and understanding of the great effects that technology can bring about. There is no better field than the philosophy of technology that could provide in this. Yet, as a layman, it is difficult to understand the philosophy of technology. Being granted with best of both worlds; studying philosophy of technology with a masters degree in industrial design engineering, I aim here to bridge the gap between philosophy and design. I will try to make understandable philosophical constructs, such as well-being and technological mediation, for design purposes. Then I will translate those into a design for well-being methodology that any designer should be able to use: *Values that Matter*. I will finally apply this methodology to a case study of the Radboudumc hospital in Nijmegen.

Chapter 1 will start with studying well-being in philosophical context. Consequently, well-being will be studied in relation to healthcare, as that provides the settings for the case study of chapter 3. The chapter will continue with a translation of the philosophical theories of well-being into three pragmatic heuristics that allow for bringing the philosophical well-being to design, without doing injustice to the philosophical theories themselves. The chapter will end with an illustration of why existing design for well-being methodologies currently fail to take into consideration the three heuristics and thereby cannot claim to adequately help designers in designing for well-being.

Chapter 2 will develop in detail a new and more adequate design methodology for well-being, *Values that Matter*, by taking into consideration the three earlier on developed heuristics. The methodology aims to solve 'normal' design problems by 'normal' technological solutions that best embody well-being. The methodology revolves around human-technology relations via mediation theory, involves insights from value sensitive design and grants designers with the responsibility

to embody an objective well-being in design whilst concurrently meeting users' subjective well-being.

Chapter 3 will bring into practice *Values that Matter* via the case study of ViSi Mobile. This device can continuously measure the vital signs of hospitalised patients. It will be implemented in the Radboudumc hospital to reshape current healthcare into one ready for the future. Applying the design methodology to this case study gives, on the one hand, insights in improving the design methodology and allows, on the other hand, for understanding how ViSi Mobile is affecting the well-being of patients, nurses, doctors, relatives and other stakeholders. The chapter will conclude with a redesign of ViSi Mobile that best brings about well-being for the stakeholders involved.

### Definition of terms

To prevent that the reader gets lost in semantics, different linguistic expressions need to be discussed. Let us look into the topic of this thesis: design and well-being. What is design and what is well-being?

The term *design* is often used by scholars as a synonym for *technology* or for *artefact*, *product*, sometimes even *instrument* or *tool*. According to the dictionary, *artefact* encompasses all human-made objects, whilst *instruments* and *tools* are only those objects that serve as means to an end. Yet, are not all objects made by human beings means to ends? And what makes up design and technology? *Design* is seen, by the dictionary, as a process to create an object for a certain end, a *product*. *Technology* is then defined as the practical application of knowledge to an end (dictionary.com, 2018). Both terms are seen in the dictionary as processes, whilst in normal life they are often used to refer to the end stage of the object itself.

To prevent confusion, this thesis will only use the words *design* and *technology*. The word *design* will be used as a noun and as a verb. The noun *design* will in the thesis refer to a human-made object that has been intentionally designed by an individual or a group of individuals to meet a certain end. It will be used as a synonym for *technology*. *Technology* thus encompasses all objects

that have been designed intentionally to serve an end, a design problem. It thereby is the result of the practical application of knowledge, not the process itself. The verb *design*, on the other hand, will refer in the remainder to the process of bringing into practice knowledge to develop *a design*. *A designer* is then a person that has the knowledge and practical skills to create *a design*. All people that make use of *a design* are named *users*.

Let us then continue to the second important linguistic expression that this thesis contains: *well-being*. Besides well-being authors have used many other terms that are used to refer to almost the same content: *flourishing*, *happiness*, *quality of life*, *the good life*, *life satisfaction* or *eudaimonia* (Brey, 2015). The diversity in expressions that refer to almost the same content, make it difficult to study the topic. I will only make use of the term *well-being* and will, to preserve readers' comfort, not overwhelm them with a collection of synonyms. I will not define well-being here as the first chapter will be entirely devoted to studies on the definition of well-being.



1



**TECHNOLOGY  
& WELL-BEING**

## ■ 1.1 The concept of well-being.

Over time, the human being has developed an immense array of technologies. A short inventory shows amongst millions of others the stone tools as prehistoric technologies, later on the wheel, the steam engine that started the industrial revolution, the automobile, the internet and genetic modification possibilities. It has even been argued that it is this large body of technologies, allowing the human being to master its environment, that renders the human being unique (Marx & Engels, 1867, p.76).

Let us now turn to one specific technology, a bridge, described by Langdon Winner in his famous article: *"Do artifacts have politics?"* He introduces the architect Robert Moses that was asked around the 1930s to design this bridge connecting New York and Long Island beach (Winner, 1980). Moses' bridge appeared after construction to be too low to let pass public transportation. Consequently only the people of the higher classes, in possession of a car, were able to reach the beach.

Moses' example shows that designers have the ability to shape life with technology. Philosopher Hans Achterhuis believes designers should consciously make use of this ability. He pleads for conscious design in the article: *"De moralisering van apparaten"*, which implies that we should not only try to moralise humans but as well the technologies they are using (Achterhuis, 1995).

At first, Achterhuis' view was criticised for endorsing a technocratic worldview by impeding human freedom and dignity with behaviour steering technologies (Verbeek, 2006). Over the past years, however, there is a growing acceptance that technologies shape life anyways. Given this, designers could better create technologies that make users' lives better: that improve their well-being.

### **Well-being as the ultimate value of life.**

*How should we live?* It is a question that has certainly once or twice made entrance in the mind of the reader. The question is at least as old as ancient Greece. At that time, Aristotle wrote in *"Nicomachean Ethics"* and

*"Eudemean Ethics"* that *eudaimonia* could answer the nagging question (Kraut, 2014). *Eudaimonia* encompasses *eu*, which means *well*, and *daimon*, translated into *spirit*, together freely translated as *living well*. *Eudaimonia* was for Aristotle the highest good in life. This good is desirable for its own sake and not for the sake of any other good. Any other good is desirable for the sake of *eudaimonia*.

Since technology affects life, it makes sense to follow Aristotle's line of thinking and embody in technology *eudaimonia*, or as most accurately translated: well-being. Well-being could apply to two levels: the individual and societal level. Individual well-being aims at improving individual's life. Well-being of society aims to improve societal conditions by, for example, preventing crime (Davey, Wootton, Thomas, Cooper, & Press, 2007). This thesis' focus is on achieving individual well-being by design<sup>1</sup>.

Apart from intrinsic value, well-being has extrinsic value. Results show that higher levels of well-being result in better physical health; better neuroendocrine regulation, lower cardiovascular risk and better immune functioning (Deci & Ryan, 2006). Furthermore, improved well-being fosters social relationships and pro-social behaviour (Kesebir & Diener, 2008). Well-being as well is said to go hand in hand with creativity, ability to deal with stress and productivity (Lyubomirsky & Layous, 2013; Pohlmeier, 2013).

As might be clear by now, well-being is the ultimate value that people - and designers - should strive for. Before being able to

focus on embodying well-being in design, the term itself needs further clarification. In what follows, the three main philosophical theories on well-being will be explained: hedonism, desire satisfactionism and objective list theories. Consequently, a light will be shed on the relation between the philosophical well-being and healthcare, as the healthcare industry provides the context for the case study of chapter 3 of this thesis. Finally, the last part of this first chapter will relate well-being to design. This part will build up the basis for the chapters to follow.

In this thesis, I do not aim at providing the ultimate and only true definition or theory of well-being, as that would do injustice to all philosophers that found their life's purpose in defining the concept. I do not even aim at appreciating certain philosophical theories over others. In reviewing the philosophical theories on well-being, I will only try to find the relationship between well-being and design. This should help me to develop three tangible and pragmatic guidelines for measuring and embodying well-being in technology. The guidelines will show what is still lacking in existing methodology on design for well-being and provide heuristics for developing a new methodology.

For more information on well-being, the reader should consult Appendix 1. This appendix provides a detailed overview and comparison of a diversity of theories on well-being from philosophy, psychology, economy and healthcare. The first field has been covered as it provides the basis for this thesis. Psychology and economy have been studied because of their great bodies of literature on the concept. Healthcare has been targeted as it covers the case study of this thesis.

### **Well-being in philosophy.**

The philosophical tradition knows three main theories describing well-being: hedonism, desire satisfactionism and objective list theories (Brey, 2012a; Crisp, 2001a; Parfit, 1984, pp.3-4). Each theory will be described hereafter.

### **Hedonism**

Hedonism is rooted in the ethical theory utilitarianism that emerged around the 18th century. Jeremy Bentham shaped the movement by his principle of utility; claiming human behaviour to result from solely pleasure and pain (Bentham, 1780, p.6). Following this, well-being is the greatest balance of pleasure over pain. Bentham's ideas nowadays account for *quantitative hedonism* that defines well-being via the measures duration and intensity of pleasure over pain. The theory does not appreciate certain pleasures over others. John Stuart Mill has criticised this with his famous quote: "it is better to be a human being dissatisfied than a pig satisfied; better to be Socrates dissatisfied than a fool satisfied" (Mill, 1871, p.14). Mill initiated *qualitative hedonism* that includes, apart from duration and intensity as well the quality of pleasures. The high, intellectual, pleasures should be appreciated over the low, sensual, ones.

In the hedonic life, one aims at maximisation of pleasant experiences and minimisation of unpleasant ones. The authenticity of experiences is thereby not taken into account, as critically pointed out by Robert Nozick. He developed a thought experiment aiming to illustrate the wrong in hedonism (Nozick, 1974, pp. 42-45). In that, people are given the choice to either live a pleasant machine-simulated life that cannot be distinguished from the real life, or to live a real life including unpleasant situations. Remarkably, people prefer to live the real, authentic life. Nozick thereby shows that pure pleasure cannot account alone for well-being. The philosophical theory desire satisfactionism brings in authentic experiences and is at the same time able to solve another often contested problem in hedonism. Namely, hedonism fully revolves around feelings that cannot be measured, whilst desires can.

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1. The focus is on individual well-being because technology is directly in contact with individuals. Although this focus, individual well-being might simultaneously improve social well-being (Tromp, Hekkert, & Verbeek, 2011).

### Desire satisfactionism theories

Desire satisfactionism emerged around the 19th century mostly to overcome hedonism's inability to measure well-being. As pleasure and pain are solely feelings, they cannot be measured. Desires, instead, can be evaluated. People are normally able to rank their desires according to their preferences and this ranking allows for objective assessments of one's level of well-being.

There are in general three different subcategories. The first, *simple desire satisfactionism*, considers well-being to concern only desires that one currently has. The more of those short-term desires become fulfilled the better one's well-being. Yet, one's short-term desires might conflict with those in the long-term. To account as well for well-being in long-term, the *reflective desire theory* does not only include short-term but as well long-term desires. Those long-term reflective preferences are appreciated over short-term desires. Still, this theory cannot account for potential future desires. The *informed desire theory* therefore finally believes well-being is achieved when fulfilling desires that one would ideally have on short- and long-term notice when able to make external objective assessments over own life.

### Objective list theories

Hedonism and desire satisfactionism both encompass subjective personal evaluations in their definition of well-being. The objective list theories do not believe in the ability of people to subjectively assess their lives, blinded by personal biases. Instead of subjective evaluations, the objective list theories aim at developing one list with objective qualities that each person should acquire to achieve well-being, irrespective of his preferences (Brey, 2012, p.5). The more elements of the objective lists are met, the better one's well-being will be. Several proposals have been done on the elements that should be included on the objective list. Those proposals either relate each element on the list to a connecting principle or simply believe each element in itself improves well-being (Wall, 2007).

The *perfectionism theories*, as a category

of the first, aim at connecting the elements of well-being on the basis of human nature. All elements that contribute to the perfection of human nature, that what is essential and necessarily distinctive of human beings, should be included on the list (Hurka, 1993, p.14). The most well-known perfectionist theory in this field is Aristotle's. Aristotle believes that humans should strive for eudaimonia via living the virtuous life with rationality and reason. There are two types of virtues: virtues of intellect and ethical virtues. Virtues of intellect engage in reasoning: theoretical wisdom, science, intuitive understanding, practical wisdom and craft. Ethical virtues are the mean between extremes, the elements of the soul: courage, temperance, liberality, magnificence, pride, honour, good temper, friendliness, truthfulness, tact and justice (Aristotle, 350 BCE; Kraut, 2014).

Another perfectionist theory that studies well-being via human nature is the one of philosopher Thomas Hurka. Hurka builds a non-teleological three-dimensional view of human nature, consisting of physical, theoretical and rational perfections that together lead to well-being. Physical perfection is achieved in the finest functioning of the body. The latter two encompass ideal theoretical and practical rationality and actions. Perfection is not an egocentric property that should lead to self-realisation. Rather, it is a quality that mankind should strive for (Hurka, 1993).

Martha Nussbaum has as well famously contributed to the perfectionism theories. She builds her theory on Amartya Sen's capability approach that believes well-being is not in having resources, but in having certain capabilities; that what people are able to do and to be. These capabilities depend on functionings, the beings and doings of a person that result from available resources and physiological, physical and social circumstances. Alternative combinations of functionings result in one's set of capabilities. An individual should be free to decide on which functionings from the capability set to bring into practice to generate well-being. It is this process that should be studied to understand one's well-being (Sen, 1993, pp.30-53). Sen has

left open which capabilities are necessary to obtain well-being. Nussbaum instead has proposed ten items: life, bodily health, bodily integrity, senses-imagination-thought, emotions, practical reason, affiliation, other species, play and control over one's environment (Nussbaum, 2003).

The latter group of theories lists elements of well-being for their *intrinsic goodness*. Many proposals have been done. Derek Parfit has developed a list that aims to realise the best in individual's life. He proposes the elements moral goodness, rational activity, the development of one's abilities, having children and being a good parent, knowledge and awareness of beauty (Parfit, 1984, p.499). John Finnis proposes seven basic values: practical reflection, life, knowledge, play, aesthetic experience, sociability, practical reasonableness and religion. He believes that there are plenty of other values that can determine human behaviour, but those are not the core ones (Finnis, 2011, pp.85-89). According to Guy Fletcher, one's well-being consists of achievement, friendship, happiness, pleasure, self-respect and virtue (Fletcher, 2013, p.214). Then, James Griffin believes accomplishment, components of human existence; autonomy, basic capabilities and liberty, understanding, enjoyment and deep personal relations to belong on the objective list (Griffin, 1986, pp.67-68). Mark Murphy suggests the following basic goods: life, knowledge, aesthetic experience, excellence in play and work, excellence in agency, inner peace, friendship and community, religion and happiness (Murphy, 2001, pp.96-137). Finally, Bruno Santos lists six elements on the basis of 'good-maker properties': characteristics that provide elements with intrinsic value. The elements are autonomy, affective relationships, meaningful achievements, knowledge, pleasure and self-respect (Santos, 2015, pp.459-460).

Despite all theories that claim to have found the ultimate and only exhaustive objective list, there is not one list that is

widely agreed upon. Common critiques to objective lists apply to their inability to explain why lists are exhaustive, why the elements are good for everyone, why lists do not take into consideration the diversity in people and how elements of the lists relate to each other (Brey, 2012, p.5).

### **Well-being in healthcare.**

The previous text has illustrated what well-being is from a philosophical perspective. Appendix 1 illustrates how the fields of psychology and economy define well-being. The following part of this text will cover the relation between well-being and healthcare, as the case study of this thesis concerns technology in healthcare.

In popular literature, well-being is often used to refer solely to health, or in specific, good physical health (Crisp, 2001b). This section on well-being will illustrate that whereas well-being is more than health, health could simultaneously be more than physical health.

In 1946 the World Health Organization proposed a revolutionising definition of health that aimed to go beyond physical health alone: "health is a state of complete physical, mental, and social well-being, and not merely the absence of disease and infirmity" (WHO, 1946)<sup>2</sup>. In this, they place health under the denominator of 'physical, mental, and social well-being', thereby bringing up the question what types of well-being exist in addition and if not, how health still differs from well-being.

One of the first initiatives that aimed to make use of this new definition of well-being was the Health Related Quality of Life (HRQoL). Introduced around the 1980s, HRQoL aims to study the effects of "chronic illness, treatments, and short- and long-term disabilities" (Foundation Health Measure Report, 2010, p.1) on one's quality of life: physical, mental, emotional and social functioning. HRQoL is mostly used as a policy tool for identifying aspects of community life that require improvement, needs for better legislation

2. Although a new definition of health has been proposed, health continued to be commonly used as physical health only. Today the new definition is already obsolete because it declares ill elderly with chronic disease. This is undesired in a society with a growing number of ageing. The focus should shift towards elderly's abilities, which requires again redefining health (Westerhof & Keyes, 2010).

and the effectiveness of community broad interventions. It furthermore facilitates cooperation between different disciplines in the physical, mental, emotional and social domains (Centre for disease control and prevention, 2016). As the concept is used worldwide, several measurements have been developed for assessing a country's HRQoL. The PROMIS, Patient Reported Outcomes Measurement Information System, for example, measures the effect of disease or disorder on people's evaluation of their physical, mental and social lives (Cella et al., 2007). The WHO has developed a more detailed questionnaire applicable all over the world (The WHOQOL Group, 1998), assessing via questionnaires HRQoL related to the domains physical, psychological, independence, relationships, environment and spirituality/religion/personal beliefs (WHO, 2012).

More theories on this broader definition of healthcare have emerged in recent years. Machteld Huber, for example, has proposed the framework of positive health that studies individual's health as the combination of bodily functions, mental functions & perception, spiritual & existential qualities, quality of life, social & societal participation and daily functioning. Bodily functions refers to being in good physical health. Mental functions & perception means to experience pleasure and feelings of control and self-respect. Spiritual & existential includes reaching goals. Quality of life is about feeling happy in long-term. Social & societal participation is to have good social contacts. Finally, daily functioning means to have the capabilities to live daily life (Huber, 2014; Huber et al., 2011). In addition, Compton & Hoffman explain how to improve positive health. They propose to involve in hospital healthcare more social relations and tangible forms of assistance, relaxing sounds, emotional expression and belief in self-control (Compton & Hoffman, 2012b, pp.127-151). Moreover, Seligman has translated his psychological theory on well-being into one on positive health (Seligman, 2008). In that, he sees health as the combination of subjective feelings, biological functioning and the functional ability to deal with life. Of the three areas, the

subjective area covers all personal feelings, including physical well-being, absence of symptoms, feelings of confidence, control, optimism and life satisfaction. Biological functioning is about good physical health. The final area refers to one's ability to deal with life, given his health status and physical environment. Finally, Corey Keyes shows the importance of social relations for positive health (Keyes, 1998) and illustrates that absence of disease does not directly correlate to the presence of mental health (Keyes, 2002; Westerhof & Keyes, 2010).

All proposals on well-being that aim to transcend health as physical quality only comprehend many aspects of well-being. For example, the HRQoL questionnaires study people's subjective short- and long-term well-being in relation to their disease or disability, by developing an objective list that becomes subjectively assessed. Huber's theory does a similar attempt. Fragments of hedonism can be found in her proposed domain mental functions & perception, desire satisfactionism in the domain quality of life and objective list theories in the domain of daily functioning. Seligman's theory on health is very similar to theories on well-being too. His area subjective feelings is inspired by hedonism, whilst the biological and functional area are grounded in the objective list approaches (Seligman & Royzman, 2003). In proposing a HRQoL or a positive health, all authors seem to transcend the concept of health and bring it into well-being.

What is then the difference between theories on healthcare and theories on well-being? The answer lies in their starting points: well-being in relation to healthcare focuses on the limitations of mental or physical disease on daily life. Well-being outside of this domain targets the positive aspects of life itself, whilst "many traditional HRQoL and social indicators fail to capture these types of positive experiences of people's daily lives" (Foundation Health Measure Report, 2010).

As a conclusion, theories on positive health and well-being are very alike, apart from their starting points (respectively the healthy or ill individual). This shows that popular literature, in the end, is not

entirely wrong. Well-being is actually very alike (positive) health. Therefore, instead of translating physical health into positive health and thereby making it like well-being, I propose to keep on to the clear distinction between physical and mental health and well-being. In that, health becomes an element of well-being. Improving health then directly means improving well-being. Simultaneously, well-being would have direct positive effects on health. High levels of eudaimonic well-being are, for example, correlated with lower levels of daily salivary cortisol, pro-inflammatory cytokines and cardiovascular risk and longer duration of REM sleep (Miquelon & Vallerand, 2008; Ryff, Singer, & Dienberg Love, 2004). So instead of adopting a positive health, we should better develop a new standard that the healthcare industry should strive for: well-being.

## ■ 1.2 Well-being in design.

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As the aim of this thesis is to develop a design for well-being methodology, this part of the chapter will translate the philosophical theories of well-being into three pragmatic guidelines that provide heuristics for building up this methodology. It will consequently show why existing design for well-being methodology currently fails to take into account the heuristics.

### **Heuristics on design for well-being.**

In developing heuristics on design for well-being, no claims about the nature of well-being will be made to prevent doing injustice to any of the philosophical theories on well-being. The heuristics will only allow for making the practical connection between well-being and design. Below, I will illustrate each heuristic. The first covers the anticipation on the relation between technology and well-being. Heuristic two concerns the elements constituting well-being. Heuristic three covers well-being as a subjective and objective evaluation.

In relating well-being to technology, it becomes clear that each philosophical theory on well-being grants technology a different role. First, in the hedonic tradition, technology for well-being should maximise users' pleasure and minimise their pain (Kool & Agrawal, 2016). This translates into technologies that provide pleasurable multi-sensory experiences for any type of user, whilst preventing pain in the form of, for example, user exclusion or uncomfortable experiences. Second, technology in desire satisfactionism could improve well-being in three ways (Tupa, 2012). First, technology could satisfy desires. A prosthetic limb, for example, might fulfil the deep desire to practice sports. Second, technology allows for finding the information necessary to understand one's desires. The internet, for example, opens up possibilities to understand better one's own desires. Third, technology can generate desires. Technology, for example, allows for gender selection of offspring. This might generate the desire for either a boy or girl, whereas this desire might not have existed without the technology. Finally, in the objective

list tradition, technology again could fulfil three roles in improving well-being, quite alike its previous roles (Johnstone, 2012). First, technology could directly fulfil one of the elements of an objective list. For example, medical technologies could directly contribute to the element of bodily health. More, technologies could indirectly contribute to the fulfilment of one of the elements. A smartphone, for example, provides the context for building up a friendship. Finally, technology is able to create new elements belonging to the list. A wingsuit, for example, provides the human with the capability to fly. Although this capability is not any objective quality yet, technology could make it one.

In aiming at design for well-being, the first necessary heuristic refers to the need for designers to be aware of the impact of their designs on users' well-being and the ability to anticipate on that. Where technology has the potential to improve users' well-being, it could simultaneously decrease, negatively affect, the ultimate value or even change the content of what constitutes the value (Aydin, 2018, p.6). Designers of technology should ideally be able to anticipate how their technologies will affect the well-being of its users. Only that would allow designers to bring technologies to the market that can fairly claim to improve users' well-being. Therefore, here the first heuristic that a design for well-being methodology should follow: 1. A design for well-being methodology should anticipate on the effect of technology on well-being.

Before a designer is able to anticipate on the effect of technology on users' well-being, he should first understand what the concept entails and how it could be

measured. Let us, therefore, compare the three philosophical theories on well-being to get a grip on their similarities, allowing us to find other pragmatic guidelines on using well-being in design.

At first sight, the theories on well-being seem very different. Hedonism's focus is on pleasures, subjective mental states that cannot be measured easily. Desire satisfactionism aims to fulfil desires, subjective mental states that can be objectively evaluated. Objective lists focus on non-mental states only by fulfilment of objective qualities and thus allow for external evaluation. As the theories seem very different, they do not allow for easily embodying well-being in design without valuing one theory over the others.

Under greater examination, however, the theories have common grounds that provide a start in developing the other two design for well-being heuristics. First, when looking at the similarities between the theories, hedonism and desire satisfactionism seem to have subcategories similar to objective lists. Qualitative hedonism appreciates certain pleasures over others. This requires a categorisation of pleasures. This categorisation shares characteristics with objective lists, as they would both provide a list with qualities contributing to well-being. Following the same type of reasoning, defining which desires lead to well-being in the informed desire variant, requires again developing a list.

As all philosophical theories on well-being seem to share characteristics of an objective list and objective list theories allow best for external evaluation of the level of one's well-being, objective lists have great potential to serve as a tool in a design for well-being methodology. Yet, which elements of well-being should be included on the objective list that designers should follow? Many objective list theories have already been proposed and none of them has been able to explain why its elements are the ultimate and only exhaustive elements contributing to well-being. It seems therefore impossible to compile one ultimate list that would apply always. Moreover, that would do great injustice to

the different circumstances of each unique individual. To solve the problem, I would challenge designers themselves to build up an objective list that constitutes well-being in the context of their design problem every time they start a design project. Having this objective list, would at all times allow designers to assess their ideas on the basis of their defined well-being. Certainly, this requires some guidance, as designers cannot just come up with what well-being entails in their context. A design for well-being methodology should provide designers with these tools. The second heuristic that a design for well-being methodology should follow is then: 2. A design for well-being methodology should enable designers to define an objective list of well-being tailored to the context of the design project.

There is still one challenge ahead relating to the scope of well-being. Where hedonism lays well-being fully in subjective evaluations of individuals, objective list theories see well-being as a set of qualities that require objective assessments because individuals cannot evaluate the qualities themselves. How should design for well-being deal with this? I would propose to preserve a dichotomy between subjective and objective well-being. Let us first consider the subjective well-being: users' appreciation of a design. In his attempt to define happiness, Ruut Veenhoven distinguishes between two components: hedonic affect and contentment. The first covers "the degree to which the various affects a person experiences are pleasant in character" (Veenhoven, 1984, p.26). The second "is the degree to which an individual perceives that his aspirations are being met" (p.27). To improve users' subjective well-being, designers should develop technologies that both improve hedonic affect and contentment. Yet, as subjective well-being then entails both people's current short-term affect and the fulfilment of their (long-term) aspirations how should designers deal with conflicts between them? Reflective desire satisfactionism has answered this question by valuing long-term well-being over the short-term one. Translating this answer into a heuristic for

design for well-being would impose a new challenge on designers. Namely, designers would then be given the responsibility to embody long-term well-being in design, as that is valued over short-term interests, whilst users still desire to be met in their short-term well-being. This situation is undesirable since it could result in users not willing to buy the new technology that only meets contentment and not affect. Consequently, the user will be left with nothing. Therefore, the designer should assure that users will always experience a positive affect whilst using their technologies and simultaneously embody, where possible, users' long-term contentment.

Still, well-being is more than affect and contentment only. It contains elements that cannot solely become subjectively assessed. Users are not the ultimate experts of their own well-being. First, as people are by nature inclined to value short-term rewards over long-term goals (Schüll & Zaloom, 2011, p.515), they cannot make proper decisions over their entire well-being. Second, people could fail in considering certain values of well-being, as they would simply not think of them. Take, for example, the values autonomy and transcendence. Many people might not include those values in what constitutes well-being for them, even though they would agree in hindsight that these values matter. Designers should take care of this objective well-being that users cannot or forget to consider themselves by embodying it in design.

Designers should thus develop technologies that meet users' subjective well-being, both affect and contentment, and that take care of objective elements of well-being users would not consider themselves. That would then result in the final heuristic on design for well-being. 3. A design for well-being methodology should guide designers in developing designs that embody an objective well-being, whilst contributing to users' subjective well-being.

So, in designing for well-being, methodology should take into consideration three heuristics. Those heuristics are the practical translation of the philosophical theories on well-being and aim to do justice to all of them.

### **Existing design for well-being methodologies.**

I am not the only one attempting to involve well-being in design. Several approaches to design for well-being already exist. A detailed description of those approaches and their (dis)advantages can be found in Appendix 2. In what follows, I will describe only shortly the existing theories and relate them consequently to the three defined heuristics. That will demonstrate why existing methodology is currently unable to adequately design for well-being.

An overview of design for well-being methodologies has been given by Philip Brey. He lists the categories of emotional design, capability sensitive design, positive psychology approaches and life-based design (Brey, 2015). To this, I would finally add the methodology positive design.

First, the category of emotional design aims to improve by design hedonic well-being. Jordan's pleasure design and Norman's emotional design, for example, provide guidelines for creating technologies that provide instant pleasurable experiences on respectively a physio-, socio-, psycho- and ideo-level (Green & Jordan, 2003, pp.190-191) or a visceral-, behavioural- and reflective level (Norman, 2005, pp. 63-99). Then, capability sensitive design, as developed by Ilse Oosterlaken (Oosterlaken, 2013) aims to involve the capability approach in design, following the objective list theories. Oosterlaken shows that capability sensitive design would include characteristics of inclusive and participatory design but has not provided any more insights for involving capabilities in design. The category of positive psychology finds its origin in psychology. Only the theory of Ruitenbergh and Desmet provides a detailed framework. It sees well-being as a form of desire satisfactionism, in which the meaningful activities of life equal desires. Technology for well-being should stimulate meaningful activities: activities that enable the development of skills whilst contributing to personal values (Ruitenbergh & Desmet, 2012). The final category, life-based design is an approach developed by Leikas, Saariluoma and Heinilä (Leikas, Saariluoma, Heinilä, & Ylikaupila, 2013;

Saariluoma & Leikas, 2010). The approach wants to go beyond technological usability by studying the needs for using technology in context, for which they introduce four phases: form of life analysis, concept design and design requirements, fit for life design and innovation design. Life-based design is a promising design for well-being methodology grounded in reflective desire satisfactionism. Finally, an upcoming approach in design for well-being is the one developed by Pieter Desmet and Anna Pohlmeier: positive design. The approach brings together design for pleasure, design for personal significance and design for virtue. The first pillar follows the hedonic tradition. The second aims at improving life satisfaction via reflective desire satisfactionism. The final could be seen as an objective list approach in which technology aims to meet virtues of life (Desmet & Pohlmeier, 2013; Pohlmeier, 2012; Pohlmeier, 2013).

Where the appendix describes in more detail each theory and its (dis)advantages, they will here be compared to the three earlier defined design for well-being heuristics.

1. Clearly, each design for well-being theory starts from the assumption that technology could improve the well-being of users. Yet, that makes it even more remarkable that none of the design theories provides a tool for understanding how new technologies will affect well-being. Only life-based design provides a start by studying technology in its wider context of use. Although that will already provide better insight into the effect of technology on well-being, it cannot account yet for a systematic anticipation of the effects of technology on users' well-being. A great opportunity for a design for well-being methodology lies in defining systematic guidelines on involving technology assessments.

2. Design for well-being is a quite preliminary movement in the design industry. Few theories have been developed that often have different flaws and still lack a detailed framework for use. Brey has identified some major problems in design

for well-being theories, of which one is the epistemological problem. It concerns understanding of what well-being is in a particular situation (Brey, 2015). It is exactly this problem that points to heuristic two. All existing theories on well-being start from their own definition of well-being. For example, emotional design sees well-being as hedonism, the positive psychology approach of Ruitenbergh & Desmet as a meaningful life and positive design considers all three philosophical traditions in combination with Martin Seligman's PERMA-elements (Seligman, 2004). So where all theories agree that well-being is a versatile concept, they concurrently stick to their own definition and do not redefine this per context. Since philosophy has not been able to agree upon one definition of well-being, after all those years, design should not stick to one definition either. Instead, it should challenge designers to redefine well-being per context to do justice to the circumstances of the design project.

3. Of all existing design for well-being methodologies, none currently takes into consideration both subjective and objective evaluations and well-being on both short- and long-term notice. Emotional design, for example, is only focused on a short-term subjective conception of life, whilst capability sensitive design and Ruitenbergh & Desmet's theory follow only long-term objective well-being. Life-based design and positive design seem to involve well-being on short- and long-term notice. Yet, both theories measure well-being via users' subjective opinion only. It is remarkable that positive design claims to improve virtues by design, but still lets users evaluate their own well-being. Users will not incorporate the virtuous life in assessing their own well-being, which will result in designers not doing so either. An ideal, currently still missing, design for well-being theory would, as argued, let designers embody an objective well-being in design that users would not consider themselves, whilst meeting users' subjective affect and contentment.

**Conclusion on well-being.**

In this thesis, I aim to develop a design for well-being framework that allows designers to easily embody well-being in design because the current methodologies fail to do so. This framework will follow three heuristics, which were derived on the basis of pragmatic interests, from the philosophical theories on well-being, without thereby doing injustice to those theories. The heuristics are 1. A design for well-being methodology should anticipate on the effect of technology on well-being. 2. A design for well-being methodology should enable designers to define an objective list of well-being tailored to the context of the design project. 3. A design for well-being methodology should guide designers in developing designs that embody an objective well-being, whilst contributing to users' subjective well-being. The following chapter will, by taking into consideration the three heuristics, build up the design for well-being methodology *Values that Matter*.

This methodology will carefully take into consideration the three heuristics defined. It will meet them by incorporating mediation theory in design, finding inspiration in value sensitive design and balancing designers' and users' knowledge. The methodology will be fully structured around the human-technology relations that come about when introducing a newly designed technology in its context. Designers are challenged to anticipate these human-technology relations. They should visualise the effect of their technology on all stakeholders and their relations with themselves, the world and others. This should help to understand what the technology will do with the well-being of these stakeholders involved. That way, designers will be given the tools to create technologies that embody best short- and long-term and objective and subjective well-being.

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**SUMMARY: Design for well-being heuristics.**

In developing a design for well-being methodology, three heuristics should be taken into account:

1. A design for well-being methodology should anticipate on the effect of technology on well-being.
  2. A design for well-being methodology should enable designers to define an objective list of well-being tailored to the context of the design project.
  3. A design for well-being methodology should guide designers in developing designs that embody an objective well-being, whilst contributing to users' subjective well-being.
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Values that Ma



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MATTER**

## ■ 2.1 Sources of inspiration.

The previous analysis of the theories on well-being and the three resulting heuristics is the foundation for the following part of this thesis. In what follows, I will build up a theory on design for well-being. The theory aims to provide a framework to solve 'normal' design problems taking into consideration well-being, based on the three heuristics as afore defined. In creating this design methodology, inspiration will be gained from fields apart from design for well-being, as shown per heuristic below.

1. A design for well-being methodology should anticipate on the effect of technology on well-being.

The mediation theory of Peter-Paul Verbeek could be of great use in understanding what technology does with the well-being of its users. It could help in understanding the human-technology relations and anticipate on the effects of technology on well-being. Mediation theory will here be described in detail, to embed its elements later on in the design methodology that will become developed.

To understand mediation theory, we should first turn to two classical traditions describing the human-technology relation: instrumentalism and technological determinism (Verbeek, 2010, p.11). The instrumentalist view sees technology as a neutral means for human ends. Technological determinism holds technology to be an independent, determining force that greatly influences humans. Nowadays both views have been rejected for a more balanced view that came up by the introduction of phenomenology.

Phenomenology, originated in the 20th century, aims to study the consciousness of human beings from a first person's perspective. Phenomenology's central concept is intentionality, referring to all mental states of individuals that are directed towards something in the world, shaping their actions and perceptions (Smith, 2013). There are two points of critique to phenomenology that have caused the start of postphenomenology. First, phenomenology assumes to be able

to find an objective view of the world, whilst there is 'no view of nowhere'. This means that the human cannot be understood separate from the world in which he lives, neither can the human perceive the world without taking a humanised stance (Langer & Merleau-Ponty, 1989). Second, since the human and the world mutually constitute each other, they should not be seen any longer as two separate entities. To overcome this, Don Ihde has started the movement postphenomenology, which has been worked out in detail by Peter-Paul Verbeek (Verbeek, 2010).

Central in postphenomenology is the relation between technology, world and human beings. The movement is built on the idea that humans shape technologies and simultaneously become shaped by them: mediation. Verbeek explains in his book *"What things do"* that there are two dimensions in mediation: the hermeneutical dimension and the existential dimension (Verbeek, 2010).

### **Hermeneutic dimension of technology**

Hermeneutics is the study of interpretation. A technological hermeneutics studies how human beings perceive and interpret the world via the mediation of technological devices. To understand technological hermeneutics, Don Ihde directs to experience because that is the area in which human and world merge. He distinguishes two dimensions of experience: microperception and macroperception. Microperception covers the sensory experiences of the body; perception. Macroperception concerns the analysis and

making sense of the sensory experiences of the body based on the cultural context of the person; interpretation (Ihde, 1990, p.29). Technology can affect both dimensions of experience. Direct technological mediation is shaping microperception. Indirect technological mediation shapes macroperception. In hermeneutical sense, technology transforms human's perception and interpretation via amplification or reduction of certain elements of the world.

Ihde then introduces four different human-technology relations: relations of mediation encompassing embodiment relations and hermeneutic relations, alterity relations and background relations (Ihde, 1990). Verbeek adds two additional relations. He introduces the composite and the cyborg relation, based on the change of intentionality of humans due to technology. Via the use of technologies, this intentionality could become a mediated, composite or hybrid intentionality. Mediated intentionality means that the human does not directly experience the world, but via the technologies that he is using. This mediated intentionality will be seen in the hermeneutic and background relation of Ihde. Composite intentionality comprehends that human's and technology's intentionality will work together, as will be seen in the composite relation. Finally, hybrid intentionality includes that the human and technology merge into a new entity that has an own new intentionality, which will be seen in the cyborg relation (Verbeek, 2008).

#### *Relation of mediation*

In the relation of mediation, humans perceive their world through technology. In this, technology could render itself invisible or could be clearly present, respectively the embodiment relation and the hermeneutic relation.

#### • *Embodiment relation*

In an embodiment relation, humans perceive the world through a transparent technology. The technology amplifies the original experience but does not change its characteristics. This is called a transformation of low contrast. Glasses,

telescopes or microscopes are exemplifying technologies that allow seeing objects of different sizes in the same understandable proportions.

#### • *Hermeneutic relation*

In the hermeneutic relation, technology is clearly present, rendering visible qualities of the world that would have otherwise remained invisible to the human eye. Technology's representation of the world requires interpretation. This is called a transformation of high contrast. A thermometer is an exemplifying technology that represents temperature.

#### *Alterity relation*

In the alterity relation, technology is not the intermediary between the human and its world, but the human is directly related to the technology itself. The technology here becomes an alter-identity: a 'living', advising, (partly) autonomous and interacting thing. The human being, for example, is in an alterity relation with a vending machine for train tickets. The machine takes money, disposes its tickets and is able to give advice on the right routes (Achterhuis, 2001, p.131).

#### *Background relation*

Technologies that have a background relation to human beings shape their relation to reality in a concealed manner. The technologies shape the world whilst staying unnoticed themselves. The central heating system or refrigerator are typical background technologies that, only when they stop working, become present-at-hand.

#### *Composite relation*

The composite relation is an extreme variant of the hermeneutic relation. Technologies add their own intentionality to the one of humans. For example, radio telescopes are able to visualise the universe by detection of electromagnetic waves that are invisible to the human eye.

#### *Cyborg relation*

The cyborg relation is an extreme variant of the embodiment relation. Technology

becomes part of the body and thereby creates the joint intentionality between human and technology. A pacemaker or a prosthetic limb are examples of technologies that result in cyborg relations.

### **Existential dimension of technology**

The hermeneutic dimension of technology illustrates how the human perceives and interprets his world via technologies. In the existential dimension of technology technologies translate human behaviour and their existence. They invite for or inhibit behaviour. Verbeek illustrates the existential dimension of technology by the ideas of Bruno Latour. Latour states that human, world and technology together form a network in which each element should be treated equally, symmetrical. The elements are actants executing action. When humans interact with the world, technology is the mediator that transforms, translates, distorts and modifies the meaning of the elements they are connecting and thus the action of the human beings (Latour, 2005). Technology does so by means of scripts. The concept of scripts has been introduced by Madeleine Akrich and Bruno Latour (Akrich & Latour, 1992). Scripts are programs of action that are embedded in the design of technologies. They encompass all ideas of a designer on technology's use, user, context, etc. They are read by the user that merges his program of action with technology's: translation. Inscription of a script in a technology takes along 'delegation', holding that certain responsibilities become delegated from user to technology. A speed bump, for example, prescribes drivers to slow down to prevent harming their car. The script, or program of action, of the speed bump joins the program of action of the car drivers, which results in safer traffic situations.

A certain script will not automatically bring about desired behaviour. Ihde illustrates this via the term *multi-stability* (Ihde, 1999). Multi-stability refers to the multiple ways of using technology. For example, a hammer can be used to nail down wood, according to designer's intentions, but the hammer could be used as well as a weapon. There are many examples of technologies that were

designed with certain positive intent, but that turned out to cause different negative results. Edward Tenner wrote an entire book on these unintended consequences of technology (Tenner, 1997). He, for example, mentions the 'safe cigarette', designed to reduce people's intake of nicotine by decreasing the amount of nicotine in the cigarette. Adversely, smokers started to smoke more often and inhaled deeper, which only enlarged their intake of nicotine. This example shows that even though designers could have best intentions, technology could still mediate behaviour in undesired ways. It is up to designers to predict all possible mediations and rule out the undesired ones.

As a conclusion, the intimate relationship between humans and technologies concerns a mutual co-existence and could be described in terms of mediation. The mediation of technology, building on the ideas of Verbeek, Ihde and Latour, provides a great way of thinking that, once merged with design methodology, would help designers to take into account and anticipate on the major effects of their technologies on well-being.

Only few other authors have introduced mediation to design. Swierstra and Waelbers illustrate that it is morally important to consider technology's mediating role when it affects 'the good life'- or well-being (Swierstra & Waelbers, 2012). The authors do not provide insight into how to do so. Verbeek suggests analysing technology's impact via designer's moral imagination (Verbeek, 2006) and proposes to study locus, type and domain of mediation to anticipate, assess and design mediation (Verbeek, 2013). The idea is promising, but it still lacks concrete guidelines that designers could follow to intentionally design technology's mediating role. The design methodology that will later on be developed aims to do so instead, whilst taking into consideration as well the other two heuristics on well-being in design.

2. A design for well-being methodology should enable designers to define an objective list of well-being tailored to the context of the design project.

Design heuristic two, illustrating that designers should be given the tools to define well-being per context, could find inspiration in the value sensitive design approach, proposed by Bataya Friedman and Peter Kahn (Friedman, Kahn, & Borning, 2002). Value sensitive design has been proposed to bring in values in the field of human-computer interaction and has since then spread to any type of technology. The approach consists of three iterative phases: conceptual, empirical and technical. In the conceptual phase, all direct and indirect stakeholders related to the technology become identified, including all values at stake. An analysis is executed on how the technology affects the values at stake and how to deal with conflicting values. The empirical phase consequently turns to the user to gain better understanding of his values and needs. Finally, in the technical phase, the technology to be designed becomes compared to existing related technologies to learn from them.

Value sensitive design sees well-being as one value amongst many others. I would see well-being as the ultimate value encompassing many others, as inspired by the objective list theories. Following this latter line of thinking, the approach could be very insightful in developing a design for well-being approach. It provides guidelines on how to start each design project. Namely, at the start, the designer should define which values, elements of well-being, matter in that particular context. Those values should consequently become related to technology and become positively embodied where possible. Technology could enhance, threaten or transform existing values (Manders-Huits & Zimmer, 2009, p.275).

Vermaas et al. identify a major issue in design for values: the methodological issue (Vermaas, Hekkert, Manders-Huits, & Tromp, 2015, pp.193-194). It questions if designers are actually able to identify values, how design should be translated to

embody values and how to anticipate on unintended consequences of technology on values. The authors only introduce the problem but omit to provide an answer. All three problems cannot be solved with existing design methodology. I will try to tackle them via the design methodology that follows.

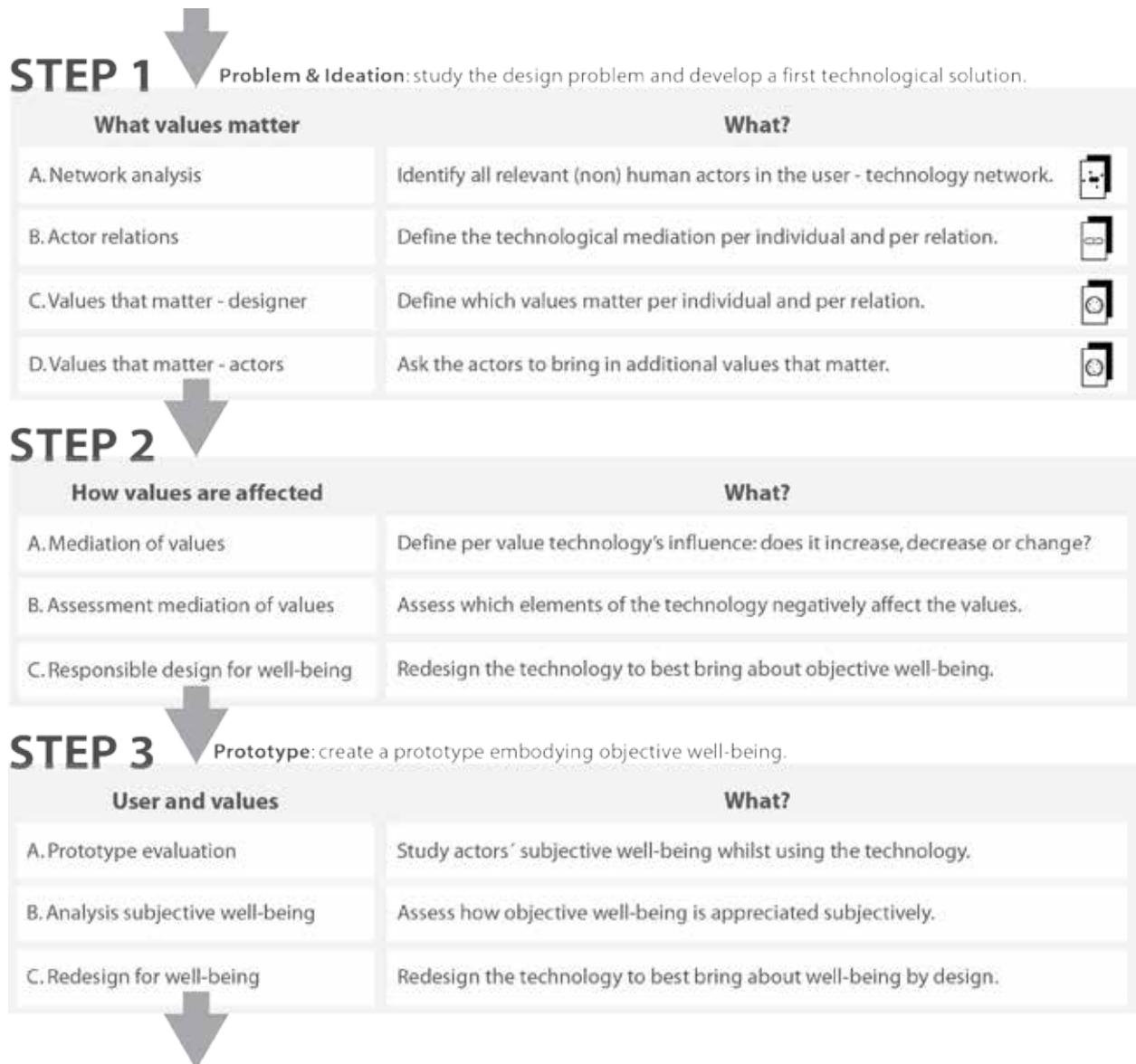
3. A design for well-being methodology should guide designers in developing designs that embody an objective well-being, whilst contributing to users' subjective well-being.

To take into consideration the final heuristic on well-being in design, let us turn to 1950, when industrial design became an expertise. At that time, technology embodied designers' preferences. Designers took themselves as a measure for optimal design and imposed that on the user. Unfortunately, that excluded many types of people from use (Valtonen, 2009). A few decades later, technology became adapted more to users' preferences. Design methodologies as inclusive design and participatory design became popular. Inclusive design takes into account any type of user, including disabled and elderly (Clarkson, Coleman, Keates, & Lebbon, 2013, pp.10-12). Participatory design focuses on inclusion of the user during the design process to better understand his needs and values (Abrás, Maloney-Krichmar, & Preece, 2004). 'The user as expert' became the common ideal in design.

Yet, as we have seen, users are not the ultimate experts of their own well-being. They cannot make the right decisions about their long-term well-being, biased by their short-term one, and might fail to consider all elements of well-being. The design methodology below is different from others in that it aims to reconcile designers' and users' knowledge. I will reintroduce the designer as an expert. Yet, this time, the designer should not follow his subjective preferences but should objectively assess how technology could affect and embody well-being. In combination with user input and evaluation, this should bring about best well-being by technology.

## 2.2 Values that Matter<sup>3,4</sup>

In what follows, the design approach *Values that Matter* will be introduced. This name refers on the one hand to the importance of values, elements of well-being, in life and on the other hand to the context-dependence of values, because not all values matter in each situation. The approach will help to solve normal design problems by technologies that take well into consideration well-being. To make it of practical use, clear guidelines and tangible tools will be developed helping designers to best embody well-being in design.



1. Design methodology *Values that Matter*.

3. *Values that Matter* has been developed iteratively. It has been based on the insights gained from theories on well-being, value sensitive design and mediation theory. Then the theory has been put into practice and improved via insights gained during its use.  
 4. See Appendix 3 and the external methodology kit for the tools of the *Values that Matter* methodology.

## Input 1. Problem & Ideation

Each design project starts with a problem that needs solving. It depends per project to what extent the solution is already developed. Some projects start with a clear technological solution in mind, whilst others begin blank. Before continuing with the first step of this design approach, the designer should acquire knowledge over the design problem and obtain a first idea of a technological solution that might solve it. This input is necessary for the mediation analysis that will follow.

*Values that Matter's* methodology can be used in an iterative way. The designer can restart each step to improve every time better well-being through technology.



## STEP 1

### What values matter

*Aim: map out well-being in the context of the design issue.*

This first step aims to illustrate the context of the design problem and its relation to well-being via the creation of an actor-network. The main actors in the network are the user whose well-being should be improved and the technology that aims to do so. The other actors of the network are all relevant human stakeholders that are directly or indirectly, via other stakeholders, related to the technology. The type of contextual network affects which values matter.

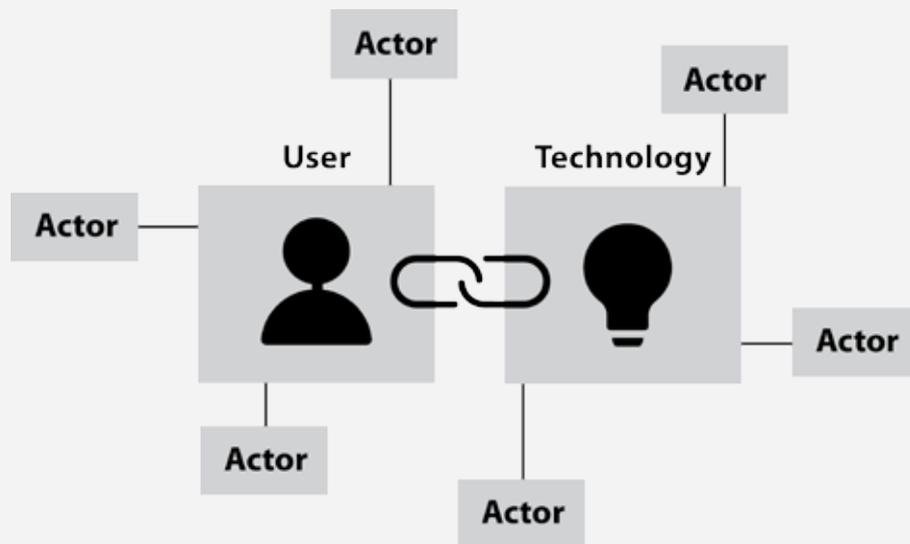
*Why: the content of well-being depends on the context of study.*

Well-being is not one ultimate value. It consists out of many values that together contribute to the concept. The design problem, the relevant actors, the potential technology and the relations between all actors influence which values of well-being become affected. A context analysis helps to identify all values that matter.

*A) Network analysis.*

To start a mediation analysis of technology's effect on well-being, the designer should first identify all relevant actors of the context. There are two main actors: the user of the technology and the technology itself. Technology should aim at improving user's well-being without burdening or simultaneously improving that of other human actors. Therefore, the designer should proceed with identifying all other relevant human actors that are affected by the technology, either directly or indirectly via other actors.

*Tools:* To identify all relevant actors, the designer could start to talk with the main user and other actors already identified. Those will provide insight into additional actors. As well, related technologies could provide insight into potential important actors. The actor cards are a source of inspiration helping to define which actors could be taken into account during the design process.



2. Network analysis: identifying all actors related to the main user- technology symbiosis.

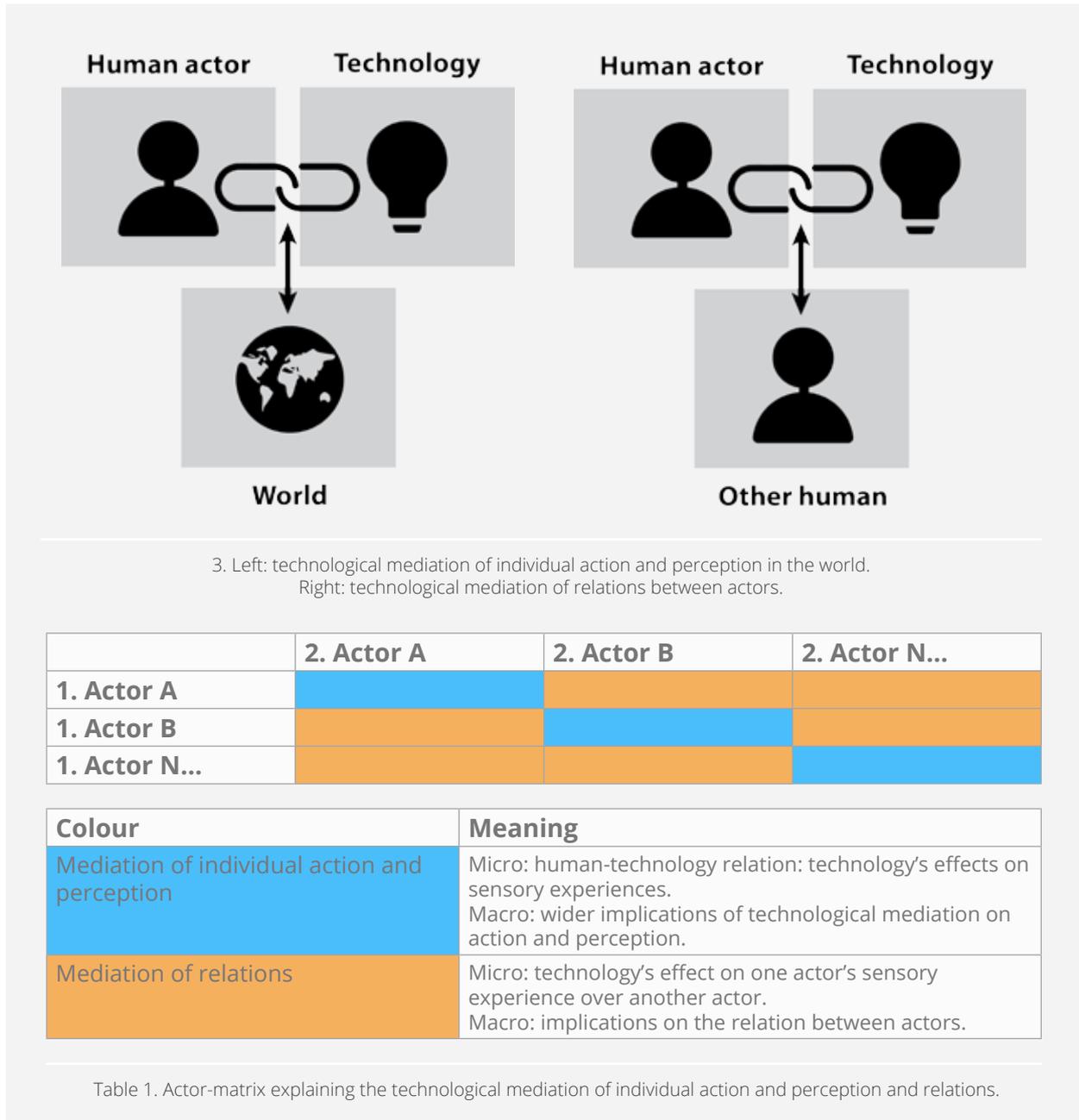
### *B) Actor relations.*

This phase provides the designer with an overview of the relations between the different actors of the network. The phase starts by the creation of an actor-matrix. This matrix should list in column one from top to bottom the main user and then the other actors. This should be repeated in the first row from left to right.

There are now two different types of crossings in the matrix. For each actor- same actor crossover, the designer should define the relation between this actor and the technology: the human-technology relation. There are six potential types of human-technology relations that could come about: embodiment, hermeneutic, alterity, background, composite and cyborg relations. This human-technology relation first affects micro-mediation: technology's direct effects on one's sensory experiences. Then, the human-technology relation has consequences for macro-mediation: technology's effects on one's wider actions and perceptions in the world.

The other type of crossing in the matrix is one between two different actors. The designer should here define how the technology he aims to design affects the relation between these two actors: mediation of relations. The designer should start from the actor in the column and analyse how technology shapes this actor's perception of and relation with the actor in the row. Again, when possible try to differentiate between micro- and macro-mediation. The micro-mediation illustrates how technology renders visible the other actor. This results on a macro-level in a certain type of interaction between the two actors. The result of this phase is a table that maps out in detail how the future technology will mediate all actors involved in the design problem.

*Tools:* It might help to gain insight into the relations between actors to place the actor cards on a table and map out visually the network between main actor, technology and other actors. Try to understand where and how technology exerts its influence. The relation cards could be used to understand the type of human-technology relations.



*C) Values that matter- designer.*

In this phase, the designer should identify all values that matter: the elements of well-being that become affected by the context of the technological mediation. To do so, he could use the value cards<sup>5</sup>. Those cards list a wide variety of values contributing to well-being. The designer should define all values (of the value cards) that become affected by the technology and place them in the actor-matrix. This will result in a list of values that play a role per mediation of individual action and perception and per mediation of relations.

5. More about the value cards can be found in Appendix 3 and the external toolkit. The cards are based on bringing together all values proposed by the reviewed objective list theories on well-being. The appendix includes a table that illustrates how the values were derived and how often each value was mentioned in the theories. It does not necessarily mean that values with high occurrence rate per definition have to apply to every case study.

This phase should initially be executed by the designer alone. The designer is able to assess the actors, technology and values that matter from an external and objective perspective. Thereby, he should prevent bringing in subjective preferences.

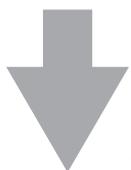
*Tools:* To identify which elements of well-being matter in the context, value cards could be used in combination with designer's intuition and knowledge gained via, amongst others, literature. The cards provide a selection of values that contribute to well-being. The value cards, and any additional identified value, could be placed in the actor-matrix made before to get an understanding of how technology affects the values of each individual actor.

|               | 2. Actor A | 2. Actor B | 2. Actor N... |
|---------------|------------|------------|---------------|
| 1. Actor A    | Values     | Values     | Values        |
| 1. Actor B    | Values     | Values     | Values        |
| 1. Actor N... | Values     | Values     | Values        |

Table 2. Actor-matrix with technological value mediation.

*D) Values that matter- human actors.*

In the previous steps, the designer has identified the actor relations and belonging values that matter from an external and objective perspective. Thereby he has been able to identify aspects of well-being the actors would probably not think of. Nevertheless, the designer might have overseen certain important insights of technological mediation or of values that matter. It is therefore recommended to consult the most relevant human actors and repeat the previous two steps with them. This might provide additional insights in mediation and important values.



## STEP 2

### How values are affected

*Aim: determine how technology affects the values of well-being.*

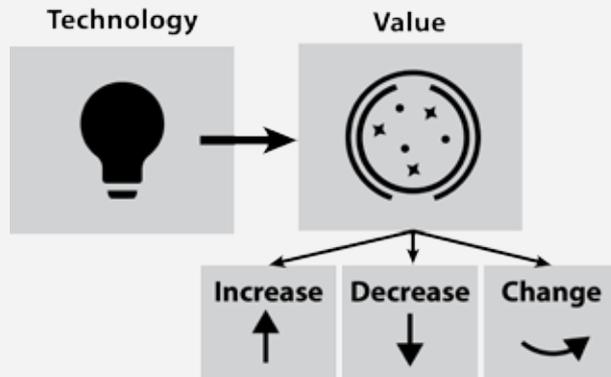
Technology mediates well-being. The use of technology could affect values in three ways. It could improve the value and thereby contribute to well-being, decrease the value and thereby decrease well-being and it could change the content of the value. In that way, technology could reshape the definition we give to a certain value.

*Why: technology affects the values of well-being.*

To improve via technology well-being, the mediating effect of technology should be understood. This step is executed to analyse technology's mediation of well-being and to bridge by design objective and subjective well-being.

*A) Mediation of values.*

Having defined per actor which values matter, the designer should now determine how technology mediates those values. Determine per value technology's effect. Does technology contribute to the value (either direct or indirect), decrease it or change its definition? The designer should use his imagination for visualising how technology affects the values of well-being. He could as well study similar technologies already in use.



4. Value mediation: effect of technology on values.

This phase is executed by designers alone. The designers are able to assess the effect of their technology on values, as they know their technology best.

*B) Assessment mediation of values.*

The previous step provided the designer with insight in technology's effect on each value. Now the designer should study for each value that becomes negatively affected by the technology or that changes content in an undesirable way, which aspect of the technology is causing this effect. The designer should thereby gain insight into how the different aspects of the technology could be changed to bring about a better, positive, value mediation.

*C) Responsible design for well-being.*

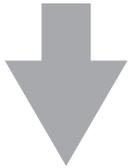
In this phase, the designer should redesign his initial idea so that it brings about best well-being by taking into consideration the knowledge gained in the previous steps. The well-being that the designer embodies in his technology, will be called *objective well-being*. The way the actors experience well-being as a result of that technology, will be called *subjective well-being*. The challenge lies in finding the design configuration that embodies best objective well-being, including aspects of well-being actors would not think of themselves, that becomes experienced as positive subjective well-being.

At first, the designer should try to redesign his initial technology as such that the objective values of well-being, the values that matter, become embodied best. In case of conflicting values of two actors, the designer should value mostly the values of the main actor. How to solve any other conflict in values (for example, two conflicting values of the main user) should be decided on by the designer. He could opt for adopting the value that is most easy to embody or the value that creates most impact.

Concurrently, whilst designing technology with the best objective well-being, the designer should anticipate on user's subjective well-being experiences. The earlier studied micro-mediation could help in gaining insight into actors' subjective well-being. The designer could furthermore make use of design methodologies that focus on short-term well-being: Jordan's pleasure design (Green & Jordan, 2003), or Norman's emotional design (Norman, 2005) (see Appendix 2). When the embodied

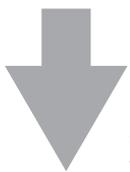
objective well-being conflicts with actors' subjective preferences, the designer should try to find another way of translating objective well-being into a positive subjective one.

This design approach does not bring about an absolute truth on how and on which values to embody in design, nor for what design is optimal. It only provides a way of thinking, an awareness of the values that matter so that they can be taken into consideration better.



## Input 2. Ideation & Prototype

Having defined how design best embodies the values that matter in balancing objective to expected subjective well-being, the designer should develop a first prototype that could be tested by users to understand their actual subjective well-being.



## STEP 3

### User & Values

*Aim: gain understanding in technology's effect on subjective well-being.*

The previous two steps aimed to embody objective well-being in design as such that it would bring about actors' positive subjective well-being. In this step, the actual effect of technology on subjective well-being is measured to make sure that the technology actually brings about subjective well-being and that the embodied objective values become appreciated positively.

*Why: embodied objective well-being becomes evaluated by users subjectively.*

Individuals cannot judge objectively their well-being, because they are biased by their subjective preferences. Therefore, the designer should embed an objective well-being in design and anticipate on users' subjective appreciation. The designer cannot actually know how actors will appreciate subjectively the design. Subjective well-being as a result of technology should therefore be measured via the input of individuals themselves and improved where needed.

*A) Prototype evaluation.*

Start your analysis with your main user. Present the prototype of your technology to the main user for testing. Create a survey that analyses user's subjective well-being on the basis of his *affect* and *contentment*. First, *affect* is the hedonic balance between one's pleasant and unpleasant current emotions. Those result from user's direct appreciation of the technology. Second, *contentment* explains how the user appreciates the technology in relation to his long-term goals. Studying both elements of subjective well-being, will provide the designer with insight into how the embodied objective well-being becomes appreciated subjectively.

To better evaluate subjective well-being, present the user with the survey multiple times. More data gives insight into the fluctuation of short-term hedonic affect and the extent to which the contentment of users varies over time. When necessary, create additional surveys that study the well-being of the other human actors that become affected by the technology.

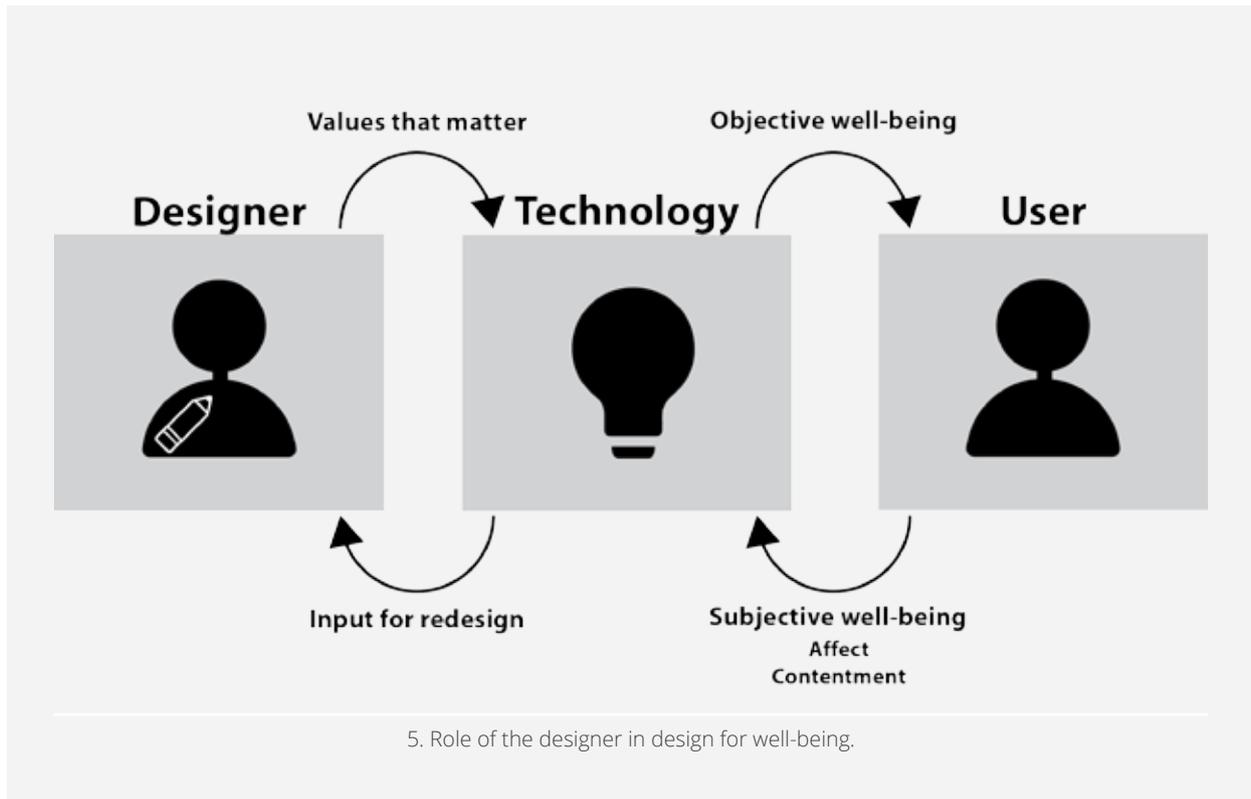
*B) Analysis subjective well-being.*

After the surveys, the designer should analyse the results. The main question thereby is whether the objective embodied well-being becomes actually translated into a subjective one. For that, the designer should first evaluate the short-term hedonic affect of the main actor. How does he rate his hedonic well-being? And does it fluctuate heavily over time? Consequently, the designer should evaluate the main actor's opinion over his contentment as a result of the embodied values. Does the user experience a negative effect of the technology on his long-term well-being? And are there big fluctuations in user's appreciation of his long-term well-being?

Via an in-depth interview with the main actor, the designer should gain understanding in the causes of remarkable results. Why does the user, for example, generally rate badly his hedonic well-being? Why does the user experience negative effect on one of his long-term goals? Or why is there so much fluctuation in user's opinion on one of his long-term goals? Does the technology bring about these ratings? The designer should identify the critical aspects of technology's design that bring about negative effects on actors' subjective well-being. When other human actors were studied, analyse as well their results and conduct interviews when necessary to identify all potential problems in the design.

*C) Redesign for well-being.*

Having identified all critical aspects of technology's design, the designer should redesign his technology. In this, he should again aim to best embody the objective values of well-being in balance with the newly gained knowledge over users' subjective well-being. When the redesign is drastically different than the initial tested design, it is recommended to repeat (some of) the previous steps to make sure the design best affects well-being.



### Conclusion on *Values that Matter*.

The hereby proposed design approach meets the three heuristics defined. First, the approach provides tangible guidelines for anticipating on the relation between technology and well-being via mediation analysis. Thereby it can prevent better undesired and unintended consequences of technology. Second, the approach, inspired by value sensitive design, does justice to the circumstances in which well-being becomes defined. It starts each design problem by defining well-being in context as a set of values. In that, *Values that Matter* tries to tackle the methodological issue, as pointed to before, that design for value approaches up until now could not deal with. This methodological issue concerned identification of values, embodiment of values and anticipation on unintended consequences. First, *Values that Matter* tries to provide tools for identifying the right values in the design context. By involving actors, value cards and mediation analysis, the designer should be able to target the important values. Consequently, by linking values to the causing aspects of technology, the designer gains insight into how to embody values in design. Finally, as shown, the interwoven mediation framework helps in anticipating on technology's effect and concurrently its unintended consequences. Finally, *Values that Matter* meets heuristic three. The approach takes into consideration that well-being cannot solely become defined by users alone, as users are biased by, amongst others, their short-term desires. Therefore, the methodology grants an important role to designers in embodying in design an objective well-being. This objective well-being takes into account the values of well-being users would not consider themselves. The methodology proceeds with understanding users' subjective evaluations of the design as an input for the redesign. This way, the approach tries to bring about best well-being by balancing its objective and subjective components.

In short, the design approach *Values that Matter* allows perfectly for embodying well-being in design, by following the three heuristics<sup>6</sup>.



7. Strengths *Values that Matter*.

6. Appendix 4 describes how the practice of design for well-being in itself might affect the values of trust, responsibility, freedom and autonomy.



3.

A hand wearing a VR controller is positioned in the foreground, pointing towards a computer monitor. The monitor displays a VR application interface with various data points and graphs. The background is a blurred office setting.

# CASE STUDY: VISI MOBILE

## ■ 3.1 The technology ViSi Mobile.

In the previous two chapters the *Values that Matter* design methodology has been developed. This chapter will apply the methodology to the case study of ViSi Mobile, after having explained the technology and its role in bringing about the future of healthcare.

### **Technology and the future of healthcare.**

Gunther Eysenbach, editor of the Journal of Medical Internet Research, coined in 2001 the term *eHealth*. It is defined as a way of thinking to improve healthcare via information and communication technologies. From 2001 on, the term has often been redefined and renamed (i.a. medicine 2.0, web 2.0, health 2.0, mHealth, telecare, telehealth). Although terms and definitions vary, they all share the opportunities of information technologies for improving healthcare (Boogerd, Arts, Engelen, & Van de Belt, 2015).

Innovation expert of REshape Center, Dr Zayna Khayat, believes in eHealth's potential. She illustrates that innovation could bring along changes in the following domains of healthcare: timing, precision, modality, duration and power (Khayat, 2017, 2018). With *timing*, she refers to the change from today's reactive healthcare towards a pro-active, anticipatory healthcare. Data collection of patients and diseases will provide caregivers in the future with better insight into the development of diseases, allowing them to predict patient's health. This database becomes nourished by continuous monitoring devices and quantified self-applications. The application migraine alert, for example, is a pro-active health provider. It is able to predict one's upcoming migraine episodes based on variables as weather, stress, sleep and activity (Muoio, 2017).

The second element, *precision*, includes the change from a general healthcare system towards a personalised system. In this, healthcare becomes better tailored to the needs of individuals. Technologies could facilitate this personalisation. The artificial intelligence chatbot Tess, for example,

will be able to give anywhere, anytime, personalised mental healthcare advice based on machine learning algorithms (X2AI, 2018).

The third aspect, *modality*, targets the place of care. Today's healthcare is centred in institutions. Khayat believes the future of healthcare will be decentralised. Technologies will make it possible to provide healthcare there where needed and desired. Livv Mobile health, for example, produces smartphone powered mini ECG scans that can be made anywhere and send immediately to the hospital for advice (Livv Mobile Health, 2018).

The fourth aspect of healthcare that technologies could affect is *duration*. Current healthcare is episodic, only provided in case of emergencies. Future healthcare will be continuous, integrated in daily life. Fitbit and other smart health trackers are a first step into the continuous integration of healthcare.

Finally, Khayat believes technologies will bring along a shift in *power* of healthcare. Today healthcare is powered by institutions that provide care. Future healthcare will possibly be powered by the individuals in need for care. We can already see a rise in patient-powered initiatives, "patientpreneurs" as they are called (Khayat, 2017, p.22). One remarkable project is the open source, do it yourself project #WeAreNotWaiting (Twitter, 2018). The project has been started by diabetes patients that together try to develop and utilise diverse information technologies to gain insight into and improve their health.

### **ViSi Mobile and the future of healthcare.**

To pursue via innovation the future vision on healthcare, REshape Innovation Center

has been launched by the Radboud University Medical Center. The program aims at reshaping healthcare by bringing together different stakeholders, problems and technological solutions to innovate the hospital.

*"Numbers tell the tale!"* is a project REshape is currently executing. The project has been launched to study the opportunities for healthcare of continuous data collection of hospitalised patients (Radboudumc, 2017). Aim is to improve via data collection the efficiency of hospital's management and the quality of healthcare.

Traditionally, to monitor the health of hospitalised patients, patient's data is collected by nurses. Patients receive visits of nurses three times a day, in regular intervals of eight hours. During those visits nurses collect data to calculate a MEWS: a modified early warning score. The MEWS is a number that summarises the physiological state of a patient to detect early clinical deterioration after surgery and important physiological changes. The MEWS is calculated as a result of systolic blood pressure, heart rate, respiratory rate, body temperature, oxygen saturation, amount of administered oxygen and the AVPU, a score that defines the conscious state of a person. Higher MEWS are related to more intensive care unit admission and increased mortality. It takes approximately six minutes to measure, via several devices, the necessary data of a patient, write it down, calculate the MEWS and later on insert the data in the electronic health record system.

This traditional way of collecting data has some problems. First, the process is time-consuming and leaves the nurse only little room for communication with patients. Furthermore, the MEWS-score is not always reliable. It could lack data nurses were not able to measure, could be subject to inter-observer variability and to errors that come along with manually inserting data. Finally, the large gap of eight hours between two subsequent measurements could result in missing essential data that can have immediate effects on patient's health. The Radboudumc hopes to overcome the problems in the traditional episodic measurements by introduction of

continuous monitoring devices (Weenk et al., 2018).

The Radboudumc started a study on continuous data collection in 2014 with the device *Checkme* of Viatom. It is a small device able to measure cuffless blood pressure, skin temperature, heart rate, oxygen saturation and 1-lead electrocardiogram. Thereby, *Checkme* is able to measure four of the five vital signs. The patient should initiate measurements himself, by appropriately positioning the hand on the device. Data collection is finished now within 25 seconds. Studies on device's



8. Checkme, Healthpatch, ViSi Mobile.

reliability show that its data differed from control data in core temperature. Though, vital signs and MEWS data are similar to control data. This means that the device is reliable and accurate to use (Schoot et al., 2016; Weenk et al., 2018). The technology is not ready yet for broad application though, because some patients cannot measure independently their own personal data. Additionally, the device does not measure yet respiration rate, the fifth vital sign.

The next study on continuous data collection focused on two different technologies: *ViSi Mobile* and *HealthPatch*. The study has been executed between 2014 and 2015. In this, 20 patients from two different wards, internal medicine and surgery, were connected to one of the two wearables. *ViSi Mobile*, developed by Sotera Wireless, consists of a module for the wrist connected via cables to a sensor on the thumb and a sensor and patches on the shoulder and chest. *ViSi Mobile* measures continuously all vital signs: arterial blood pressure, heart and pulse rate, respiration rate, diminished oxygen saturation, 3 to 5 lead electrocardiogram and skin temperature. The measurements are visualised on the wrist module and sent via wifi-signals to an external computer (SoteraWireless, 2018). The *HealthPatch* consists out of an adhesive patch and a sensor that measures single-lead electrocardiogram, heart and pulse rate, heart rate variability, respiration rate, skin temperature, body posture, fall detection and activity. Just as *ViSi Mobile*, *HealthPatch*'s data can be monitored continuously at distance. An algorithm translates consequently the vital signs of either one of the devices into a modified and more accurate MEWS, the VRS: Vital Risk Score. When the VRS outranges its limits, an external alarm goes off that allows nurses to immediately check patient's deterioration and when necessary provide healthcare.

The pilot study on *ViSi Mobile* and *HealthPatch* focused on technological and practical usability. Technological reliability of the devices was measured via comparison of technology's data with the traditional data gained by nurses. Practical usability was measured via semi-structured interviews

with patients, relatives and nurses. The pilot study turned out to be a success. Both *ViSi Mobile* and *HealthPatch* generated reliable data that allowed for early detection of signs of deterioration. Patients furthermore indicated to experience increased feelings of safety. There were, however, some issues that need to be addressed before further implementation of the technologies is appropriate. Technological problems were found in, amongst some minor other problems, dropping out of the wifi-connection, false-positive alarms and losing contact between skin and patches. Patients furthermore indicated that *ViSi*'s wristband was heavy and has many cables. Finally, the batteries of *ViSi Mobile*'s wristband only last for twelve hours and therefore have to be replaced twice a day (Weenk et al., 2017, p.10).

Based on the pilot studies, the Radboudumc has decided to keep on testing continuous data monitoring via *ViSi Mobile*. *ViSi Mobile* has been chosen over *HealthPatch*, because it is able to measure all vital signs, rather than only a few. From May 2018 on the hospital will provide sixty patients over the wards internal medicine and surgery with the wearable *ViSi Mobile*. In early phases of implementation *ViSi*'s measurements will be combined with traditional measurements of nurses. In later stages, the Radboudumc hopes to be able to fully replace episodic nurse measurements by continuous monitoring of *ViSi Mobile*.

Continuous data collection of hospital patients via *ViSi Mobile* could greatly contribute to the future vision of healthcare as presented by Dr. Khayat. First, continuous data collection is able to change timing. A database on patients and diseases could potentially reshape healthcare from reactive to pro-active, particularly since life-threatening events can be predicted already 8 to 24 hours before the event itself (Mapp, Davis, & Krowchuk, 2013, p.300). Then, in precision, a continuous monitoring system allows for better insight into individual data and consequently for tailored healthcare. *ViSi Mobile* does not directly affect modality yet, as it will be deployed in hospitals only. Yet, when it becomes an integral part of

an entire self-monitoring lifestyle, it has potential as well to change healthcare's current modality from hospital to home. Furthermore, as continuous monitoring already says, it is continuous in duration. Thereby, it will reshape healthcare from episodic to continuous. Finally, it has potential to transmit power to the patient. The patient could gain more autonomy by having insight into own health.

Before ViSi Mobile is able to reshape healthcare, the hospital needs to undergo

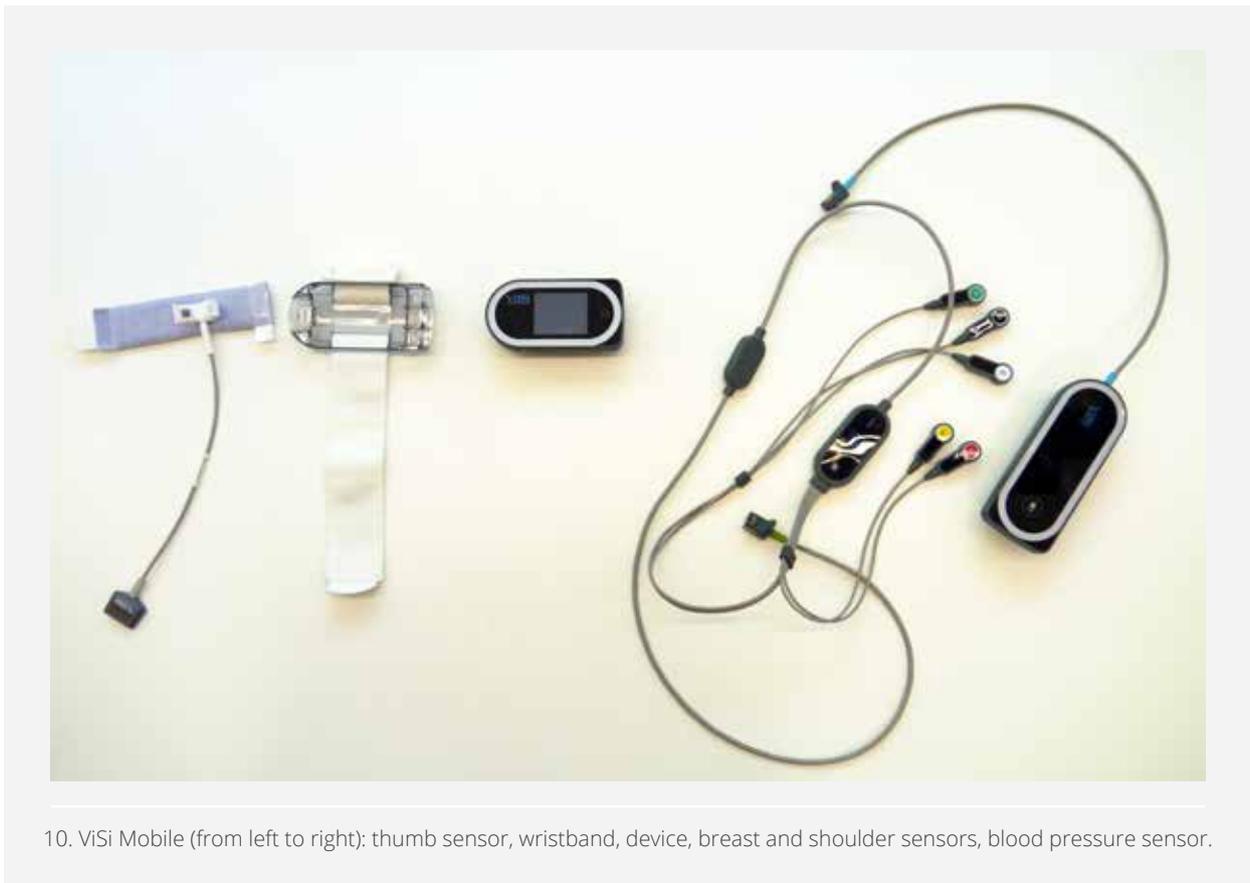
a paradigm shift. An external centre should be established that monitors continuously data of patients and can raise alarm when necessary. More, instead of manual measurements, the nurses should now install and interpret ViSi's data. Doctors finally need to deal with healthcare information they did not have before. Due to this paradigm shift, it becomes highly important to assess the effects of ViSi Mobile and its implementation on the well-being of all actors involved.



9. Cartoon newspaper about traditional monitoring of patients. [translation from left to right: "I don't think there is a shortage of hospital personnel", "Last night I received every hour visits from a doctor, a co-assistant and a nurse", "I could not sleep at all"] (Leisink, 2018)

## 3.2 Values that Matter & ViSi Mobile.

ViSi Mobile could reshape healthcare. The technology is able to solve the problems in traditional vital sign measurements by its technological potential. Apart from its technological and economic feasibility, only few research has been done on ViSi Mobile's effect on well-being. This thesis will apply the newly developed design for well-being methodology to ViSi Mobile<sup>7</sup>. Which values are at stake in ViSi Mobile? Does the technology improve or decrease those values or does it even change the understanding of them? In other words, how does ViSi Mobile mediate well-being? And how could well-being consequently become embodied in its design? Answers to these questions will be provided in the following section. In anticipating on the mediating role of ViSi Mobile, I have studied in detail literature on the technology, talked with the main actors and wore ViSi Mobile myself for three days (see Appendix 5).

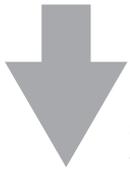


10. ViSi Mobile (from left to right): thumb sensor, wristband, device, breast and shoulder sensors, blood pressure sensor.

7. The scope of this thesis lies in testing and implementing the first two steps of *Values that Matter*. Step 3 will only be shortly touched upon since it is neither possible time-wise nor of relevance for this thesis to redesign the ViSi Mobile and evaluate it with the actors.

## Input 1. Problem & Ideation

This design project starts with a clear problem and an already clear solution. The design problem lies in the traditional way of measuring patients' health. This process is time-consuming, not always reliable and is missing essential data in between the eight-hour intervals. The solution is found in continuous monitoring of patients' vital signs via the wearable ViSi Mobile. ViSi Mobile could accurately deliver constant health-related data. Consequently, doctors will gain better insight into the progression of diseases. This will improve the quality of healthcare.



## STEP 1

### What values matter

#### *A) Network analysis.*

The two main actors at play in this case study are the patient whose health is monitored via ViSi Mobile and the technology ViSi Mobile itself. The technology ViSi Mobile includes the wearable device with patches and sensors attached to patient's body, the algorithm that defines the VRS and the computer interface that allows surveillance staff for monitoring health at distance. As healthcare of the future will become patient-centred, as well technology should be so. Therefore, ViSi Mobile should mostly improve the well-being of the main patient, without burdening well-being of other actors.

Other relevant human actors include the nurses, the doctors and the surveillance staff that from now on will use ViSi Mobile to provide healthcare. The surveillance staff is a group of people that monitors constantly ViSi's data. The role of the surveillance staff could be fulfilled by nurses or doctors themselves, or by an apart designated group of people. Then, family, friends and partner of the patient form an important group of actors: relatives. Furthermore, a group of actors is formed by other patients. Those patients are attached to ViSi Mobile as well and are therefore both related to the main user and the technology. Finally, I consider the group other people as a group of actors. This group is not a well-defined group that has its own interests with ViSi Mobile. Yet, I include the group because it is in indirect relation to the technology by affecting the self-image of the main patient, as will become clear later on.

#### *B) Actor relations.*

In this step, the actual mediation analysis of ViSi Mobile will be executed. The table below summarises the potential technological mediations that will come about via ViSi Mobile. Each actor - same actor crossover covers the human-technology relation resulting in technological mediation of individual action and perception, to which will be turned first. Each crossing point of two different actors illustrates how ViSi Mobile mediates relations: the action and perception of the actor in the column over the actor in the row, turned to secondly. There are direct mediations of relations: when the patient is involved and indirect ones: when the patient is not involved.

|                    | Patient | Nurse  | Doctor | Surveillance staff | Relatives | Other patients | Other people |
|--------------------|---------|--------|--------|--------------------|-----------|----------------|--------------|
| Patient            | Blue    | Orange | Orange | Orange             | Orange    | Orange         | Orange       |
| Nurse              | Orange  | Blue   | Pink   | Pink               | Pink      | Grey           | Grey         |
| Doctor             | Orange  | Pink   | Blue   | Pink               | Pink      | Grey           | Grey         |
| Surveillance staff | Orange  | Pink   | Pink   | Blue               | Pink      | Grey           | Grey         |
| Relatives          | Orange  | Pink   | Pink   | Pink               | Blue      | Grey           | Grey         |
| Other patients     | Orange  | Grey   | Grey   | Grey               | Grey      | Grey           | Grey         |
| Other people       | Orange  | Grey   | Grey   | Grey               | Grey      | Grey           | Grey         |

- Mediation of individual action and perception
- Direct mediation of relations (with patient)
- Indirect mediation of relations (without patient)
- Relations unaffected by technology

Table 3. Technological mediation matrix.

### Mediation of individual action and perception.

#### ■ Patient-ViSi Mobile: composite relation

*Micro-mediation:* The patient-ViSi Mobile relation is characterised by the composite relation that combines two types of intentionality: first ViSi’s intentionality and consequently that of the patient looking at the technology. For patients, health is something intangible; invisible for the human eye, including mostly subjective feelings over one’s own body. Patients are unable to grasp their own health and unaware of what exactly constitutes the concept. ViSi Mobile renders visible health. It is a material translation of reality. ViSi quantifies health into a set of always the same objective qualities such as blood pressure, respiration rate and heart rate. Thereby, the technology actually goes beyond representation of reality only. It constructs reality by constituting health. The use of ViSi Mobile will direct patients to ViSi’s intentionality. Thereby, it changes patients’ intentionality into the combination of original subjective feelings over own body with quantifiable data perceived on ViSi’s screen.

*Macro-mediation:* ViSi’s mediation of health could have implications on a macro level for the self-perception of patients. First, patients’ image of own health could change because ViSi renders health into numbers visualised on a screen. When patients experience a balance between their original subjective feelings and the new objective data, the data could become a source of control, a way of verifying and confirming feelings. Yet, when data and feelings do not match, which is when one feels bad or good and the data tells otherwise, patients could start to either lose trust in the data or in own bodily feelings, which would negatively affect self-consciousness and self-confidence. The mismatch between feelings and data could even reintroduce Descartes’ notorious mind-body dualism in which feelings are mind and ViSi’s data body. Patients could suffer from feelings of alienation from their own body when the data does not make sense to them. Moreover, dependence on data could create anxiety when fluctuations in the data are detected and patients are not fully informed on how to interpret those.

Then, the presence of continuous data furthermore allows patients to objectify themselves, to make a study object of their own body. The constant objectification of own body could make patients feel exposed. Patients are unable to hide and cannot simply opt-out of the system once started. They could experience their body as not solely their property anymore.

ViSi certainly affects patients in a positive way as well, which can be derived from the reasons people have for using self-tracking devices at home: self-entertainment: the enjoyment of own data collection, self-association: trying to understand the self in relation to others, self-design: trying to optimise the self, self-discipline: having a sense of purpose and motivation and finally self-healing: being independent from healthcare (Gimpel & Nißen, 2013). ViSi could as well provide enjoyment in use. Furthermore, it could improve self-understanding, provide the tools for self-optimisation, provide a tangible purpose and provide patients with autonomy by making them responsible for own health. Moreover, the tool could improve feelings of safety by the thought of being monitored. Finally, ViSi Mobile makes it possible to leave bed and walk around, making patients feel strong and autonomous.

#### ■ Nurse-ViSi Mobile: embodiment relation

*Micro-mediation:* The aim of the nurse is to gain insight into the health of patients to provide care. Given this aim, there are two types of human-technology relations that could be identified between the nurse and ViSi Mobile. It depends on the studied scope which relation it is. Let us first study the broad scope. This scope starts from zero: healthcare without technology. The introduction of ViSi Mobile would now be ground-breaking. The nurse would be in a hermeneutic relation with ViSi Mobile: it would render visible health, whereas before health was only the intangible opinion of patients.

In taking the smaller scope, a scope that starts from the traditional manual three daily measurements of patients' health via the technological devices already in use, the new human-technology relation that comes about by the implementation of ViSi Mobile is an embodied one. In the embodiment relation, technology amplifies what the human already could perceive. Since the nurse was already, via technology, able to see health as data, the introduction of ViSi Mobile only amplifies this data. It amplifies episodic health into continuous health.

*Macro-mediation:* The amplification of health data by ViSi Mobile will change nurses' job. Nurses should first from now on install and deal with ViSi Mobile. That will grant them with spare time for not having to measure three daily patients' data, which was a time-consuming process. Some nurses are thereby afraid of becoming replaced by the device. The spare time could be spent on personal contact with patients or, as patients are monitored anyways, other tasks. This latter situation would generate a decrease in nurse-patient contact.

Moreover, nurses' ideas of health change due to ViSi Mobile. ViSi renders visible health in a different way than their traditional devices did. The nurses should from now on make decisions on the basis of ViSi Mobile, taking into account the circumstances of the patient. For example, when the patient says he feels perfect, but ViSi tells otherwise, the nurses find themselves in a difficult position. They have to balance their knowledge, patient's feelings and ViSi's data in making decisions for

providing the best care. For example, ViSi could suddenly show that a patient suffers from apnoeas at night. This data was not visible before and could scare off nurses, whilst the apnoeas are harmless and the patient has had them every night for a long time already. Nurses should find a way of dealing with all the information that ViSi Mobile generates. When ViSi finally allows nurses to improve giving care, nurses could experience more job satisfaction.

#### ■ **Doctor-ViSi Mobile: hermeneutic relation**

*Micro-mediation:* Doctors are in a hermeneutic relation with ViSi Mobile. For them, ViSi Mobile opens up an entire world of pro-active healthcare. By expressing health as continuous objective data of many patients at once, doctors obtain essential information they could not perceive before. ViSi Mobile thereby allows doctors to gain detailed insight into patient's past, current and future health and in the development of diseases.

*Macro-mediation:* ViSi Mobile is a source of data from which information about patient's health and the progression of diseases could be gained. Instead of curing disease, doctors' job slightly shifts towards preventing disease. That raises difficult questions and great responsibilities. For example, suppose that a doctor is able to predict that a patient will get a heart attack within a day. The doctor wants to give preventive medicines to the patient, but the patient refuses to take them because he does not feel sick. What should the doctor do? Furthermore, what should the doctor do when he cannot do anything in preventing the heart attack? Should the patient be informed about this potential life threat? And what about uncertain data that provides a chance of ten percent that a heart attack might occur. Is the doctor going to inform the patient and his family then or does that only create unnecessary anxiety? The situation might even be more difficult when the patient is not at the hospital but at home. Will the doctor then send a rescue team to the patient, whilst the patient feels perfect? And what happens when a doctor has been monitoring a patient that becomes ill anyways? Was the doctor able to foresee this? And is he therefore now responsible for patient's illness?

Although these questions might only make sense in a far future, the introduction of ViSi Mobile could be the starting point of this far future and could, therefore, bring along great changes in the job and responsibility of doctors.

#### ■ **Surveillance staff-ViSi Mobile: background relation**

*Micro-mediation:* ViSi Mobile brings into existence this entity of actors. Surveillance staff's task is to react to incoming alarms by sending a nurse to the patient. They are not directly in contact with patients and could be unaware of how ViSi Mobile works. They are therefore in a background relation with the technology. This surveillance role could be fulfilled by a designated group or by nurses. In that case, the nurse is involved in different types of human-technology relations at once.

*Macro-mediation:* The surveillance staff is solely in contact with computers and alarms, not with patients. The distance created by the technology between surveillance staff and patients could result in surveillance staff's loss of engagement in providing healthcare which could consequently result in low job satisfaction, boredom, only little attention to the task and therefore in missing essential life-threatening alarms.

### ■ Relatives-ViSi Mobile: embodiment relation

*Micro-mediation:* One could suggest the hermeneutic relation as the appropriate human-technology relationship here. After all, relatives are able to see via ViSi Mobile in the hospital the health of the patient, which was not visible before. Yet, suppose now that relatives can consult the information of ViSi Mobile as well from home. Then ViSi Mobile would not only render visible health of the patient. It would as well amplify the presence of the patient for relatives; an embodiment relation. It is potentially the combination of these two relationships that relatives would desire: to experience more often patient's presence and to be assured that it goes well.

*Macro-mediation:* For now, relatives are only indirectly related to ViSi Mobile, via the patient. Yet, they could obtain a direct relation to the technology when the technology allows them to monitor patient's data from home. This would give the relatives a sense of control over the patient and a sense of presence of the patient. It might make them as well anxious for monitoring data they do not understand.

### ■ Other patients-ViSi Mobile: alterity relation

*Micro-mediation:* Other patients in the hospital, as well attached to ViSi Mobile, will see the main patient and ViSi Mobile as one coherent whole. Those patients are not related to either the patient or the technology but to the cyborg patient-ViSi Mobile. Thereby, the cyborg is an alternative identity and establishes an alterity relation.

*Macro-mediation:* As other patients find themselves in the same situation as the main patient, they could become curious about the data of this patient. ViSi Mobile could become a conversation starter and a tool for inter-patient comparison.

### ■ Other people-ViSi Mobile: alterity relation

*Micro-mediation:* The same alterity relation as in other patients can be found here. The difference is that other people do not understand what ViSi Mobile is and do not wear the device themselves. Therefore, they only perceive the alternative identity, but cannot relate to it. Apart from a short sensory experience, ViSi Mobile does not directly mediate this group. Yet, this group is important since ViSi Mobile mediates the way how patients perceive themselves through the eyes of these 'other people'.

|                           | Human-technology relation | Mediation of individual action and perception   |
|---------------------------|---------------------------|---|
| <b>Patient</b>            | Composite                 | The patient is directed at ViSi Mobile's intentionality: displaying health as a constant set of quantifiable factors. |
| <b>Nurse</b>              | Embodiment                | ViSi Mobile amplifies episodic health data into continuous health data.   |
| <b>Doctor</b>             | Hermeneutic               | ViSi Mobile renders visible pro-active healthcare.  |
| <b>Surveillance staff</b> | Background                | Unaware of the infrastructure of the system, these people only react when an alarm goes off.                          |
| <b>Relatives</b>          | Embodiment                | ViSi Mobile could amplify the existence of a patient.   |
| <b>Other patients</b>     | Alterity                  | Patient and ViSi Mobile are seen as a coherent system that can be compared with one's own system.                     |
| <b>Other people</b>       | Alterity                  | Patient and ViSi Mobile are seen as a coherent but unknown whole.   |

Table 4. Mediation of individual action and perception of ViSi Mobile.

## Direct mediation of relations (with the patient).

### ■ Patient-Nurse

*Micro-mediation:* Still unclear, ViSi Mobile might make patients see nurses more often, as nurses gain spare time for personal contact. On the other hand, patients might see nurses less often, when nurses delegate their tasks to ViSi Mobile.

*Macro-mediation:* The type of patient-nurse relation relies on the exact future role of nurses. When nurses gain, by the introduction of ViSi Mobile, time to more often meet with patients, their social relationship will improve. Yet, when due to high workload and delegation of responsibility towards ViSi Mobile nurses come by less often, not only the social contacts of patients will decrease but they might as well start suffering from feelings of anxiety and loneliness, because whom is giving care to them? Finally, the patient-nurse relation could become influenced by the potential constant insight into patients' data. For example, nurses can detect when patients are nervous in their presence, which might make patients feel uncomfortable and ashamed.

### ■ Patient-Doctor

*Micro-mediation:* It will probably not directly change how often patients will see a doctor. Patients will only gain the idea of the doctor being monitoring them.

*Macro-mediation:* Patients might feel trust and safety in relation to a doctor. Namely, ViSi allows for sending continuous data to the doctor that consequently can better predict and anticipate on patients' health. Yet, when the doctor does not often visit patients, they could experience as well feelings of shame and anxiety towards the doctor. Because who is this unknown doctor that is able to monitor them?

### ■ Patient-Surveillance staff

*Micro-mediation:* Patients will from now on know that they are monitored constantly by a team reviewing their health, but they might not know who this team is.

*Macro-mediation:* Towards the surveillance staff, patients could either feel safe or unsafe. Some might feel safe for having someone constantly monitoring their health. Others might feel unsafe for not knowing whether their health is actually monitored, which could take along anxiety, stress and suspicion towards the hospital.

### ■ Patient- Relatives

*Micro-mediation:* The freedom of movement that ViSi Mobile provides, allows patients to go out of bed more and to be better in touch with relatives. ViSi Mobile will furthermore not directly change how often patients will see their relatives.

*Macro-mediation:* Patients might obtain a better relation with relatives when ViSi allows for monitoring them from home. Then, patients know that not only they and the hospital are responsible for their health, but that relatives are looking after them as well. The relation might improve as well via better freedom of movement.

### ■ Patient-Other patients

*Micro-mediation:* Patients will see from now on other patients that are as well attached to ViSi Mobile.

*Macro-mediation:* Seeing other patients with a ViSi Mobile, might create feelings of community and engagement, being not alone. The device might become fraternising and could be a conversation starter. It as well could generate the tendency for comparison. How does other patients' data look in comparison with own data? This could simultaneously make patients feel uncomfortable, ashamed and exposed.

#### ■ Patient-Other people

*Micro-mediation:* Patients could experience others looking at them more than before.

*Macro-mediation:* ViSi Mobile is a quite heavy and remarkable device. Especially during introduction phases, most people will not know what it is and could stare at the patient wearing the device. Thereby ViSi Mobile could become a stigmatising apparatus. Patients wearing it could be immediately detected as patients. The stigmatising effect of ViSi might make patients feel uncomfortable and could make patients feel sick by just wearing it. The stigmatising aspect might even decrease patients' willingness to go out of bed, when they do not want to be seen by others with the device.

#### ■ Nurse-Patient

*Micro-mediation:* Nurses would potentially see patients more often when they gain spare time via ViSi. Yet, at the same time, there could be less contact when responsibility becomes transferred to ViSi, rendering visible patients as only data.

*Macro-mediation:* By introduction of ViSi Mobile, nurses will establish two types of relations with patients. On the one hand, patients become reduced to a set of data, objects of study. On the other hand, having more freedom for personal communication with patients, nurses could establish better relations with patients. They could gain more understanding in patients' feelings. Nurses will face the challenge of bringing together patients with the set of objective data to make optimal healthcare decisions.

#### ■ Doctor-Patient

*Micro-mediation:* Doctors will see from now on patients mostly as short- and long-term patterns of data, objects of study that need perfection.

*Macro-mediation:* ViSi Mobile allows doctors to provide patients with better healthcare by generating deeper understanding in their health than before. A patient will only be one source of data, amongst many others, that could contribute to the database of diseases. This might imply a shift from mostly personal contact between doctor and patients towards fewer personal contact and more data analysis.

#### ■ Surveillance staff-Patient

*Micro-mediation:* Surveillance staff will mostly only become aware of patients when alarms ring.

*Macro-mediation:* The ones monitoring all data and alarms of patients will be distanced from the patients as persons. They only see data and detect alarms that are not directly linked to a person, only to a bed. That might decrease their job satisfaction.

#### ■ Relatives-Patient

*Micro-mediation:* When patients' data can be watched from home, relatives will become more aware of patients' presence and health.

*Macro-mediation:* For relatives, the thought of their loved one attached to ViSi Mobile, is comforting. It could feel safe and reassuring that their loved one is monitored continuously, although that requires trust in the hospital. These feelings increase when relatives are able to monitor at home the data of the patient. Relatives might then feel more connected to the patient. Simultaneously, being able to monitor the health of a patient from home could make the relatives anxious and obsessed by the data they do not understand well.

■ **Other patients-Patient**

*Micro-mediation:* Other patients will experience the cyborg patient-ViSi Mobile.

*Macro-mediation:* The relation between other patients and the main patient would be the same as the relation the other way around (patient-other patients). Namely, ViSi could establish a feeling of unity, being attached to the same device. Simultaneously, it makes curious for comparison and could make people feel watched, uncomfortable.

■ **Other people-Patient**

*Micro-mediation:* 'Other people', being all people unaware of what ViSi Mobile is, see the patient wearing ViSi as a kind of cyborg; an entity that is hospitalised, attached to a strange medical device.

*Macro-mediation:* The stigmatising effect of ViSi Mobile makes people think patients wearing ViSi Mobile are sick. They might be afraid for patients and for asking them about ViSi Mobile.

|                                    | <b>Direct mediation of relations (with the patient)</b>               |
|------------------------------------|---|
| <b>Patient-nurse</b>               | Relation might improve when more contact between patients-nurses.     |
| <b>Patient-doctor</b>              | When doctor is known, patients might feel safe and trust healthcare.  |
| <b>Patient- surveillance staff</b> | When surveillance team is known, patients might feel safe.            |
| <b>Patient-relatives</b>           | Monitoring patient's data from home might improve this relationship.  |
| <b>Patients-other patients</b>     | ViSi could be engaging and a conversation starter.                    |
| <b>Patients-other people</b>       | ViSi is stigmatising and could make patients feel sick.               |
| <b>Nurse-patient</b>               | Nurses have to make sense of patients as persons and as sets of data. |
| <b>Doctor-patient</b>              | Patients become objects of study, sets of data that need perfection.  |
| <b>Surveillance staff-patient</b>  | Surveillance staff can lose engagement for not knowing patients.      |
| <b>Relatives-patient</b>           | Monitoring patient's data from home might improve this relationship.  |
| <b>Other patients-patient</b>      | ViSi could be engaging and a conversation starter.                    |
| <b>Other people-patient</b>        | The patient - ViSi Mobile cyborg might be seen as a scary entity.     |

Table 5. Direct mediation of relations of ViSi Mobile.

### Indirect mediation of relations (without the patient).

The indirect relations are all relations between the actors apart from the main patient. The implications of ViSi Mobile on these relations will be shown here, to assess potential negative consequences on other actors' well-being.

#### ■ Nurse, Doctor

ViSi Mobile does not greatly affect the relations between doctors and nurses, apart from changing the content of their jobs. Nurses should provide doctors with information about the intangible, subjective, health of patients, to keep doctors connected to the living, feeling bodies of patients.

#### ■ Surveillance staff, Nurse, Doctor

ViSi Mobile brings into existence the surveillance staff. The surveillance staff, either nurses or a separate team, should warn the nurses or doctors when an alarm comes in. ViSi Mobile does not directly affect these relations in a moral sense.

#### ■ Relatives, Nurse, Doctor, Surveillance staff

The relation between relatives and hospital staff is mostly a matter of trust and depends on the way how ViSi Mobile will be used. Relatives could gain a better relation with the hospital staff when they know the patient is looked after for well. When relatives can look after patient's health from home, they could alarm the hospital staff when necessary. This would greatly comfort relatives but could be very burdensome for the hospital staff that now has to deal with not only the patient but as well with worried relatives. When the patient could wear ViSi Mobile at home, the role of relatives becomes even more important. In that case, relatives could take over some responsibility from the hospital staff to look after the patient at home.

#### ■ Other patients, Other people

The actors other patients and other people solely exist in relation to the main patient. They are not related via ViSi Mobile to the other actors.

|  | Indirect mediation of relations (without the patient)   |
|--|---|
| <b>Nurse-doctor</b>                              | Nurses should provide doctors with information about the feelings of patients.  |
| <b>Surveillance staff-nurse-doctor</b>           | ViSi brings into existence the surveillance staff. Nurses and doctors should, from now on, work together with this new team.  |
| <b>Relatives-nurse-doctor-surveillance staff</b> | Relatives should trust hospital staff. When they can look after patients from home, whilst patients are in the hospital, hospital staff might have a higher workload. This workload might decrease when patients can receive care and use ViSi Mobile at their own homes. |

Table 6. Indirect mediation of relations of ViSi Mobile.

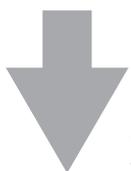
*C) Values that matter- designer.*

Based on the previous mediation analysis and with help of the value cards (see Appendix 3), I have derived which values of well-being matter per actor and per relationship, which is shown in the table below and discussed consequently.

|                       | Values   |
|-----------------------|--|
| <b>Patient</b>        | Autonomy (1), Bodily integrity (2), Bodily health (3), Identity (4), Purpose (5), Privacy (6), Relations (7), Safety (8) |
| <b>Hospital staff</b> | Control (9), Purpose (5), Relations (7), Transcendence (10)  |
| <b>Relatives</b>      | Autonomy (1), Relations (7), Transcendence (10)  |

|                | Patient             | Nurse         | Doctor        | Surveillance  | Relatives | Other patients | Other people |
|----------------|---------------------|---------------|---------------|---------------|-----------|----------------|--------------|
| Patient        | 1, 2, 3, 4, 5, 6, 8 | 1, 2, 6, 7, 8 | 1, 2, 6, 7, 8 | 1, 2, 6, 7, 8 | 7         | 2, 4, 7        | 2, 4, 7      |
| Nurse          | 7, 10               | 5, 9          |               |               |           |                |              |
| Doctor         | 7, 10               |               | 5, 9          |               |           |                |              |
| Surveillance   | 10                  |               |               | 5, 9          |           |                |              |
| Relatives      | 7, 10               |               |               |               | 1         |                |              |
| Other patients |                     |               |               |               |           |                |              |
| Other people   |                     |               |               |               |           |                |              |

Table 7. Values affected by ViSi Mobile per actor / relation.



## STEP 2

### How values are affected

*A) Mediation of values.*

*B) Assessment mediation of values.*

In what follows, I will describe for the patients, hospital staff (including doctors, nurses and surveillance staff) and relatives how ViSi Mobile mediates their most important values of well-being. I have left out the actor groups other patients and other people, as those are not directly mediated by ViSi Mobile. Consequently, I will turn to the ideal design of ViSi Mobile that best affect actors' values.

#### Mediation of patients' values

*Autonomy:* The vital signs that ViSi Mobile displays, give patients the autonomy to look after their own health and call for help when necessary, independent from the monitoring hospital staff. Patients might gain a practical wisdom to make well considered decisions about their healthcare themselves, provided that they can actually make sense of the data ViSi Mobile displays, which is often today not the case. Yet, where patients gain autonomy over their own body in relation to the hospital staff, they lose autonomy with regards to ViSi Mobile itself. Namely, in the past patients defined their health solely based on feelings. Now ViSi Mobile is 'interfering' in defining own health by expressing it in numbers. This becomes problematic when patients' feelings do not correspond to the data displayed by ViSi Mobile. Patients could accordingly start to distrust either the data or their own body. In the first scenario, patients retain autonomy but ViSi Mobile becomes useless to them. In the

second scenario, patients fully delegate autonomy to the device and could thereafter experience alienation from their own body. Ideally, ViSi Mobile's design allows patients for understanding their health and making well-considered decisions and balancing their feelings with ViSi's data to best improve autonomy.

*Bodily integrity:* Bodily integrity, the inviolability of the body, becomes first improved by ViSi Mobile because the device allows patients to freely move around, secured by constant monitoring. Yet, as the device is constantly monitoring patients it could decrease bodily integrity simultaneously. A mismatch between feelings and ViSi's data could make patients anxious and alienated from their own body. The negative feelings increase when patients' bodies become objects of study. ViSi Mobile should ideally try to prevent the undesired mechanisation and medicalisation of the body.

*Bodily health:* The initial purpose of ViSi Mobile is to improve bodily health via data generation for pro-active healthcare. It allows furthermore to freely move around and to get good night rests, which both as well improve health. Yet, by improving health, the device directly changes the content of the concept as well. Ciano Aydin illustrates this: "These technologies are not neutral tools that merely measure 'health' but 'health' is also co-determined by what they measure (and what is not disclosed and left out). They provide norms for what is considered as 'healthy' and influence whether people consider themselves healthy" (Aydin, 2018,p.6). ViSi Mobile renders health for patients into objective, measurable momentary data as heart rate, blood pressure and respiration rate. Yet, health is more than that. It includes feelings and long-term data patterns. Since patients only see their current variables, they get a wrong image of what health is and might wrongly believe they are sick when the variables change. ViSi Mobile should ideally render health into inclusion of feelings and long-term data patterns too, to prevent miscommunication and anxiety. Apart from direct health improvement and change of the concept of health, bodily health could slightly decrease through ViSi Mobile since it could be heavy, stigmatising and obstructing to sleep on the shoulder, which should ideally be changed in a redesign.

*Identity:* Insight into own data could provide patients with a sense of self-understanding and identity and maybe even an acceptance of their own disease. This positive effect only comes about when patients' feelings are balanced with ViSi Mobile's data.

*Purpose:* ViSi Mobile could potentially provide hospitalised patients with a purpose. Namely, the insight into their own health could motivate patients to strive for improvement, for better health. Yet, ViSi Mobile currently only shows the vital signs of patients that they have to make sense of themselves and translate into actions for health improvement. Since patients cannot easily do that themselves, a future ViSi Mobile should ideally provide patients with healthcare advice and goals for health improvement. That would enable patients to experience better purpose and eventually achievement.

*Privacy:* ViSi Mobile decreases the ability of patients to determine what information about themselves is shown to others; their privacy. Namely, the hospital staff is directly able to see their data via the computer and other people can see personal data on the display on patients' wrist. In relation to the first concern, patients should ideally be well informed on who is able to access their data and what is done with it. Concerning the information shown via the wrist device, patients should be able to shield their data from sight of random other people.

*Relations:* ViSi Mobile affects relations between patients and others. First, the patient-nurse relation could be improved via ViSi Mobile, provided that ViSi Mobile allows nurses to spend more time on personal conversations with patients. Second, the relation with relatives could improve when those would be able to monitor the data of the patient from home, which is currently not the case. It would probably comfort patients when they know they are being looked after for by their loved ones. Third, patients could experience relations towards other patients wearing ViSi Mobile. Patients could form a patient community in which experiences about ViSi Mobile can be shared and data compared. Showing private information might at the same time feel uncomfortable for some. Fourth, ViSi Mobile could decrease the relation between patients and other people unaware of what ViSi Mobile is, when the patients experience the device as stigmatising. Finally, the relation with hospital staff that is monitoring patients' data can only be established when the monitoring staff is directly in contact with patients. When patients do not know by whom they are being monitored, they could feel suspicion and distrust.

*Safety:* It depends per patient how ViSi Mobile affects feelings of safety. Some patients might feel safe by the thought of being constantly monitored by others that can intervene in their health when necessary. Yet, others might feel unsafe for being unaware and unsure of actually being monitored. Moreover, when patients return home and have to hand in ViSi Mobile, they might start to feel unsafe as well for losing the reassuring monitoring device. Ideally, patients should be aware of being monitored well and should gain monitoring guidance when leaving the hospital.

#### **Mediation of hospital staff's values**

*Control:* ViSi Mobile allows the hospital staff to be better in control over patients and healthcare. Future questions as of how to deal with anticipatory healthcare and delegation of responsibility should be targeted, to stay within control.

*Purpose:* ViSi Mobile could provide hospital staff with the purpose of striving for best pro-active healthcare. Provided that the hospital staff understands how to use the device, they might, for example, be able to prevent IC-admissions and decrease the mortality rate in the hospital. That might create feelings of achievement for the hospital staff.

*Relations:* ViSi Mobile allows the hospital staff to deliver better, personalised healthcare that could improve the general relation between the hospital and patients and relatives and the personal relation between the nurses and patients. The hospital should prevent that the technology will replace personal contact.

*Transcendence:* Being able to deliver tailored healthcare, could create feelings of transcendence for nurses and doctors. ViSi Mobile allows them to be there in a better way for the patients, to commit themselves better to the higher good of providing healthcare to people.

#### **Mediation of relatives' values**

*Autonomy:* Relatives might today feel powerless for being unable to help patients in improving their health. ViSi Mobile does currently not change those feelings. Yet, when the device provides relatives with insight into the health of the patient from home, they gain autonomy and control over the health of their loved one.

*Relations:* The same ability to monitor patients from home might make relatives feel more related to the patient. Yet, when that entails fewer visits to the hospital, the relations between patients and relatives could decrease.

*Transcendence:* When relatives can monitor the health of a patient from home, they might believe they contribute to a higher good; being there for the patient.

### C) Responsible design for well-being.

The previous two steps showed how ViSi Mobile currently affects the values of well-being and already gave understanding in how the design could be changed to affect well-being better. This step will propose a detailed redesign of ViSi Mobile. The redesign recommendations do neither consider technical nor economic feasibility. Instead, the redesign aims at improving objective well-being of the actors involved. The table below illustrates which objective values of well-being become improved by the different aspects of the redesign.

| Redesign ViSi Mobile   | Values improved  |
|--|--|
| ViSi Mobile provides patients with healthcare advice.                          | <i>Patients:</i> autonomy, purpose   |
| Patients can register their feelings on ViSi Mobile.                           | <i>Patients:</i> autonomy, bodily health, bodily integrity, identity               |
| ViSi Mobile provides patients with insight into their long-term data patterns. | <i>Patients:</i> autonomy, bodily health, bodily integrity, identity               |
| ViSi Mobile can be personalised.   | <i>Patients:</i> bodily integrity, identity  |
| Patients can use ViSi Mobile at home and gain access to its data.              | <i>Patients:</i> autonomy, safety  |
| ViSi Mobile has an alarm button.   | <i>Patients:</i> autonomy, safety  |
| Patients give informed consent.  | <i>Patients:</i> privacy   |
| ViSi Mobile is small.  | <i>Patients:</i> bodily health, relations, privacy                                 |
| ViSi Mobile safeguards personal relations between hospital staff and patients. | <i>Patients:</i> relations<br><i>Hospital staff:</i> relations, transcendence      |
| Relatives can monitor patients' health from home.                              | <i>Patients:</i> relations<br><i>Relatives:</i> autonomy, relations, transcendence |

Table 8. Redesign of ViSi Mobile so that it brings about best the values of objective well-being.

### ViSi Mobile provides patients with healthcare advice

To give patients a purpose, improve their autonomy and allow them to grasp ViSi Mobile's data, the device should provide goals. It could challenge patients to leave bed and walk around via a pop-up note that gives advice on the basis of healthcare data and activity tracking. Patients should become triggered to improve their own health based on the received advices. To enjoy achievements, patients should be rewarded, as well via a pop-up note, and be able to see the progress they are making.

### Patients can register their feelings on ViSi Mobile

ViSi Mobile should provide patients with the opportunity to report subjective well-being. A pop-up could, for example, emerge once in a while on the display that informs on patients' feelings. Patients could then, via the touch screen give an answer. Reporting on subjective well-being might help patients in balancing ViSi's objective data to own

feelings. Patients will get to know better the relation between their feelings and the device's data. Doing so, ViSi will not render health as only objective quantifiable data but will include feelings. It could then prevent the feeling of being alienated from own body as a consequence of the experienced mind-body dualism. It might even slightly decrease the feeling of the body becoming objectified, mechanised. Apart from that, the subjective well-being measures will be beneficial for the hospital itself to gain more insight into the health of patients.

### **ViSi Mobile provides patients with insight into their long-term data patterns**

Patients should gain access to their long-term data patterns and understand how their health has changed over the long-term since health is much more than only current vital signs. Providing patients with insight into their long-term health will help them to understand their current disease and health better. This way, ViSi Mobile will not render health as a set of momentary vital signs only but will do justice to the complexity of the concept.

### **ViSi Mobile can be personalised**

Since each patient is very different, ViSi Mobile should be personalisable. Each patient has different interests, feelings and desires that together crystallise into different preferences on ViSi Mobile. When patients start wearing the device, nurses should ask them for their preferences. Would they want to see their data constantly to improve and monitor health, only a few times a day to prevent unwanted medicalisation, or not at all to prevent anxiety? Nurses should be able to change the preferences throughout the hospitalised period. Patients should concurrently be informed on the meaning and right way of interpretation of all own health-related data that they can see. This should prevent them from worrying when small changes occur in their vital signs or when own data seems 'worse' than the data of other patients. It would improve the patient's self-understanding, identity and their bodily integrity. Research is necessary on the optimal visualisation of data for patients.



11. Redesign ViSi Mobile providing healthcare advice.

### **Patients can use ViSi Mobile at home and gain access to its data**

When patients return home, continuous monitoring normally stops. The shift from constant to zero monitoring could make patients feel unsafe. To prevent this, patients should, before leaving the hospital, become well-informed about their health and the right healthy behaviour. The hospital could, in particular cases, decide to continue continuous monitoring whilst patients are at home. As well, patients could be informed on using smartwatches for monitoring their health. The hospital should provide help in integrating ViSi Mobile's data with the smartwatches.

### **ViSi Mobile has an alarm button**

ViSi Mobile should include an alarm button that the patients and the relatives could use in case of emergency. Since patients wear ViSi Mobile on their arm, they will have access to the alarm button everywhere. This will provide them with the safety and autonomy to walk around more and to look after themselves.

### **Patients give informed consent**

Patients should be fully informed about ViSi Mobile and hospital's surrounding infrastructure and should give informed consent on being monitored this way. Informed consent allows patients to preserve their freedom of choice. They should have the possibility to know exactly which data the hospital gathers, who is constantly monitoring their data and who is able to access their data. This transparency creates trust between patients, relatives and hospital and values patients' privacy. Data must never leak. Moreover, it reassures patients in being looked after for well at all times.

### **ViSi Mobile is small**

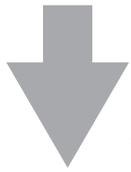
ViSi Mobile's appearance should become inspired by smartwatches. It should become a small and comfortable device to wear that is discrete enough to prevent stigmatisation. Even better, it would be great when instead of stigmatisation, ViSi Mobile could create feelings of proud. This is possible when the device becomes a new technological feature that looks appealing and provides patients with interesting capabilities they did not have before and would greatly like to show to their relatives. Ideally, ViSi Mobile becomes a device that patients should be eager to wear. Then, since healthcare should become patient-centered, it is remarkable that ViSi Mobile's logo and display are now by default directed to the nurse and not to patients. In a redesign, the logo and the data on the screen should be patient-centred.

### **ViSi Mobile safeguards personal relations between hospital staff and patients**

Nurses should gain and actually take time for personal conversations with the patients. This time should be spent on getting to know the feelings of patients in relation to their health and to using ViSi Mobile. It would first improve nurses' job satisfaction. As well, it would improve the relationship between nurses and patients and it would improve the balance between patients' feelings and the objective data on ViSi Mobile's screen. Patients should furthermore become introduced to the surveillance staff, to assure them of being in good hands.

### **Relatives can monitor patients' health from home**

To improve the well-being of the relatives, relatives should have the ability via an application to gain insight from home into the current health data of the patient. This will provide them with a purpose during the hospitalised period of the patient; namely, they can look after the patient. It will grant them confirmation of patient's health and give them the feeling that they can contribute to patient's well-being.



## STEP 3

### User & Values

Being out of scope, step 3 will not be executed as described in the design methodology. Instead, I will present here the opinion of the different actors over the redesign to gain a first understanding in how the embodied objective well-being becomes appreciated subjectively. The textual redesign was discussed during three interviews with three patients (men aged 50-75) and in a focus group with 3 doctors and 5 nurses (4 men, 4 women aged 28-60). Below, I will discuss first the features of the redesign positively appreciated. Those indeed balance well objective well-being with actors' subjective one. Consequently, I will turn to the aspects of the redesign appreciated negatively and assess why actors' subjective well-being does not match the objective embodied one. Appendix 6 provides a detailed description of the interviews and focus group.

### Features appreciated positively

The hospital staff and the patients very much appreciated the redesign features of providing patients with healthcare advice, providing insight into long-term data patterns, personalisation, using ViSi Mobile at home, including an alarm button, smaller design and safeguarding personal relations. In all these features, there is a balance between the objective embodied values of well-being and users' subjective well-being.

First, both hospital staff and patients would want ViSi Mobile to provide health-related advice. The nurses spontaneously started to bring in suggestions: *"Patients should gain a notification when they are walking to the entrance of the hospital: DO NOT SMOKE!"* Two of the patients furthermore indicated they would follow the advice. It is therefore certainly recommended to include advice in a redesign of ViSi Mobile to improve patients' autonomy and provide them with a purpose to strive for.

Then, one of the three patients had already asked the hospital to gain access to his long-term data patterns. He, as well as all other participants, believed that providing patients with access in their long-term data patterns would inform and empower them. Although not all patients are equally interested in the data, those that prefer to have insight should gain so. Healthcare data should be democratised. Moreover, the hospital staff pointed out that not only patients but as well other institutions as home caregivers should be given access to the data to provide better healthcare.



Home care institutions should gain access to ViSi's data.  
- nurse 1.



I would like to connect this device with my smartphone health apps.  
- patient 1.



All participants agreed on making ViSi Mobile personalised, because of the diversity in patients. Whilst some patients only get anxious from seeing ViSi Mobile's data, others find it reassuring and comforting, which justifies the need for personalisation.

In anticipating the future, all employees of the hospital agreed upon using ViSi Mobile at home. This would decrease the workload of hospitals. Hospitals would then monitor patients' data and send a family doctor in case of emergencies. Patients as well saw the benefits of being monitored at home. One would be relieved, being afraid for doctors. Another would find it reassuring to have continuous monitoring of his blood pressure and gain better information about it for anticipation. It would in long-term improve patients' feelings of autonomy and safety.

Everyone furthermore immediately agreed that including an alarm button would certainly benefit the device. It would be easy and provide patients with autonomy, especially when they are not in their beds.

Further, certainly, all of the patients and hospital employees agreed on changing ViSi Mobile's appearance. ViSi Mobile should be smaller, less intrusive, better attached to the skin and not illuminating accidentally at night, as one of the patients agitatedly pointed out.

Finally, the participants supported the need for safeguarding personal contact between hospital staff and patients. The hospital staff illustrated that some of the nurses already tended to visit patients less often by having delegated their tasks to the device and argued to prevent this by all means.

### **Features appreciated negatively**

The following redesign features were not solely positively appreciated: registering feelings, informed consent and granting access to relatives. This resulted from conflicting values between the different actors or from conflicts between objective well-being and subjective users' appreciations.

The hospital staff and the patients disagreed on their appreciation of registering feelings via ViSi Mobile. Whilst the hospital staff disliked the feature, patients tended to like it. First, the nurses argued that the strength of their job lies in understanding feelings via personal contact. They did not want to delegate this to a device, afraid of losing their added-value. It could potentially decrease nurses' long-term well-being on the values of relations and autonomy. Of the patients, the first indicated that it would not provide the hospital of useful information to include this feature but would use it anyways, the other feared patients cannot bear the responsibility of reporting feelings and the final one would actually like the feature.

The feature of registering subjective feelings would in long-term allow patients to understand the relationship between their bodily feelings and the objective data of ViSi Mobile. Whereas the current design renders health into objective data only, this redesign feature would add subjective feelings to what health is and thereby prevent patient's confusion and alienation from own body. When only nurses would ask feelings, ViSi Mobile would still render health as objective data only. There is here first a conflict between the well-being of nurses and that of patients, because nurses fear to become replaced by ViSi Mobile whilst patients would benefit from the feature. Secondly, there is a conflict between patients' subjective and their objective

well-being. Whereas not all patients immediately understood the use of the feature on short-term notice, it would benefit them in long-term.

I would therefore recommend letting ViSi Mobile ask about patients' feelings to create a balance between objective data and feelings. This should certainly not replace nurses' role. The nurses should still come by for understanding patients' feelings. In using ViSi Mobile at home, where there are no nurses around, the device should ask more often for subjective feelings, thereby indeed filling in nurses' role.

Second, the hospital wants all patients to be connected to ViSi Mobile. Patients then should not be given the choice for opting in or out, which was the feature of informed consent. Yet, to preserve patients' privacy, they should give consent. The solution to this conflict in values between actors might be simple. The nurses indicated that patients would normally simply follow up their expert advice and wear ViSi Mobile when asked to. So instead of asking each patient on informed consent for wearing the device, ViSi Mobile just becomes embedded in the regular healthcare system and is consequently given consent when patients agree on hospitalisation.

Finally, the hospital staff all agreed that granting access to relatives to access patients' current health would only increase the burden of their work. Namely, relatives would get anxious about seeing the data and consult the hospital too often. This subjective dissatisfaction of nurses might result in a decrease of their long-term daily functioning and control. They could suffer from a lack of time to execute their job due to the calls of relatives. In a similar sense, one of the patients indicated that since his relatives would not be able to interpret his data, it would only generate anxiety. Another patient indicated that his wife would certainly want to check his data, but feared as well it would only cause worries. So, although some relatives might want access and thereby gain autonomy, ViSi Mobile should not grant it to preserve nurses' short- and long-term well-being and protect relatives from anxiety.

“ My wife would certainly check my health from home. She will not understand it though. It will make her anxious- *patient 2*. ”



12. The opinion of different actors over the redesign of ViSi Mobile.

**Conclusion on ViSi Mobile & well-being.**

In this final chapter of the thesis, *Values that Matter* has been applied to the case study of ViSi Mobile. The focus was mostly on step 1 and 2. In step 1, all relevant actors were identified and the potential influence of ViSi Mobile on the actors and their relations was visualised. In step 2 the technological mediation was related to the most important affected values of well-being. That allowed for embodying well-being better in the proposed redesign. Step 3 was not entirely executed like the methodology prescribed. Only the textual redesign was presented to nurses, doctors and patients. They showed how they appreciated subjectively the embodied objective well-being. That led to final recommendations on improving ViSi Mobile for best well-being.

First, a future ViSi Mobile that would best bring about well-being provides patients with healthcare advice to improve their autonomy and provide them with a purpose to strive for. Then, to render health beyond objective momentary data only and prevent a mismatch between bodily feelings and the device's data, patients should be able to have access to their long-term data patterns and be asked once a day about their feelings, certainly not replacing the nurses as the ones gaining information about subjective feelings. Actually, the hospital should at all times safeguard the preservation of personal contact between the patients and the hospital staff. Furthermore, ViSi Mobile would in the future optimally be used as well at home and multiple healthcare institutions should be able to access its data. This would decrease the burden on hospitals, allow them to provide better healthcare in association with other healthcare institutions and provide patients with autonomy and feelings of safety. For improving the same values, ViSi Mobile should be provided with an alarm button. Then, obviously, the ViSi Mobile of the future will be a small, comfortable and non-stigmatising device. Finally, since not one patient is the same and each one would appreciate differently the afore features, ViSi Mobile should be provided with personalisation options that match to patients' preferences.

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- 3/5 lead ECG
- heart & pulse rate
- blood oxygen saturation
- RR (respiratory Rate)
- Skin temp.
- BP (blood pressure)

# DISCUSSION & CONCLUSION



## ■ Discussion.

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*Values that Matter* allowed for understanding and redesigning ViSi Mobile in relation to well-being. Yet, as the methodology is still a prototype in itself, it has its strengths and weaknesses and requires follow-up research.

In this thesis, I have tried to break out of philosophers' paradigm by translating philosophical principles into tangible, understandable guidelines that each layman would be able to use. The design methodology *Values that Matter* makes accessible philosophy to the world of design. It brings into practice theory that remained so far mostly invisible and incomprehensible for non-philosophers. From now on designers will have the valuable means to develop and understand technologies for well-being.

### **Practical usability**

In translating philosophy into pragmatic guidelines, some of the philosophical content might have gone lost. For example, *Values that Matter* brings together hedonism and objective list theories. Proponents of either one of the theories would probably highly contradict the ability to bring together the areas. Yet, since I have not aimed at defining well-being as a philosopher but tried to bring philosophy into practice, the reader should take for granted that some of the philosophical content might have gotten lost.

Another aspect of discussion of *Values that Matter* is that it has been based on three heuristics about well-being that were extracted from the philosophical theories on the concept. Those statements might have biased the way I developed *Values that Matter*. Thus, as each theory might have its (biased) foundation, future research that challenges it is required.

Moreover, *Values that Matter* has been put into practice via the case study of ViSi Mobile whilst it became improved by that same case study simultaneously. It is therefore obvious that the theory has brought about good results for this case

study. Follow-up research should show whether *Values that Matter* is applicable to other technologies as well. Moreover, since I developed the theory and put it into practice, future research should as well show whether *Values that Matter* is actually understandable by any other designer without knowledge of philosophy. Would every designer be able to use the methodology? And would the methodology bring about reliable and desirable results whomever its designer? As the methodology asks designers several times to make use of their intuition and practical reasoning, it should not bring about different results per designer. To test the methodology on its practical use, different designers should bring it into practice.

For now, *Values that Matter* brings about an enormous amount of insights. Whereas the theory perfectly allows designers to diverge and generate information in especially phase one, it currently slightly fails to converge, to reduce the insights into understandable bits of data that could be easily translated in phase two into a redesign. Future improvements of the methodology should target this.

### **Well-being**

*Values that Matter* focuses on well-being as an ultimate value that needs to be embodied by design. In that, it does neither directly consider economic nor technical feasibility. One could then question the usability of the approach. Yet, the aim of the approach is not to provide the ultimate and only way of designing certain technologies. Rather, it aims to make designers aware of technology being more than economic and technical feasibility by showing its great effects on well-being. Designers should use this information together with traditional

economic and technical information to bring about the best-balanced design. *Values that Matter* highlights an, up until now, underexposed phenomenon that should be given equal, if not more, importance as economic and technical requirements in normal design problems. There are opportunities in studying the optimal balance between well-being, economic and technical feasibility, if there is one.

### Values

Let us then continue with the values of well-being. The values, as listed on the value cards, were simply based on comparing all proposed objective list elements illustrated in part one, without questioning those values. Future research should first study what qualifies as a value of well-being. Furthermore, are all values of equal importance or is it possible to rank values? And is a universal hierarchy possible, or should this be done per context? Are there furthermore values that matter in each situation compared to values that only matter in particular situations? Finally, how to deal with values that are interlinked or overlap in content, such as *purpose* and *achievement*? It may have become clear that future research on design for well-being should study in detail the values of well-being itself.

### Actors

In the case study, I focused on the patient as the main user whose well-being should become improved, without burdening that of other actors. I did so because healthcare of the future should become patient-centered, as well should healthcare technologies. It might be difficult in other design problems to focus on only one main user. Actually, it might even be unethical. The problem of balancing the well-being of different actors remains challenging and needs further research. Moreover, design for well-being methodologies need to consider in detail what the range of actors to involve is. For now, I only included the direct and indirect actors that are related to the *working* technology. But why not to include the actors involved in the production and recycling process? Furthermore, here I

started with the patient as an autonomous and well-thinking being that of all actors knows best his own subjective well-being. Thereby I slightly underestimated the great role of nurses. Namely, patients often bluntly follow nurses' professional opinion in providing them with healthcare. Maybe I should have targeted better the nurses to gain information about both patients' subjective and objective well-being.

### Mediation analysis

Since I have been using mediation analysis in the design for well-being methodology, this requires some thought as well. Namely, the type of technological mediation that comes about depends on different factors that need to be clarified beforehand. First, it depends on technology's phase of implementation. Just after the introduction of a technology to the market, technology's mediation might differ from late adoption phases. In my analysis, I wrote down both. Each designer should do what is most appropriate for his case.

Besides, technological mediation depends on the point of departure: a non-technological world or the current world in which the new technology is not yet implemented. In designing for well-being the current, technological world is best taken as the point of departure to understand how the new technology will change the current situation. Finally, in executing a mediation analysis, designers could try to involve non-human actors since there are probably technologies that mediate the relations between humans and a diversity of non-human elements. A new design methodology should then be developed because the actor-matrix made here would not be sufficient anymore.

*Values that Matter* so far is just a prototype in itself. It can become improved every time when applying the theory to a different case study, to not only improve better technology for well-being but as well the methodology for well-being.

## ■ Conclusion.

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Very recently, Takao Someya's research group at the University of Tokyo presented their ultrathin flexible sensors and displays (Someya, 2018). The bionic skin electronics can measure and display vital signs wirelessly. Although the research is very preliminary, it provides many opportunities for continuous monitoring of vital signs of hospitalised patients. It would at first already take away ViSi Mobile's disadvantages of being heavy and stigmatising. Yet, that does not mean the technology thereby directly improves patient's well-being in comparison with ViSi Mobile. Bionic skin sensors would engage in an entirely different human-technology relation than what ViSi Mobile does. It allows for such greater embodiment that the technology almost merges with the body.

Ideally, each technological development, as an answer to a contextual problem, should be analysed and designed, apart from technological and economic feasibility, in terms of well-being. The remarkable mediating effects of technology should never be overlooked because doing so could potentially result in undesired and unintended consequences.

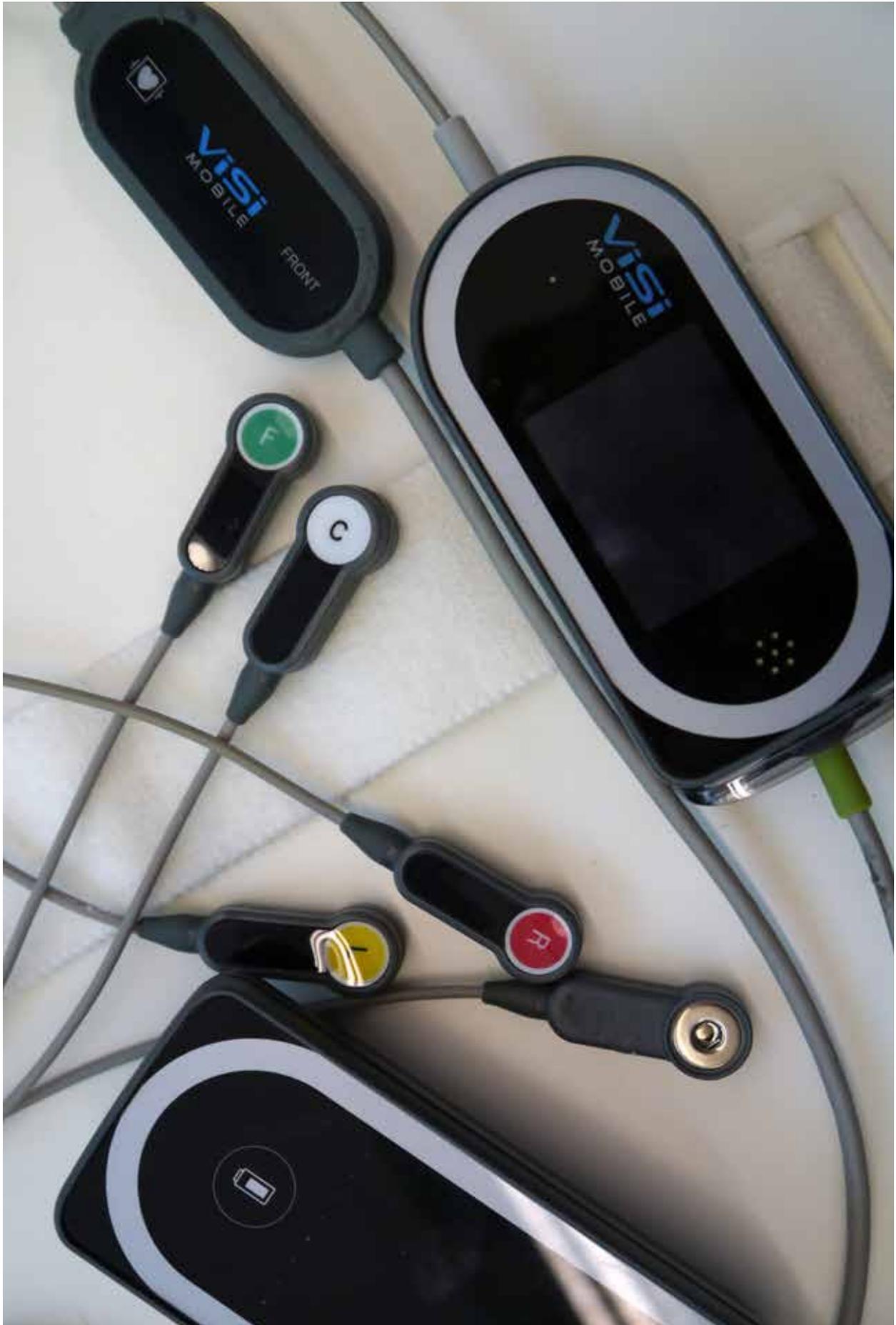
This thesis has provided a design methodology, based on literature research on well-being, that enables designers to consider and make use of the technological mediation of well-being. The design methodology, *Values that Matter*, is unique compared with other design methodologies for well-being on several grounds. First, by involving a step-by-step mediation analysis of technologies, the design methodology is able to foresee potential undesired and unintended consequences of technology on well-being. Second, *Values that Matter* acknowledges the versatility and the context-relatedness of the concept of well-being. Finally, it replaces the user as the only expert of one's own well-being through a better-balanced interplay between the objective designer that needs to embody

objective well-being in design whilst meeting the subjective preferences of the different actors involved.

To verify and improve *Values that Matter*, it has been put into practice via the case study of ViSi Mobile, the device that the Radboudumc has started to use for the continuous monitoring of the vital signs of hospitalised patients. The first two major steps of the design methodology were applied to ViSi Mobile. This allowed identifying redesign potential, such as for including healthcare advice, providing access in long-term data patterns and involving subjective well-being measures, so that ViSi Mobile would better bring about the well-being of patients, nurses, doctors and relatives. A textual version of this redesign, that embodied objective well-being, was presented to diverse actors involved with ViSi Mobile. Actors' subjective well-being evaluations of the redesign of ViSi Mobile provided new insights into again improving ViSi Mobile's design to ensure better well-being.

*Values that Matter* is a prototype in itself. It requires future research on how designers will put it into practice, how well-being relates to technological and economic constraints, what constitutes a value, which scope of actors should become involved and how mediation analysis could contribute even better.

So rather than bluntly developing and adopting the very promising bionic skin electronics for continuous monitoring, I would suggest to first analyse the values that matter.



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# List of figures, tables & appendices.

## Figures

|  |     |
|--|-----|
| 1. Design methodology <i>Values that Matter</i> .        | 30. |
| 2. Network analysis.                                     | 32. |
| 3. Technological mediation.                              | 33. |
| 4. Value mediation.                                      | 35. |
| 5. Role of the designer in design for well-being.        | 38. |
| 6. Design methodology kit <i>Values that Matter</i> .    | 38. |
| 7. Strengths <i>Values that Matter</i> .                 | 39. |
| 8. Checkme, Healthpatch, ViSi Mobile.                    | 43. |
| 9. Cartoon newspaper traditional monitoring of patients. | 45. |
| 10. ViSi Mobile.   | 46. |
| 11. Redesign ViSi Mobile.                                | 60. |
| 12. Actors' opinion on ViSi Mobile.                      | 64. |

## Tables

|  |     |
|--|-----|
| 1. Actor-matrix technological mediation.                       | 33. |
| 2. Actor-matrix value mediation.                               | 34. |
| 3. ViSi Mobile- actor-matrix technological mediation.          | 48. |
| 4. ViSi Mobile- mediation of individual action and perception. | 51. |
| 5. ViSi Mobile- direct mediation of relations.                 | 54. |
| 6. ViSi Mobile- indirect mediation of relations.               | 55. |
| 7. ViSi Mobile- actor-matrix value mediation.                  | 56. |
| 8. ViSi Mobile- redesign and values.                           | 59. |

## Appendices

|  |          |
|--|----------|
| 1. Theories on well-being.                                 | A 2.     |
| 2. Design theories on well-being.                          | A 10.    |
| 3. Value cards.  | A 16.    |
| 4. Meta-values & design for well-being.                    | A 18.    |
| 5. Three days with ViSi Mobile.                            | A 20.    |
| 6. Actor opinions.   | A 24.    |
| 7. Attachment: methodology kit <i>Values that Matter</i> . | external |



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Purp

Having a sense of purpose, something that gives meaning to your actions and motivation.

# APPENDIX

## How to design for well-being?

a methodology on design for well-being  
to embody well-being in ViSi Mobile

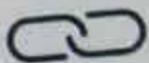
Msc. Merlijn Smits



Values that Matter



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Alterity  
relation

Technolo

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# 1. Theories on well-being.

This appendix will study the psychological and economic theories on well-being. It will then list those and the ones of philosophy and healthcare (see main thesis) in tables, to get an overview of all literature on well-being.

## **Well-being in psychology.**

The field of psychology gained global interest in the concept of well-being around the turn of the last century. At that time, Martin Seligman plead for more positivity in the field of psychology and he named it positive psychology (Csikszentmihalyi & Nakamura, 2011; Seligman, 1998). Seligman wanted to bring back a balance between the study of illness and disease and well-being and positive health, which had been lost after the Second World War. Since Seligman's plea, the field of positive psychology has been growing. Positive psychology's areas of study include people's positive subjective states, positive individual traits and positive environmental circumstances (Compton & Hoffman, 2012a). Within the fields of study, diverse psychologists have asked themselves the question of what constitutes and influences well-being and came up with their own theory of well-being (Seligman & Csikszentmihalyi, 2000).

The psychological theories are often roughly demarcated in two groups inspired by hedonism and eudaimonia. In hedonism, well-being means to have good feelings. Well-being is an end state, the result of a set of actions. This end state is a short-term well-being, named happiness. In this psychological hedonistic field research is done on what makes experiences for an individual (un)pleasant. In eudaimonia well-being is more the process of living itself and has a long-term interest. Psychology that follows the eudaimonic tradition often refers to well-being with life satisfaction or self-realisation. The most influential, complete and unique psychological theories on well-being will be listed below in random order (Deci & Ryan, 2006; Miquelon & Vallerand, 2008; Pohlmeier, 2013).

### *Lyubomirsky on happiness*

Sonja Lyubomirsky has done in depth

research on well-being. She has shown that a person's current state of well-being is determined by a set of three factors: set point, life circumstances and intentional activity. The set point is a genetically determined range of well-being that a person is able to reach. The point illustrates that some people are by nature able to reach higher levels of well-being than others. The life circumstances are quite stable facts of life, such as a person's demographic characteristics, that contribute to a certain level of well-being. This factor, for example, shows that different levels of well-being can arise between cultures. Intentional activity, finally, includes everything that is done and thought intentionally. Influencing intentional activities is most rewarding to improve well-being. Expressing gratitude, practicing kindness, cultivating strengths, visualisation of future selves and meditation are activities from a greater series proven to be able to directly increase individual's well-being (Lyubomirsky & Layous, 2013; Lyubomirsky & Sheldon, 2005). Subjective measurement scales would then be able to visualise the levels of well-being of people (Lyubomirsky & Lepper, 1999). Lyubomirsky's most important message is that one's well-being can certainly become influenced, though it is only partially.

### *Diener on subjective well-being*

Positive psychology is mostly concerned with subjective well-being. This term has been coined by Ed Diener in 1984 and is often referred to as 'happiness'. With subjective well-being Diener categorises all methods that assess individuals' appreciation of their own lives. During the measurement of subjective well-being, three components are studied that can be grouped in two areas: life satisfaction, positive affect and negative affect. Life satisfaction is the evaluation of life as a whole. It looks into the relation between a

person's aspirations and achievements. Life satisfaction forms the cognitive component of subjective well-being, or the eudaimonic component. Positive and negative affect refers to presence of positive and negative emotions. This forms the emotional or hedonic component. Subjective well-being is measured via questionnaires. The cognitive component could be measured via the five-item questionnaire that poses five general statements on life satisfaction. The emotional component could be measured, for example, via PANAS: the positive, negative affect schedule (Diener, 1994, 2000; Pavot & Diener, 2009). The subjective well-being questionnaires take well into account a person's own appreciation of life, but remain too vague to provide understanding in the diverse aspects of (objective) well-being.

#### *Deci and Ryan on the self-determination theory*

The self-determination theory of Edward Deci and Richard Ryan originated in the 70s around the question: what motivates action? Deci and Ryan found out that competence, autonomy and relatedness are innate, universal intrinsic motivators for action. First, competence refers to feelings of ability to successfully execute a task. Second, autonomy refers to feelings of self regulation and self organisation. Autonomy helps to change behaviour efficiently in changing environments. The authors believe the value to be a basic need for existence. Finally, relatedness refers to the feelings of belongingness, connection and care. Situations that allow for meeting the three needs are mostly contributing to people's well-being. Furthermore, when acting to meet a goal, the reasons for pursuing the goal influence well-being. Autonomous goals, meaning that the person pursues the goal out of self interest, enhance well-being. Yet, pursuing controlled goals, goals that have been set by external forces, will decrease well-being (Deci & Ryan, 2008). People's experience of the three needs of well-being can be measured via the basic psychological needs scale, provided by the authors.

#### *Ryff on the elements of well-being*

Carol Ryff has tried in 1989 to find the basic

elements that well-being consists of. She lists six aspects on the basis of a large comparison of other existing theories: self-acceptance, positive relations with others, autonomy, environmental mastery, purpose in life and personal growth. Self-acceptance means to have a positive attitude towards the self, to accept own strengths and weaknesses. Positive relations with others implies to have warm, trustful relations. Autonomy consists of an ability for self-evaluation, being independent and able to regulate own life. Further, environmental mastery is about the ability to change the world to meet own needs. Purpose in life is to have a goal to strive for that gives intentionality to actions and meaning to life. Finally, personal growth encompasses the ability to grow as a person, to develop own potential. Ryff's six aspects of well-being have been translated into questionnaires that ask participants to scale their well-being (Ryff, 1989; Seifert, 2005).

#### *Csikszentmihalyi on the flow theory*

According to Mihaly Csikszentmihalyi, one of the fathers of positive psychology, the key to well-being is flow. Flow is "a state in which people are so involved in an activity that nothing else seems to matter" (Csikszentmihalyi, 1990, p.9). This state of flow is characterised by the following elements: a person is fully concentrated, feels at ease to finish the task, has a clear goal in mind, experiences time differently than normal, feels in control over the situation, has achieved the balance between challenge and skill, believes the situation to be intrinsically motivating and loses self-consciousness. One's situation and personality affect the ability to reach flow. Autotelic persons, persons that act on intrinsic motivations, can best achieve flow. Csikszentmihalyi believes that flow is essential to experience well-being (Csikszentmihalyi, 1990).

#### *Seligman on authentic happiness & flourishing*

Martin Seligman, founder of positive psychology, states in the book "Authentic Happiness" that happiness consists out of three types: the pleasant life, the good life and the meaningful life (Seligman, 2004, p.13). The pleasant life is a life full of

positive emotions, comfort and pleasures. The good life is an engaged life. In the engaged life, one can be fully absorbed in activities, organisations or causes. It allows for experiencing flow. The meaningful life is a life that transcends pleasures and desires via making a positive contribution to a larger whole. To gain well-being, or as named here, authentic happiness, one should cultivate all three lives (Seligman, Steen, Park, & Peterson, 2005). The authentic happiness theory is argued to incorporate all three philosophical theories. The pleasant life follows the hedonic tradition. The good life desire satisfactionism and the meaningful life the objective list theories (Seligman & Royzman, 2003). I find the relation not very satisfying. Seligman's well-being, including the meaningful life, becomes entirely measured subjectively. That means that the meaningful life is not alike objective list theories as those are grounded in objective external assessments.

In the book *"Flourish"* Seligman replaces authentic happiness for well-being (Seligman, 2012). Well-being now consists out of five elements: the three aforementioned, relationships and accomplishment. Relationships refers to a sense of belongingness to others, feelings of integration with society and feelings of being cared for and loved. Accomplishment means to be able to reach life goals and achieve superior results. This is the beginning of the PERMA-model for well-being, named after the five elements. Seligman then states that practicing six universal virtues lead to well-being: wisdom, courage, humanity, justice, temperance and transcendence. The six virtues can be achieved in different ways, via 24 character strengths, positive traits that reflect in one's action and perception (Peterson & Seligman, 2004). Seligman believes that of the 24 character strengths hope, zest, gratitude, love and curiosity mostly improve one's well-being. Modesty, appreciation of beauty, creativity, judgment and love of learning weakly contribute (Park, Peterson, & Seligman, 2004).

### **Well-being in economics.**

Well-being has always been present in economics via the concept of utility. Utility

is the balance between pleasure and pain. Neoclassical economics studied how the principle of maximisation of utility affected the market situation. Later on, welfare economics sought to improve welfare via this utility maximisation (Brey, 2012b). Real interest in well-being however only came about around 1970. Easterlin brought up the happiness paradox that illustrates that the connection between happiness and economic wealth was not as strong as expected. Namely, Easterlin showed that the level of happiness in rich countries is not remarkably higher than the level in poor countries. Although his theory is not widely accepted, Easterlin's statement made well-being topic of economics (Bruni, 2010).

Around the same time the king of Bhutan, inspired by the Buddhist religion, proposed to replace the gross national product, GNP, by a gross national happiness, GNH. The Centre for Bhutan Studies consequently developed variables to measure GNH: ecology, culture, good governance, education, health, time use, psychological well-being, living standards, community vitality and good governance. Those variables were then divided into smaller quantities as time of sleep, frequency of feeling compassion, etc. After Bhutan, more countries gained interest in well-being as a measure of a country's status (Allison, 2012).

Nowadays, many economic measures of well-being have been developed. They are used for inter-nation comparison of well-being and policy reports that could have three purposes: monitoring of progress, informing policy design and policy appraisal (Dolan, Layard, & Metcalfe, 2010). Several of the most often used economic measures of well-being will be randomly listed below.

#### *Human Development Index*

The Human Development Index, HDI, is one of the most often used economic models for well-being based on the capability approach. It started around the 1980s from the idea that there is more to a country's development than economic growth. They propose three elements that build up well-being: long and healthy lives, knowledge and a decent standard of living. Those are measured, respectively via the objective qualities of life expectancy at birth, expected

years of schooling of children and mean years of schooling of adults aged 25+ and gross national income per capita (UNDP, 1990, pp.11-12).

#### *OECD on the better life initiative*

The organisation for economic co-operation and development, OECD, promotes policies for improvement of economic and social well-being. For that aim, they started the better life initiative project in 2011. This project maps out the well-being of different countries on the basis of eleven objective list domains that are, mostly, subjectively assessed: housing, jobs, education, civic engagement, life satisfaction, work-life balance, income, community, environment, health and safety. To even better assess the subjective experience of well-being, detailed guidelines have been developed. The guidelines consider well-being to be “good mental states, including all of the various evaluations, positive and negative, that people make of their lives and the affective reactions of people to their experiences” (OECD, 2013, p.29). This definition incorporates hedonism for short-term well-being, desire satisfactionism for long-term well-being and objective lists that become subjectively assessed.

#### *The happy planet index*

The happy planet index combines individual well-being with that of the world. The index is the result of the following sum: (well-being \* life expectancy \* inequality of outcomes) / ecological footprint. Well-being is the overall life satisfaction of people. Life expectancy refers to the average number of years people live. Inequality of outcomes is a neutralising factor for the differences between residents of a country in well-being and life expectancy. The ecological footprint finally assesses how sustainable the country is. As a result, the happy planet index is able to map sustainable well-being (Marks, 2017).

#### *Gallup*

The company Gallup measures and compares subjective well-being of countries. Via surveys, they measure the opinion of people in the five domains of well-being: purpose, social, financial, community and physical. Purpose refers to being motivated

to achieve your goals. Social means to have supportive relationships. Financial includes the ability to manage economic life for more security. Community is for feelings of safety and connectedness. Finally, physical refers to good health conditions. Next to the five domains, Gallup as well scores daily emotions (Gallup Healthways, 2014). Gallup thereby sees well-being as hedonism and subjectively assessed objective lists.

#### *Veenhoven and Mercer on livability*

Ruut Veenhoven has developed the concept of ‘livability’ to study the goodness of societies, allowing for indirect assessment of personal well-being. Livability refers to the correspondence between the needs and capabilities of citizens and the provisions of society. Society should meet both bio-physiological needs, such as food and shelter, and bio-psychological needs, including amongst others security, identity and meaning. Livability can be measured via two ways. First, the input-way starts from assessment of the society and studies then how society matches individual needs. Second, the output-way starts from the degree to which citizens flourish in a society as an indicator for society’s livability. Veenhoven opts for the output-way. He consequently suggests that citizen well-being can be measured via either health, including physical health, life expectancy, healthy life expectancy and mental health, or via satisfaction, including alienation, suicide and level of happiness. Veenhoven opts for the second, subjective way, in his book and develops clear guidelines on measurement for inter-nation comparison (Veenhoven, 1993, pp.6-15). The input approach of livability, on the other hand, has been adopted by the company Mercer. Mercer’s quality of living ranking measures ten categories that build up livability: political and social environment, economic environment, socio-cultural environment, medical and health considerations, schools and education, public services and transportation, recreation, consumer goods, housing and natural environment (Mercer, 2017). Both theories on livability define objective qualities that they either subjectively or objectively assess.

**Table 1. Philosophical theories on well-being.**

| Well-being is...        | How to improve well-being?                       | How to measure well-being?   | Categories  | Positive or unique aspects or insights   | Critique or missing?  | Technology's role   |
|-------------------------|--|--|---|--|---|---|
| Hedonism                | Maximise pleasure and minimise pain.             | It remains quite unclear. Philosophers would assess per situation what a person sees as pleasure and pain.   | <i>Quantitative hedonism:</i> pleasure is defined by duration and intensity.  | Makes well-being easy to grasp.  | Well-being is only seen as a short-term subjective state in which pleasures are all of equal value.                                     | Technology improves well-being by generating pleasurable experiences whilst minimising the unpleasant ones.   |
|                         |  |  | <i>Qualitative hedonism:</i> pleasure is defined by duration, intensity and quality.  | Allows seeing that not all pleasurable activities are of equal worth.              | Well-being is only seen as a short-term subjective state and cannot account for 'authentic experiences'.                                |   |
| Desire satis-factionism | Maximise fulfilment of desires.                  | Only simple desire satisfactionism is measurable by asking people about their desires and assessing whether those are fulfilled. The other two types cannot be measured. | <i>Simple:</i> fulfilment of only present desires.  | Makes well-being easy to grasp.  | Only considers short-term well-being.   | Technology affects well-being by 1) facilitation of understanding desires, 2) fulfilling desires; 3) generating desires.                              |
|                         |  |  | <i>Reflective:</i> fulfilment of present and long-term desires.   | Shows that well-being is not only a short-term but as well a long-term state.      | One might make choices that are not optimal seen through god's eyes.  |   |
|                         |  |  | <i>Informed:</i> fulfilment of desires that 'would be best for you' without your knowledge.   | Shows that well-being is something that individuals cannot fully grasp themselves. | Only possible in a hypothetical situation.  |   |
| Objective list theories | Meeting as much objective qualities as possible. | Study how many objective qualities are met by a person.  | <i>Perfectionism:</i> well-being is defined based on what is good for human nature. Eudaimonia is about living a virtuous life. Hurka's perfectionism about the perfected life.                   | Shows that one's way of living affects his state of well-being.                    | Just supposes that human nature is the ultimate goal to strive for and cannot account for what would contribute to human nature.        | Technology affects well-being by 1) directly fulfilling an element, 2) creating the conditions for fulfilment of an element, 3) creation of elements. |
|                         |  |  | <i>Objective goods theories:</i> several proposed objective goods together generate well-being. Proposals have been done by amongst others Nussbaum, Parfit, Finnis, Fletcher, Murphy and Santos. | Shows that well-being exists out of several components.                            | No insight in how a person appreciates the different qualities, why the qualities are exhaustive and whether they depend per situation. |   |

Table 2. Healthcare theories on well-being.

|  | Well-being is...   | How to improve well-being?  | How to measure well-being?                                 | Philosophical background  | Positive or unique aspects or insights   | Critique or missing?   | Technology's role   |
|--|--|---|--|---|--|--|---|
| Huber and Compton & Hoffman on positive health | Similar to positive health that includes bodily functions, mental functions & perception, spiritual/existential dimension, quality of life, social & societal participation and daily functioning. | Improving one's positive health via, for example, positive emotions, relaxing sounds, social relations, feelings of control, emotional expression or tangible forms of assistance or touch. | Questionnaires that study people's subjective evaluations. | Hedonism by mental functions, desire satisfactionism by quality of life and objective list theories by the existential dimension. Real objective lists are not involved though. | Stresses the importance of involving a concept of health in a theory on well-being; positive health is almost equal to well-being.     | Positive health does not really consider long-term well-being. It is difficult to measure without the development of objective lists. It does not transcend user's own evaluations of their lives. | Technology does not play a direct role. It only allows for improvement of the context of the six domains.                                       |
| Seligman on positive health                    | Improving a healthy person's situation, whilst positive health aims to improve the lives of the ill.   | Improving positive health via greater subjective feelings, better physical health and better fit with the environment.  | Questionnaires that study people's subjective evaluations. | Hedonism by the subjective area and objective list theories by the functional area (capability approach).   | Has made well-being fully quantifiable, allowing to bring well-being into institutions.  | The ill person is taken as a standard.   | Technology could bring about a better fit of the ill person with his environment to increase his well-being.                                    |
| Keys on flourishing                            | On the other part of the continuum than illness. It is a subjective assessment of emotional, psychological and social well-being.  | Improving people's appreciation of life: their short-term pleasures, long-term goals and social relationships.  | Questionnaires that study people's subjective evaluations. | Hedonism by the emotional component, objective list theories by the psychological component.  | Shows that absence of illness does not directly refer to presence of well-being and that social well-being is a multi-faceted element. | Only a subjective assessment of well-being.  | Technology should not only prevent unpleasant situations but should generate pleasant ones. It should furthermore facilitate social well-being. |

**Table 3. Psychological theories on well-being.**

|                                   | Well-being is...  | How to improve well-being?   | How to measure well-being?  | Philosophical background  | Positive or unique aspects or insights   | Critique or missing?  | Technology's role   |
|-----------------------------------|---|--|---|---|--|---|---|
| Lyubomirsky on happiness          | The result of set point, life circumstances and intentional activity.   | Influencing intentional activities as expressing gratitude and practicing kindness etc.                                | Questionnaires about people's subjective experiences of well-being in general.                                  | Hedonism, by measuring subjective experiences of intentional activities.  | Shows that well-being is highly determined by genetic factors.   | Provides no insight in the elements of well-being.  | Technology is able to improve well-being via intentional activities: expressing gratitude or practicing kindness.   |
| Dieners on SWB                    | The sum of life satisfaction, positive affect and negative affect.  | Improving the positive-negative balance and life satisfaction. No insight given into how to improve life satisfaction. | Questionnaires about positive and negative affect via PANAS, life satisfaction via the five-item questionnaire. | Eudaimonia by life satisfaction and hedonism by positive and negative affect.   | Considers well that well-being is the combination between short-term pleasure and long-term satisfaction.  | Provides no insight in the elements of well-being, nor in how to improve it.  | Technology could generate positive feelings and contribute to life satisfaction in general.   |
| Ryan & Deci on self-determination | The sum of three basic intrinsic motivational needs: competence, autonomy and relatedness.                            | Improving the three components of competence, autonomy and relatedness. Moreover, acting on autonomous goals.          | Questionnaires on the basic psychological three needs.  | Objective list theories - eudaimonia.   | Breaks down well-being into measurable parts and shows the importance of autonomous goals.   | Cannot explain why the three elements are exhaustive and does not focus on simple pleasures.  | Technology improves well-being when it creates a situation that allows to feel competent, act autonomous and gain feelings of relatedness.                            |
| Ryff on Ryff scales               | The sum of self-acceptance, positive relations, autonomy, environmental mastery, purpose in life and personal growth. | Improving the six elements of well-being.  | Questionnaires about the six elements of well-being.  | Objective list theories - eudaimonia.   | Breaks down well-being into measurable parts.  | Cannot explain why the six elements are exhaustive and does not focus on simple pleasures.  | Technology improves well-being when it creates a situation that allows meeting the six elements of well-being.  |
| Csikszentmihalyi on flow          | Enlarged by experiencing regular moments of deep engagement, flow.  | Building environments and designing products that allow for experiencing flow.   | Questionnaires about people's subjective experiences on flow.   | Eudaimonia, by studying life satisfaction.  | Gives a very detailed insight in the one element of flow and its implications for well-being and stresses the importance of intrinsic motivations. | Only focuses on flow and misses all other aspects of well-being.  | Technology could improve the ability and external circumstances of people to experience moments of flow.  |
| Seligman on Flourishing           | The sum of PERMA: positive emotion, engagement, relations, meaning and accomplishment.                                | Improving PERMA and cultivation of the six universal virtues via the 24 character strengths.                           | Questionnaires about people's subjective experiences of the PERMA-elements and their character traits.          | Hedonism by the pleasant life, desire satisfaction by the good life and objective list theories by the meaningful life. | Shows the importance of including character traits.  | Does not really incorporate all philosophical traditions as it pretends. It only looks into subjective well-being and misses to cover objective properties. | Technology improves well-being when it improves specific character traits (hope, zest, gratitude, love, curiosity) and when it positively affects the PERMA-elements. |

Table 4. Economical theories on well-being.

|                             | Well-being is...  | How to improve well-being?   | How to measure well-being?  | Philosophical background  | Positive or unique aspects or insights  | Critique or missing?   | Technology's role  |
|-----------------------------|---|--|---|---|---|--|--|
| Human Development Index     | The combination of the level of long and healthy lives, knowledge and a decent standard of living.  | Improving life expectancy at birth, education and income per capita.   | Measurement of objective qualities as life expectancy at birth, expected years of schooling, mean years per capita.   | Capability approach as part of the objective list theories is the basis for this index. But by measuring life satisfaction it could be categorised in desire satisfactionism too. | Has translated well-being into easily measurable objective qualities.   | Cannot explain why the elements are exhaustive.  | Health innovations could improve life expectancy at birth, internet and other educational technologies allow for improvement of education and increase of the average level of technology in a country would probably indirectly increase the income per capita. |
| OECD better life Initiative | The combination of housing, jobs, education, civic engagement, life satisfaction, work-life, income, community, environment, health and safety. | Improving the eleven objective domains of well-being.  | Large scale subjective measurements of objective qualities.   | Objective list theories, desire satisfactionism and hedonism.   | Provides a dynamic concept of well-being that could vary per goal and person.                                       | Fails to consider the aspects of well-being that individuals themselves do not take into account.                        | Technology cannot play a direct role. It only allows for improvement of qualities of life that thereby indirectly improve the eleven domains of well-being.  |
| Happy planet Index          | Individual and sustainable social value including life expectancy, inequality and ecological footprint.   | Improving life satisfaction and life expectancy in a country and reducing inequality and ecological footprint. | Measurement of objective qualities as life expectancy, inequality and ecological footprint.   | Objective list theories.  | Shows that well-being of the individual is not the ultimate value in the face of a greater whole: the world.        | Cannot explain why the elements are exhaustive.  | Technology only indirectly plays a role via increasing life satisfaction or life expectancy. To improve ecological footprint and reduce inequality, it should embody values as equality and sustainability.  |
| Gallup                      | The combination of five domains: purpose, social, financial, community and physical and current daily satisfaction.                             | Improving the five domains of well-being and daily emotions.   | Large scale subjective measurements of people's evaluation of the five domains.   | Objective list theories, desire satisfactionism and hedonism.   | Studies daily satisfaction in the face of larger groups.  | Cannot explain why the elements are exhaustive and well-being is very broad and fuzzy.                                   | Technology cannot play a direct role. It only allows for improvement of direct pleasure or one of the five domains.  |
| Livability                  | The result of the livability of societies.  | Improving the environment in which people live to allow them to flourish.                                      | <b>Input-way:</b> measure objective qualities of the environment.<br><b>Output-way:</b> measure the well-being of the individual via objective (suicide rate and alienation) and subjective qualities (level of happiness). | Objective list theories and desire satisfactionism.   | Greatly stresses the importance of taking into account the larger environment as influencing individual well-being. | Cannot illustrate how the environment is changing the perception and action of individuals and thereby their well-being. | Technology can be seen as part of the environment, greatly setting the conditions for people to flourish.  |

## ■ 2. Design theories on well-being.

This appendix will explore the different currently existing design for well-being methodologies and will compare those at the end of the appendix in a table, on the basis of, amongst others, their advantages, disadvantages and foundation in the philosophical theories. In exploring the existing design for well-being approaches, first those grouped by Philip Brey will be studied (Brey, 2015) and consequently approaches he did not consider.

### *Emotional design*

The group emotional design sees well-being as hedonism. Two major methodologies can be found within emotional design: pleasure design of Patrick Jordan and emotional design of Donald Norman.

- *Jordan on pleasure design*: The theory pleasure design challenges designers to develop products that evoke pleasurable experiences via their affordances. Based on the four pleasure framework of psychologist Lionel Tiger (Tiger, 1992), Jordan describes four levels of pleasure to target via design: physio-, socio-, psycho- and ideo-pleasure. Physio-pleasure results from pleasant sensory experiences. Technology should evoke pleasant sensory experiences to increase well-being. Socio-pleasure results from enjoyment of social interactions. Technology could increase socio-pleasure via facilitation of social interactions or via brand image. Psycho-pleasure relates to satisfaction derived from executing and finishing, even mundane, activities. The pleasure depends mostly on internal motivation. Technologies could facilitate actions and thereby increase psycho-pleasure. Finally, ideo-pleasure concerns pleasure derived from enjoyment of situations that meet values and taste (Green & Jordan, 2003, pp.190-191).

- *Norman on emotional design*: Donald Norman as well pleads for well-being via pleasant emotions. He demarcates three levels of technology that generate emotion: the visceral-, behavioural- and reflective level. On the visceral level one can find the first response of a user to a technology. This

is based on technology's appearance. The behavioural level is pleasure that results from positive interaction between user and technology. The reflective level finally refers to users' values met by the technology (Norman, 2005, pp. 63-99). The better each level generates positive emotions, the more the technology contributes to users' well-being.

The category of emotional design considers only a small part of well-being by targeting it via hedonism: short-term pleasures. The category could be useful to understand the short-term well-being derived from technology, but is not a sufficient approach to design for overall well-being.

### *Oosterlaken on capability sensitive design*

Ilse Oosterlaken has written an entire dissertation on the use of the capability approach in design (Oosterlaken, 2013). She pleads for capability sensitive design, because technology has great potential to improve capabilities. The capability approach, as already seen in philosophy, shows that the level of one's well-being cannot be judged by available resources alone but should instead study what one is able to do with those resources. Consequently, technology should not focus on provision of resources, on having nice aesthetics or a good brand image, but on the creation of capabilities in life.

Oosterlaken shows that the capability approach includes characteristics of inclusive and participatory design. Inclusive design is design that is appropriate for any type of user, including disabled and elderly (Clarkson, Coleman, Keates, & Lebbon, 2013,

pp.10-12). Participatory design focuses on inclusion of the user during the design process to better understand his needs and values (Abrás, Maloney-Krichmar, & Preece, 2004). Both approaches aim to develop technologies that meet the needs of a diversity of users and thereby take into consideration what the users are really able to do with a certain technology. Capability sensitive design should as well follow this line of thinking.

Still, research on the capability approach has not yet resulted in a detailed design for well-being approach. Oosterlaken shortly proposes to make use of the value sensitive design approach but does not provide a design methodology herself.

Due to a lacking methodology, capability approaches in design take along a number of problems. There is first no consensus yet on what capabilities matter in life to embody in design. What should one furthermore do with conflicting capabilities? And how to account for technologies that improve well-being but not human capabilities, such as short-term hedonism? Furthermore, there is no guidance on embedding capabilities in design nor on measurement of well-being in relation to design. The approach is therefore not usable yet for designers and misses crucial elements of the overall concept of well-being.

#### *Ruitenbergh & Desmet on positive psychology approaches*

Positive psychology approaches are originated in psychology. There are only few design approaches in this field that have a clear definition of well-being and framework for use. One of those is the theory of Ruitenbergh and Desmet. They see well-being as life satisfaction, corresponding to the ideas of desire satisfactionism. They aim to achieve it via meaningful activities: activities that enable to develop skills and contribute to personal values. Designers should target meaningful activities and develop contributing technologies. The technologies should focus on generation of positivity rather than on reduction of negativity. Furthermore they should stimulate people to engage in activities, instead of developing technologies for

intrinsic use (Ruitenbergh & Desmet, 2012).

The approach of Ruitenbergh and Desmet focuses on technology's ability to enable well-being. Thereby, they implicitly point to the distinction between enabling and directly generating. Technology can enable, contribute indirectly to well-being and can directly improve it. Ruitenbergh and Desmet's approach is very narrow as a design approach. It considers only technology's enabling role and values solely certain aspects of well-being in life satisfaction, namely social contacts and an active life. Again, the theory does not illustrate how to measure well-being as a result of design.

#### *Leikas, Saariluoma & Heinilä on life-based design*

Life-based design wants to go beyond technological usability by studying the needs for using technology in context (Leikas, Saariluoma, Heinilä, & Ylikauppila, 2013; Saariluoma & Leikas, 2010). The theory starts with explaining that actions result from social rules and regulations that relate to each other: rule-following actions. The type of rule-following action should be understood in socio-cultural, biological and psychological facts and values. The combination of rule-following actions together shape the form of life, based on the ideas of philosopher Ludwig Wittgenstein. Users' form of life should be understood before starting to design technologies, because the role of technologies in human life is to support the rule-following actions that solve needs. In its approach, life-based design sees technology as an instrument for fulfilment of short- and long-term needs and goals. Well-being in life-based design is grounded in reflective desire-satisfactionism.

To guide the process, the authors developed four design phases: form of life analysis, concept design and design requirements, fit for life design and innovation design. In the phase form of life analysis, the designer analyses the life settings of the target group. He should gain understanding in their form of life, rule-following actions, life goals and needs. Consequently, he should define people's needs and analyse the potential

role of technology in that context. Side problems, typical contexts and typical actors should be visualised to gain even better understanding. Phase two describes technology's role in more detail. The designer starts ideation, reflection and picks a solution that should be evaluated with users before designing it in more detail. The fit for life design requires thorough analysis of the designed technology in relation to well-being. Is the technology really the ideal solution for the need? And is the technology ethically justifiable? Finally, in innovation design, the technology becomes implemented in normal life. The designer should build up a marketing plan that includes a culture for proper usage of the technology, its infrastructure and auxiliary necessary activities.

Life-based design is a promising design for well-being methodology. It correctly takes into account both short- and long-term desires of people. Yet, by considering well-being on the grounds of desire-satisfactionism, it has some flaws. First, users are seen as ultimate experts of their own well-being. Though, there might be important values contributing to well-being users are unaware of. Second, how should one deal with conflicting desires of one person or inter-personal conflicts? How should one furthermore deal with desires that do not bring about well-being? And how to deal with elements of well-being that are not grounded in desires? Apart from this, the theory provides a very detailed framework for use. The four design phases are typical steps of a normal design approach, but enriched by the value of well-being. Especially the guidance of technology's implementation in phase four is interesting to anticipate on unintended consequences of technology (although the theory cannot prevent them). Life-based design takes well into account the effect of context and technology on well-being.

#### *Desmet & Pohlmeier on positive design*

An upcoming approach in design for well-being is the one developed at the University of Delft by Pieter Desmet and Anna Pohlmeier: positive design. The approach brings together a wide variety of research

on well-being and does thereby, as the first approach, justice to the broadness of the concept. It results mostly from psychological research on well-being and incorporates philosophical insights. The methodology aims to improve people's subjective well-being via three pillars: design for pleasure, design for personal significance and design for virtue. The first pillar follows the hedonic tradition. It aims to improve short-term well-being via generation of instant pleasures. Design for personal significance considers long-term well-being or life satisfaction and aims to meet via technology personal long-term goals. In this, it mostly follows the reflective desire-satisfactionism theory. Finally, design for virtue could be seen as an objective list approach in which technology aims to meet virtues of life. As a methodology per pillar, Desmet and Pohlmeier refer to the existing frameworks of, amongst others, emotional design, capability approaches and Seligman's universal virtues. Designers should furthermore keep in mind to generate possibilities for users, balance the three pillars, create personal fit between user and technology, involve the user actively and create long-term impact (Desmet & Pohlmeier, 2013; Pohlmeier, 2013). Pohlmeier furthermore lists four types of influence of technology on well-being. Technology can first directly generate well-being. Second, it can enable activities that produce well-being. Third, it can be a symbolic representation of what matters to people and thereby could result in well-being. Finally, technology can support activities that generate well-being (Pohlmeier, 2012).

The positive design framework does justice to the many facets of well-being. It involves all three philosophical theories and refers to multiple psychological theories on well-being. It furthermore provides practical guidelines on how to develop technologies that improve well-being. The four types of influence of technology on well-being show technology's diverse roles as either direct or indirect creator of well-being. All arguments suggest the theory to be an ideal guide on design for well-being. Yet, the theory does not provide anything new. It only brings together what has already been seen. More

importantly, it should go beyond subjective well-being only, because users are not full experts of their own well-being. The virtue pillar in the framework suggests that the theory goes beyond subjectivity. Namely, the virtue pillar is grounded in objective list theories and people will normally not incorporate virtues in the subjective assessment of their own well-being. Even though the virtue pillar pretends to be objective, well-being in the framework is fully subjective. Therefore, the theory is inconsistent. The authors might have aimed to bring in an objective list pillar in their theory. This, however, does not work in relation to well-being as only a subjective component. This inconsistency is a big flaw of the positive design framework.

#### *Friedman & Kahn on value sensitive design*

Another promising approach that could generate great insights in design for well-being is the value sensitive design approach. The approach does not provide any insight in what well-being is, but provides even more insight in developing a design methodology. It has been developed by Bataya Friedman and Peter Kahn to bring in values in the field of human computer interaction. Nowadays the design approach is used to proactively embody values in the design of any technology. The approach consists out of three iterative phases: conceptual, empirical and technical. In the conceptual phase, all direct and indirect stakeholders related to the technology become identified, including all values at stake. An analysis is executed on how the technology affects the values at stake and how to deal with conflicting values. The empirical phase consequently turns to the user to gain better understanding in his values and needs. Finally, in the technical phase, the technology to be designed becomes compared to existing related technologies. Those help to make better design decisions and understand the relation between values and the field of the technology. Value sensitive design believes to make a difference by bringing in values in each domain of life (home, work, online, public space, etc.), inclusion of all types of values and doing justice to the bi-

directional interaction between human and technology that could result in technology's unintended consequences (Friedman, Kahn, & Borning, 2002).

Value sensitive design sees well-being as one value amongst many others. I would see well-being as the ultimate value encompassing many others. Following this latter line of thinking, the approach could be very useful as a design for well-being approach. Yet, there are some shortcomings. First, the methodology fails to explain how values should become identified per situation. How should a designer understand which values matter? Second, the approach fails in explaining how stakeholders should become identified. Should we, for example, as assistant professor in applied ethics Noëmi Manders-Huits suggests, build up an Actor-Network (Manders-Huits & Zimmer, 2009)? Then, the approach fails to explain how the identified values should become embodied in technology. How should one build the different values into a technological object?

Based on value sensitive design, new approaches to design for values have been proposed. Vermaas, Hekkert, Manders-Huits and Tromp categorise those in user driven methodology and designer driven methodology. In the previous, design aims at improving values introduced by the user. The latter focuses on values brought in by the designer or client (Vermaas, Hekkert, Manders-Huits, & Tromp, 2015).

#### *•Participatory design*

Participatory design is an often used design approach with user driven methodology. It involves where possible the user in the design process. That has clear advantages: users are given the feeling that they matter and become better attached to the design. Furthermore, the design fits better with user's needs, because clear insight can be gained in their needs and values (Abrams et al., 2004). Participatory design works out well for users' satisfaction, but it fails to incorporate all values that matter, because users are unaware of all values that affect their well-being. It needs an external assessor to make users aware of technology's influence. This shows the

necessity in design for values to not only involve external users as value experts but to involve designer driven methodology too.

- *Vision in product design*

Vision in product design, on the other hand, is a designer driven methodology. The designer should start with simulating the future context of the product to be developed. In this context, he should conceptualise the values at stake that he wishes to design for. He should thereby make an appeal to his authentic self; inspiration should be gained from what he aims to contribute in life based on personal aspirations (Hekkert & Van Dijk, 2011, pp.26-27). Better than participatory design, the vision in product design approach is able to bring in values that matter but remain unconscious to user's eye. Starting from the designer, the approach however brings in too much designer-bias and personal aspirations and fails to do justice to all important values at stake. There is need of a design methodology that could combine user driven and designer driven methodology, to best involve all values of well-being that matter.

**Table 5. Design theories on well-being.**

|                             | Well-being is...   | How to improve well-being?   | Philosophical background   | Positive or unique aspects or insights   | Critique or missing?  | Categories  |
|-----------------------------|--|--|--|--|---|---|
| Emotional design            | A balance between positive and negative emotions.  | Design technology that generates pleasant experiences on each level of interaction.  | Hedonism, in which well-being is short-term pleasure.  | Provides detailed insight in how to develop technology to improve short-term well-being.   | Does not consider in detail long-term well-being or other important values.   | <i>Pleasure design</i> : technology could provide four pleasures: physio-, socio-, psycho- and ideo-pleasure.<br><i>Emotional design</i> : technology could provide pleasurable experiences on the visceral, behavioural and reflective level.  |
| Capability sensitive design | Fulfilment of capabilities.  | Design technology that contributes to human capabilities.  | Objective list theories, in particular the capability approach.  | Nicely introduces objective list theories to the world of design.  | Does not provide an adequate framework that can be used to design for capabilities.   |   |
| Meaningful activities       | Engagement in meaningful activities.   | Design technology that enables to contribute in meaningful activities.   | Desire satisfactionism in which life satisfaction equals well-being.   | Shows that technology can enable well-being (indirect) and generate well-being (direct).   | Does not consider all aspects of well-being. It only targets a niche of well-being.   |   |
| Life-based design           | Fulfilment of both short- and long-term desires.   | Design technology that fulfils needs of users, grounded in their rule-following actions and forms of life.   | Reflective desire-satisfactionism.   | Shows that contextual circumstances affect the human-technology relation and takes well into consideration socio-cultural, psychological and biological context. | Sees the user as ultimate expert of well-being, whilst there is more to well-being than solely desires.   |   |
| Positive design             | A subjective property that consists out of the balance between short-term pleasure, personal significance and a virtuous life. | Design technology that contributes to each pillar of well-being. It should generate immediate pleasure, contribute to long-term goals and improve virtues. | Each pillar is represented by one of the three areas of philosophy. Pleasure is derived from hedonism. Personal significance from desire satisfactionism and the virtues from the objective list theories. | Does justice to all aspects of well-being and incorporates the positive aspects of many other theories on well-being.  | Well-being is seen as a subjective component but the virtue pillar should be based on objective assessments, which makes the theory inconsistent.                                       |   |
| Value sensitive design      | One of the many values that can be designed for.   | Design technology that embodies the values of well-being.  | Objective list theories.   | Shows greatly how to target values and thereafter how to embody those in design and acknowledges that each context requires revision of values.                  | Well-being should not be one of many values, but should be the ultimate one. The theory should generate insight in how to identify values and stakeholders and embody values in design. | <i>Participatory design</i> : involves the user during the design process to understand his values. Yet, the user is not an expert of own well-being.<br><i>Vision in product design</i> : designer develops a vision of values that he embeds in the technology. Yet, this is not objective. |

## 3. Value cards.

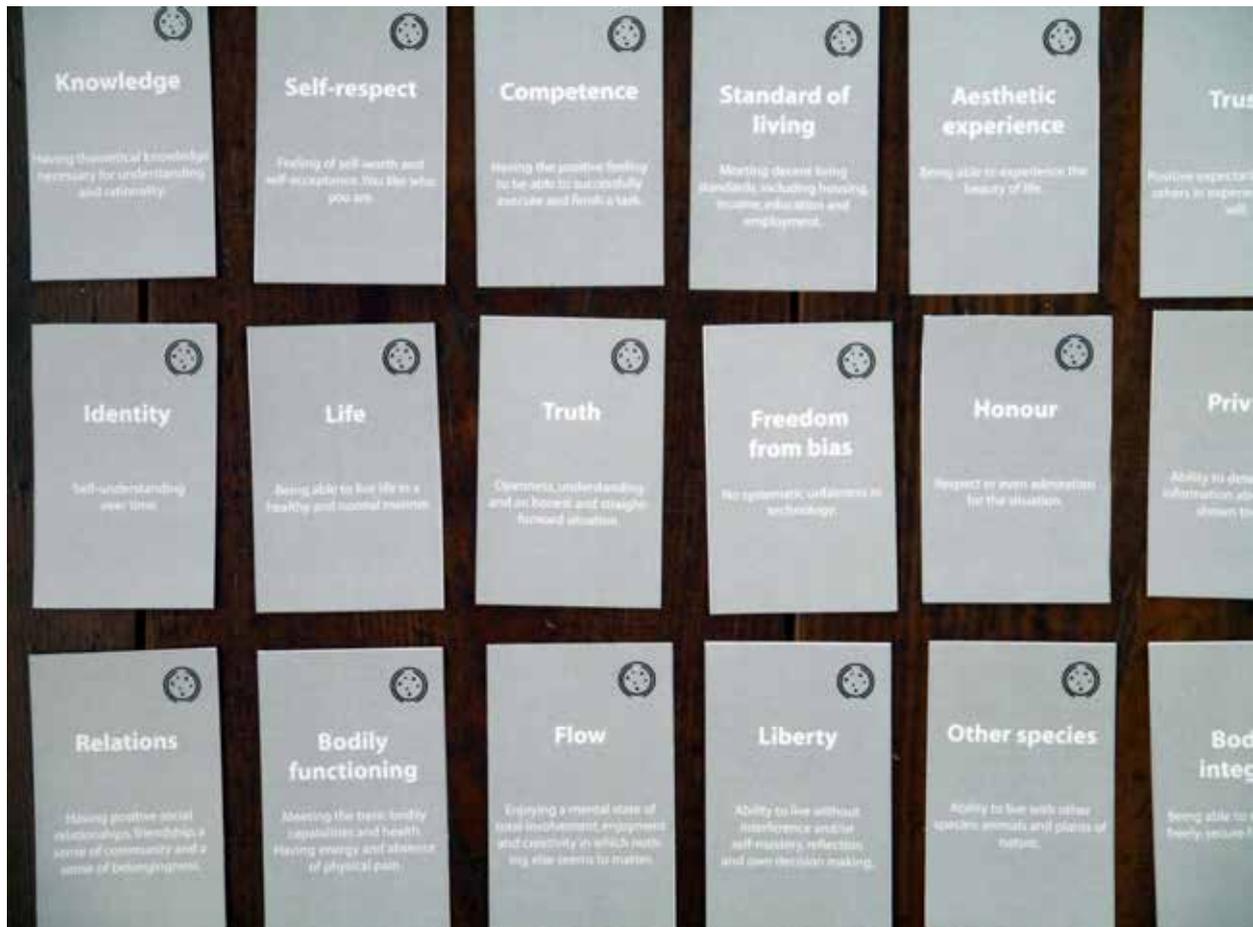
This appendix illustrates the value cards, as a tool for the *Values that Matter* design methodology.

The value cards help designers in embodying an objective well-being in their designs by finding out which values matter in the context of their design problem. The cards are based on the elements of well-being proposed by the diverse (philosophical, healthcare, psychological and economic) objective list theories as seen before. In the table on the right, all values proposed by the diverse authors have been listed. The first and second columns list the value and the number of times it was mentioned in the theories. The third column covers the authors that mentioned the value. Column

four lists synonyms, as used by the authors, of the value. Similar values were brought together under the same denominator.

The value cards were inspired by the values mentioned in the table. The table is certainly not exhaustive, as it only brings together values already proposed by different authors. It is for now still up to the designer to bring in additional values that matter in context.

Future research is required on values in design for well-being. It should target what qualifies as a value of well-being and how different values might relate to each other.



1. Value Cards.

| Value & how often mentioned |                           | Objective list theories using the value  | Synonyms used by the diverse authors   |
|-----------------------------|---------------------------|--|--|
| 10                          | Relations                 | Santos, Griffin, Fletcher, Murphy, Ryan&Deci, Seligman, Keyes, Gallup, Finnis, Aristotle | Affective relationships, deep personal relations, friendship, relatedness, love&humanity, relations, social relations, social, sociability, friendliness |
| 9                           | Knowledge                 | Finnis, Murphy, Santos, HDI, Parfit, Hurka, Aristotle, Seligman, Griffin                 | Rational activity, theoretical rationality, theoretical wisdom, wisdom&knowledge, understanding  |
| 7                           | Bodily functioning        | Griffin, Huber, Nussbaum (2x), Hurka, Gallup, Seligman (positive health)                 | Basic capabilities, bodily functions, bodily health, functioning of the body, physical health, physical, senses&imagination&thought                      |
| 7                           | Decent standard of living | HDI, OECD (4x), Gallup (2x)  | Housing, income, jobs, education, financial, work-life balance   |
| 7                           | Achievement               | Fletcher, Santos, Ryff, Griffin, Seligman, Aristotle                                     | Meaningful achievement, personal growth, accomplishment, pride   |
| 6                           | Engagement                | OECD, Gallup, Huber, Seligman, Nussbaum, Aristotle                                       | Civic engagement, social&societal participation, affiliation, community, liberality  |
| 6                           | Self-respect              | Fletcher, Santos, Ryff, Murphy, Huber, Nussbaum  | Self-acceptance, inner peace, mental functions&perceptions, emotion  |
| 5                           | Practical wisdom          | Aristotle, Hurka, Nussbaum, Finnis (2x)  | Practical rationality, practical reflection, practical reasonableness  |
| 5                           | Transcendence             | Parfit, Finnis, Murphy, Huber, Seligman  | Moral goodness, spiritual/existential dimension, temperance&spirituality   |
| 4                           | Autonomy                  | Griffin, Santos, Ryan&Deci, Ryff   |  |
| 4                           | Life                      | Nussbaum, Finnis, Murphy, HPI  | Life expectancy, long&healthy lives  |
| 3                           | Aesthetic experience      | Finnis, Murphy, Parfit   | Awareness of beauty  |
| 3                           | Control                   | Nussbaum, Ryff, Seligman (positive health)   | Environmental mastery, fit with environment, control over one's environment  |
| 3                           | Purpose                   | Gallup, Ryff, Seligman   | Meaning  |
| 3                           | Self-control              | Aristotle (2x), Seligman   | Temperance, good temper  |
| 2                           | Competence                | Ryan & Deci, Murphy  | Excellence   |
| 2                           | Courage                   | Aristotle, Seligman  |  |
| 2                           | Daily functioning         | Huber, Parfit  | Development of one's abilities   |
| 2                           | Justice                   | Aristotle, Seligman  |  |
| 2                           | Play                      | Finnis, Nussbaum   |  |
| 1                           | Bodily integrity          | Nussbaum   |  |
| 1                           | Flow                      | Csikzentmihalyi  |  |
| 1                           | Honour                    | Aristotle  |  |
| 1                           | Liberty                   | Griffin  |  |
| 1                           | Other species             | Nussbaum   |  |
| 1                           | Truth                     | Aristotle  |  |
| 1                           | Privacy                   | Friedman, Kahn & Borning   |  |
| 1                           | Freedom from bias         | Friedman, Kahn & Borning   |  |
| 1                           | Trust                     | Friedman, Kahn & Borning   |  |
| 1                           | Identity                  | Friedman, Kahn & Borning   |  |

Table 6. Values of the objective list theories.

## 4. Meta-values & design for well-being.

The process of designing for the values of well-being in itself already affects the values of trust, responsibility, freedom and autonomy. This appendix will illustrate how the process of design for well-being in itself affects values.

### Trust

First, Verbeek explains design for well-being requires trust (Verbeek, 2006, p.12). Trust encloses the willingness of users to trust that technology works as it is supposed to and fulfils the promises that it makes. Namely, technology should contribute to users' well-being in fulfilment of its function. Users should thereby trust the intentions of the designer, the brand and the technology itself.

Trust is not a requisite that arises only within design for well-being. It is a challenge that every technology, designed with intent or not, has to face. Trust is one of the elements, next to affect; the potential of a technology to generate a positive user response and commitment; attachment to a certain technology, that is essential for the survival of brands (Chaudhuri & Holbrook, 2002; Moorman, Zaltman, & Deshpande, 1992).

Technologies designed intentionally to improve well-being, are more likely to establish trust than any other technology. Namely, they have the advantage of being good for people. When the technology results in unintended consequences that work out badly, the market mechanism will easily eliminate the technology from the market. In reality, therefore, any design for well-being would evoke and thus positively affect users' trust.

### Responsibility

Second, the value of responsibility becomes affected by designing for well-being, because it raises the question of accountability for technology's outcomes. The outcome of technology, in intended mediation and unintended consequences, can be traced back to three types of agency: agency of the designer, the technology and

the user. All three agents could be held accountable for technology's influences. But which of the agents should gain final responsibility (Verbeek, 2006, p.12)?

Responsibility is a theoretical problem and will, in most cases, not result in practical implications. It suffices to assume both designer and user have taken their responsibility, as Verbeek suggests. In the rare cases that assigning responsibility becomes necessary, it should be studied per particular technology and maybe even per particular situation who should be held accountable. So the process of designing for well-being changes the content of the value of responsibility, by bringing in questions about accountability.

### Freedom

Then, design for well-being is argued to decrease users' freedom (Dorrestijn & Verbeek, 2013). Namely, the inscription of a certain script in a technology decreases its possible ways of use. Actually, all mediating effects of technology shape action and perception of users and thereby decrease their freedom. Moreover, by inscription of the value of well-being in technology, designers impose their idea of well-being on the user.

It seems worse than it is. The real effect of design on freedom depends on freedom's definition. A well-known contribution has been made by the British philosopher Isaiah Berlin who proposed two famous concepts of freedom: negative and positive. Negative freedom refers to the absence of interference of other people or things on own actions. Positive freedom, on the other hand, concerns self-mastery that enables conscious reflection and own decision-making (Berlin, 1958).

In today's society, an absolute negative

freedom does not exist. There are many influences shaping action and perception. The law, regulations, social control and any type of mediating technology influence people and restrict thereby negative freedom. Positive freedom though exists. The ideas of French philosopher Michel Foucault provide a deeper understanding of the concept that cannot be gained via Berlin's account alone. Foucault proposes positive freedom 'as a practice', meaning that one should be able to consciously reflect on life and examine its conditions (Foucault, 1976, p.95). Dorrestijn and Verbeek apply Foucault's notion of freedom to the design of technologies (Dorrestijn & Verbeek, 2013). They believe that technologies create the context for freedom in which the user could act. Design for well-being does so. Technology's mediation becomes the context for action. In this context, users can decide to follow technology's script or to de-cribe via an anti-script. For real preservation of positive freedom, design for well-being should, as Dorrestijn and Verbeek suggest, be transparent for allowing users to be critical.

### **Autonomy**

The fourth value that is affected and very much related to freedom is autonomy, which can be best explained by reference to the ideas of John Stuart Mill. In "*On Liberty*" Mill explains why state's power should be restrained to prevention of harm only. He believes any other form of influence, even the kind that aims to improve well-being, is unacceptable (Mill, 1859). A loss of individual autonomy is one of Mill's main arguments (Oh, 2016). He argues that this autonomy is necessary to achieve human excellence and diversity in society.

There is a similarity with technologies that shape well-being. Those could decrease the need for users to actively improve their well-being, because technology does so for them (Achterhuis, 1995, p.9).

That does not mean that design for well-being per definition negatively affects autonomy. It depends on design's degree of paternalism: limitations on action, developed with best intents that are perceived as limiting (Spiekermann & Pallas,

2006). There are two types of paternalism. The first, hard paternalism, does not allow for alternative behaviour in design. The second, soft paternalism, does shape action but is open to alternative forms of behaviour. This soft paternalism does not prescribe absolute action but creates the context for sovereign user actions. When design for well-being only shapes action via soft paternalism, it is certainly acceptable and preserves autonomy.

So, design for well-being in itself affects the values of trust, responsibility, freedom and autonomy. Trust improves via the process itself, the value of responsibility changes in content due to design for well-being and freedom and autonomy could negatively become affected, but should be preserved by conscious design for well-being.

## ■ 5. Three days with ViSi Mobile.

I have been wearing the ViSi Mobile device myself for three days. This helped me to experience and understand how the device mediates action and perception. This appendix describes my experiences.

*Am I healthy? How do I have to convert Fahrenheit to Celsius again? Why do people stare at me? And is my body temperature really that high? These are just some thoughts that came to my mind during the past days when I was wearing the ViSi Mobile. A device that could reshape healthcare.*

*ViSi Mobile continuously measures the vital signs; heart rate, pulse rate, skin temperature, respiration rate, blood oxygen level and blood pressure. The device brings along great opportunities for hospitals, that until today, measure patients' data only three times per day manually. ViSi's ongoing data stream allows hospitals to improve their healthcare by better healthcare efficiency, better insight in patient's health and consequently better insight in the development of diseases (Weenk et al., 2017). The Radboudumc is exploring ViSi's possibilities. For that sake I – as a 'healthy' being – have tried the device for three days, the average time patients spend in hospitals.*

**HR: 103**  
**BP: 102-72**  
**RR: 20**  
**spO2%: 99**  
**Temp: 94,9 F**

**11 AM.**  
**Day 1.**

A sensor is attached to my thumb. A big blue adhesive tape ensures its placement. The sensor is connected via a cable to a device on my wrist. The cable follows its way over my arm to a new sensor on my shoulder and then to a sensor on my chest. There the cable divides into three smaller ones connected to stickers on my belly. Once connected, fragmented numbers make their entrance on the display on my wrist. Apparently I am able to see amongst

others my heart rate, body temperature, respiratory rate, blood oxygen level and blood pressure.

There is one pressing question that immediately comes to my mind: Am I healthy? Before being able to ask, I get a question myself. "Do you often practice sports?" I nod doubtful. "I can see that, you have a low blood pressure. But you are sure healthy!", the doctor quickly adds, seeing the frown on my face. Reassured with this confirmation, I smile. Apparently my weekly cycling and running pays off.

When the doctors are gone, I look again at all data and begin to wonder: is my respiratory rate as it should be? And what about that other number, the blood oxygen level? What does it even say? I remember the doctors saying there isn't one 'right' type of data. Yet, that surely doesn't satisfy my questions. There should be one average, desired, level of data, shouldn't there? I take place behind my computer. The thumb sensor obstructs me to type properly. Nevertheless, a few seconds later Google tells me my blood oxygen level is more than average. That is just what I had to know.

Being reassured, I continue working. It doesn't go smoothly because I get constantly distracted by the data that appears on my wrist. Even though I don't know how to interpret the data and, even more, I don't process it at all, it is comfortable to check it once in a while. It gives me a feeling of control to just look at the screen. The device sometimes loses track of some of my vital signs. Especially my blood oxygen level appears to be though to measure. The missing data makes me feel agitated. Knowing it doesn't matter at all, I am inclined to look at the device until it retrieves what's been lost.

After a while, I notice I need a toilet break.

On my way to the toilet all data disappears. My data is lost! Did I break it? Luckily I didn't, because when I stop moving, the device returns to normal and shows again the, now familiar, maze of numbers. It cannot measure properly during physical activity.

Having flushed the toilet, I want to wash my hands. I stop before I open the tap. Am I actually allowed to wash my hands? On the left of toilet's mirror is a poster that shows how to wash hands properly. That is certainly not possible with this device. I decide to wash only my fingertips and make sure no water touches the sensors. For later toilet visits, I know water doesn't damage the device. Still, washing hands is not comfortable, especially because the sensor's fabric cover stays wet long.

When I want to return to my computer from one of my toilet visits, I open the toilet's door. Doing so, the cable from my wrist to shoulder locks behind the door handle and jumps out of the device. It scares me. Again the thought of breaking it comes into mind. But here too, nothing is wrong. I have to be more careful though, I realise when I encounter the same situation twice more.

**HR: 74**  
**BP: 102-72**  
**RR: 24**  
**spO2%: none**  
**Temp: 96,9 F**

**17 PM.**  
**Day 1.**

The office day is over but I still have a long evening in the hospital in foresight. I will first have dinner with a group of people I haven't met yet, after which I need to pitch a story in front of that same big group. During dinner, I see people watching me. We talk, just some polite chitchat. I feel the desire to look at the display often, but contain myself. It feels somehow wrong to be monitoring it so obsessively. When we start with the desert, I observe nobody has dared to ask me about the device on my wrist, as if it is a taboo. It is surely not because the device remains unnoticed. The secret looks of others make me feel sick. Literally. The device becomes a stigmatising apparatus that moulds its carrier into a patient. The device's data shows me I am perfectly healthy – although, that is what I hope it says - but the looks of others make me feel as if I am sick.



2. ViSi Mobile.

A brave individual then stands out of the crowd. He asks me what I am wearing. Relieved by the question, I start explaining. The man reacts enthusiastically. "I am wearing the same!" – and he points to the fitbit on his wrist. I begin to smile and suddenly sickness disappears.

Time passes. Dinner is over and I find myself in a crowded presentation room, nervously listening to the instructions of the pitches to come. The room is very hot, I notice. Unconsciously I look to my body temperature. It has been raised enormously since I entered the room. That confirms my feelings. I begin to compare every small change in my feelings to the objective data on the screen. It satisfies when both match.

Then the time has come. Pitch-time. I walk into the spotlight with a heavy heart. Many faces are pointed in my direction. I start to talk whilst trying to combat my

nerves. When I think I gained control over my nerves, the device on my wrists starts to beep loudly. It scares the hell out of me. The screen is flickering and shows in red: *alarm heart rate too high*. Apparently I hadn't managed my nerves after all.

A few hours later when I am ready to go home, I have to leave behind the ViSi. The battery had to be replaced anyways. Whilst taking off the device, I realise I start feeling insecure. I had worn the device all day long and got used to the confirming data. Slightly unsure, but relieved from the heavy device – my arm actually feels tired of having carried it all day – I go home. At night I get reminded of the device's clips that are still attached to my body. I wake up in the middle of the night of a stitching pain in my shoulder that came up when I turned around. I will have to sleep this night on my right shoulder alone.



3. ViSi Mobile.

**HR: 86**  
**BP: none**  
**RR: 18**  
**spO2%: 98**  
**Temp: 93,7 F**

**7.30 AM.**  
**Day 2.**

The next morning, back in the hospital, I reconnect the device to my body. I am not eager to wear it today again. Although the device is very manageable, it obstructs me in my daily activities. Do I really have to wear it? I decide I should. The average patient has to wear it three days as well.

I meet the brave man of yesterday. He punches me and asks: "Are you still healthy?". I chuckle and touch the screen. My data appears and I answer his question: "Yes, I am still healthy"- although, that is what I think the data says.

During the day, I almost forget wearing the ViSi. I am so busy that I stop looking at the device every now and then. I only get reminded of wearing it, when the alarm goes off again during a small walk outside. It is again my heart rate. The short walk was too much. Should I improve my condition then? Am I unhealthy after all?

The thought of my health and ViSi's presence disappears again and I continue my day. I take off the device when I leave the hospital to go home. Once there, I take a shower. The five sensor stickers are still attached to my body, since I am planning to wear the ViSi for one more final day. But when I enter the shower and the stickers get wet, I decide to take them off. I have worn the ViSi long enough. I got the point. It is a very promising device to monitor patients' health. But since I am not a patient, nor a doctor, the device mostly distracts me. I try to take off the stickers. That is easier said than done. After two days, the stickers have grown to my body. They come off difficult and leave behind a dirty and sticky glue. It is just as if the technology wants to leave its signature: do not forget me. I can change healthcare drastically.

## 6. Actor opinions.

To understand to what extent the redesign of ViSi Mobile would actually bring about better well-being than the original model, the involved actors were presented with a description of the the redesign. Three patients were interviewed and the redesign was discussed during a focus group with three doctors and five nurses all using the technology. This appendix will show the results of the studies.

### Patient interviews.

Three semi-structured interviews were executed with patients wearing ViSi Mobile. All patients were men, aged between 50 and 75. The interviews started with questioning patients' experiences on wearing the device: how often do they check the display, does it affect their feelings of safety and how do they experience their health through the device? The patients decided themselves on what they wanted to share. Consequently, the patients were asked about their opinion on diverse potential redesigns of aspects of the device that would affect them. Aim of the interviews was to gain insight in how ViSi Mobile's redesign would bring about better patients' well-being.

#### Do you check the display?

P1: "This device is just like the internet. You read a lot of things over there. Those often contradict. Then one starts to pretend being a doctor by studying own health. That only makes one anxious."

"The device shows a lot of information. They explicitly asked me not to look at it. So I don't."

"It depends greatly per type of person how often he will check his data and what he will do with it."

P2: "I don't want to turn crazy. I am very aware of my blood pressure and I am always afraid that it is not good. I have the tendency to watch to the display very often. But because I don't want it to make me turn crazy, I try to look at it only a few times a

day. I try to place my trust where possible in the nurses. I trust them for monitoring me and intervening when necessary. But my information certainly occupies me constantly."

"This device is similar to the internet. You turn crazy when you start to find out via the internet what is wrong with yourself. Therefore, I put my trust here in the nurses, not in the device."

"It is very nice to have my own data in hands. But one needs to know well how to interpret that data. They informed me well on that. I have learned a lot already. For example, I didn't know before what the oxygen-saturation was and that you have to measure that via your thumb. Now I know that the average value of 96 is healthy and that the number has actual value."

P3: "I am not interested at all in my own data. I fully trust my bodily feelings. Therefore I haven't checked the device at all yet."

#### To what extent does the device affect your feelings of safety?

P1: "It doesn't really affect my feelings that I am constantly monitored. I only wish to have insight in my own data and I am neutral towards what the hospital does with the data."

P2: "It feels very reassuring that the nurses are constantly checking my health. For example, I went for a toilet visit yesterday. That caused an increase in my heartbeat and the alarm went off. Immediately a nurse came by to check my health. It feels so nice

and comforting that you know somebody is actually constantly watching you and having your back when you might need it.”

P3: “I really appreciate the entire system surrounding this technology. Well, as long as the technology works of course. So far it worked fine for me. The system is very efficient and good for cost reduction of the hospital.”

“I think that the continuous monitoring is not necessary for me. I think that three daily measurements would have been sufficient. But I can imagine that it might be very important for other patients to have monitored constantly their health. Yet, I don’t feel safer by being monitored constantly, because I don’t think I need that surveillance.”

#### **To what extent does the device affect the image of your own health?**

P1: “At home, it is actually of no use to monitor my heartbeat, number of steps taken etc. Yet, still I do it, just for the sake of doing it. I like to keep track of my data. But of course, it is for no real use. Well maybe anticipating a bit.”

P2: “This device affects so much how I see the concept of health. It certainly changes. Well, in concrete terms, this device confronts me with my own vulnerability. Of course I know a bit from biology and anatomy classes of my younger years how the body works. Yet, this device shows how perfectly everything is intertwined and corresponds to each other. These values show how complex and vulnerable everything is.”

“I have always buried my head in the sand. Being in the hospital now, wearing this device, is confronting. I now experience the consequences of living unconsciously. The additional information of this device can make one anxious, but that might not be a problem, because it stimulates me at the same time to live conscious.”

P3: “Well, they discovered via this device that my blood pressure is very low. At first, it shocked the hell out of the nurses. But I

have apparently had a low blood pressure my entire life already, so I don’t have to worry. As long as I feel well, I don’t care about that low blood pressure.”

#### **Redesign**

##### **ViSi Mobile provides patients with healthcare advice**

P1: “Yes, I certainly think that it would be useful when the device would provide patients with advice. I could certainly use that.”

P2: “Yes, I think that the device giving advice wouldn’t do any harm. I think I would listen to it.”

P3: “No, I wouldn’t want to receive advice from this device. I know best myself what is good for me. Besides, I wouldn’t want to receive the advice from a device but from the nurses. But I can imagine that advices would be good for patient empowerment. After all, it is for patients’ own sake. So then it would be nice actually.”

##### **Patients can register their feelings on ViSi Mobile**

P1: “Subjective well-being? Hmm, that is a bridge too far. It would be too much only an episodic view of health and would not provide useful information.”

P2: “I think that it could be nice, that the nurses get additional information when you want them to have it. I could imagine that it is useful.”

P3: “Euhm, so I have to pass my feelings to the nurses via this device? Are people actually able to bear that responsibility?”

##### **ViSi Mobile provides patients with insight into their long-term data patterns**

P1: “I would like to have the data of this device. I already asked the nurses to grant me access. I hope to connect this data to the health applications I am using. *[Patient shows a folder on his smartphone listing at least six health monitoring applications]* I like to have some insight in my health. It is of course totally useless, it does not serve any

end. But still. I like to go for a run and know my step count. I would like to buy a new smartwatch that could measure from now on my heartbeat as well."

"Yes, so I want this data to be send via bluetooth to my smartphone."

"It is a lot of information. This short-term data is actually not that important. I wish to gain insight in my long-term patterns. That could grant me better access in the information and allows me to anticipate on it."

"It is very dangerous to continuously have insight in your data. You shouldn't see your current data, only in hindsight."

### **Patients can use ViSi Mobile at home and gain access to its data**

P1: "I am slightly afraid for doctors. That always increases my heartbeat. I like the idea of wearing this device at home. Then I can have objective measurements that I could send to the hospital myself. That would be nice."

"One should really prevent pleasing and living for the device."

"I already measure my blood pressure at home. Those measurements are connected to 'mijnradboud'. The Sint Antonius hospital does not provide this service."

P2: "It would be very nice to have this device at home. Namely, I am always very concerned about my blood pressure. It would be reassuring to measure my blood pressure at home and to send that information to the hospital. As well, having insight in my long-term blood pressures via an application would comfort me."

"Maybe I will start to use a step counter when I have left the hospital, although I doubt its reliability. I even consider on taking a smartwatch. My brother has already always been very enthusiastic on using those things. I was not in the past, but maybe now I am."

### **The device will include an alarm button**

P1: "An alarm button is sure a good idea. Then all information is clustered in one device. That would be easy and useful!"

P2: "Yes, an alarm button on this device would be a nice idea."

P3: "It is a good idea I think, although I wouldn't need it. But the most ill patients here could potentially greatly benefit from it."

### **The device will be smaller**

P1: "This band on my arm is too loose. *[The patient is constantly wearing a blood pressure band]* It is moving constantly. They told me I have to wear it. I don't mind its size, but it is annoying that it is moving so much."

P3: "This device should be smaller. This one is very large."

"The device should not be placed so close to my wrist. I have a wound here, that was caused by the needle of the infuse. This cable is hurting the wound."

"In the night, the device lights up. Maybe because I toss and turn in bed and thereby accidentally touch the display. I don't like that. It wakes me up."

### **Relatives could monitor your health from home**

P1: "No, I don't think that my relatives at home should see my data. It would only cause worries. Namely, one lacks the explanation of what the data means. When you cannot interpret the data, it only makes you anxious."

P2: "It depends. I would certainly not want all people to be able to access my health. But only my wife, yes that might be reassuring. When she has access to my data, she would certainly check it. But she won't know how to interpret it, which conclusions she can derive from it. So maybe it only makes her worried, which shouldn't be the intention."

P3: "It is not necessary to monitor my health constantly, I am not that sick."

## Focus group.

At the time of the focus group, seven patients were already attached constantly to ViSi Mobile. A focus group with five nurses and three doctors gave insights in hospital staff's opinion on using ViSi Mobile and their evaluations of the potential redesigns. At first, the attendees of the focus group discussed their experiences on using ViSi Mobile. Consequently, they were presented with the potential, for them relevant, redesigns.

### Experiences

The attendees all agreed that so far the implementation of ViSi Mobile went well. They had not experienced yet any worth-noting problems. Most patients simply agreed on wearing ViSi Mobile and indicated they felt safer by the thought of being monitored. There were some minor problems, as foreseen based on previous studies, in ViSi Mobile's large size and weight, inability to sleep on one arm, sensors that did not stick to patients' skin and in showering with the device.

The nurses all agreed on the importance of their enthusiasm and conviction in presenting ViSi Mobile to patients. They indicated that patients normally just bluntly follow their opinions and trust their expertise. Therefore, as long as the nurses carry out their trust in the device, they did not expect patients to be unwilling to wear ViSi Mobile.

The hospital staff then discussed how to deal with ViSi Mobile's information. They pointed out the importance of 'clinical thinking', which is combining theoretical knowledge with gut intuition, to make the best decisions. ViSi Mobile brings about an additional challenge in providing care. Namely, the device's data could contradict with patient's opinion and appearance. The nurses were still trying to get a hang of dealing with these new situations. They studied mostly long-term data patterns of patients to decide on which care to provide. One of the nurses then indicated that ViSi Mobile is just a tool for providing better healthcare and does not provide the absolute truth. All others agreed on that.

## Redesign

### ViSi Mobile provides patients with healthcare advice

Doctors and nurses were enthusiastic about providing the patients with goals to strive for via ViSi Mobile. They believed it would improve the health status of the patient greatly. It would aid them in providing healthcare better. The nurses immediately came with suggestions: "Patients should gain a notification when they are walking to the entrance of the hospital: DO NOT SMOKE!"

### Patients can register their feelings on ViSi Mobile

One of the nurses of the focus group strongly believed that a subjective well-being measure on ViSi Mobile should not be included. Namely, she argued that subjective well-being should be measured by nurses via personal contact. She believed that patients would interact differently with a device than with a nurse. The device would bring about a biased subjective well-being. Another nurse continued on that. She illustrated that her entire job is about understanding subjective well-being of patients. She certainly did not want to delegate this task to a technology, because it would make her job less satisfying. Finally, another nurse liked the feature but stressed that patients should not gain the false expectations that nurses are able to take away negative feelings immediately.

### ViSi Mobile provides patients with insight in their long-term pattern

One of the nurses indicated that some patients might appreciate greatly this feature, whilst others would not know how to deal with it. She believed that not only patients, but as well caregivers at home ('thuiszorg') should be provided with insight in long-term health patterns of patients. That would improve healthcare at home.

### ViSi Mobile can be personalised

The attendees of the target group showed in different ways the diversity in hospitalised patients. One of the nurses explained that some patients get stressed and anxious

when seeing their data, whilst others would want to gain thorough insight in their health. She, and the other attendees, would therefore really opt for personalised ViSi Mobiles.

### **Patients can use ViSi Mobile at home and gain access to its data**

One of the doctors argued that the future of healthcare would be more at home. He sincerely believed in the potential of ViSi Mobile to bring healthcare to home. Patients would then be wearing the device at home and send their healthcare data to hospital's database. This would provide doctors with the necessary information to provide care. The nurses surely as well believed in the potential of providing care at home via ViSi Mobile, to decrease the burden on hospitals. One of the nurses suggested that the hospital would monitor the health of patients at home, and would send the family doctor or another home care agent to stop by the patient in case of emergencies.

### **ViSi Mobile has an alarm button**

All nurses and doctors immediately agreed that an alarm button on ViSi Mobile is a good idea.

### **Patients give informed consent**

The nurses and doctors want all patients to become included in the healthcare system of ViSi Mobile. They do not want to give patients the choice for opting in or out of the system. Simultaneously, they believed that all patients would simply follow up their expert advice and wear a ViSi Mobile when the hospital asks them to. They therefore did not want to ask patients for informed consent on using ViSi Mobile.

### **ViSi Mobile will be smaller**

Based on what nurses had heard from patients, they surely believed that the design should be smaller, less intrusive for showering and sleeping and should have less sticky sensors. Still, they stressed that the size of the device already allows patients to walk around.

### **Relatives can monitor patients' health from home**

The nurses and doctors were not eager to grant access to relatives over patients' health-related data. They feared an enormous extra workload as a result of anxious relatives that will constantly call the hospital to make them aware of minor changes in patients' health.



4. Actors' opinion on using ViSi Mobile.

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Purp

Having a sense of purpose, something that gives meaning to your actions and motivation.