Are the Physiological and Digital Systems Converging?

Exploring the relation between humans and mobile technologies.

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Abstract

The use of information and communication technologies (ICT) is extending at a fast pace, affecting all parts of society, and the everyday life of most individuals. The fast progressing development of mobile technologies (smartphones and their accessories/wearable’s) is creating new trends such as health tracking and quantified self. These mobile technologies can register an increasing number of physiological features, implying that the interconnection between the physiological and digital systems is increasing. This creates a range of new possibilities within health and medical research but it also creates new challenges and the need for new knowledge in how we relate these devices to our bodies. In the psychological perspective, smartphone use is increasing and previous studies imply that these devices are affecting our behaviour, our mental health as well as our cognitive functions. This implies for a need to understand the relation we have to these devices also in a psychological perspective, focusing on emotions and cognition. This study set out to explore the relation between humans and technologies from a systems perspective. The research question involved: How are users and smartphones related in physical and psychological perspectives? The methods used were questionnaires and interviews. The respondents were students in two European universities, who described their experiences of smartphone use, and three doctors (in medicine and biomedicine) that provided interesting aspects in how mobile technologies can be related to the human body from a system perspective.

In a physical perspective the users as well as their physical environments could be described as converging with the digital systems. The need of being connected and have access to all life-spheres at once seemed to be an important driving force, implying that users are dependent on information and a converged life-style. In a psychological perspective, the emotional bond seemed stronger then the actual physical need. The perceptions of smartphones differed, but a common denominator described by both Swedish and Albanian users, was the perception of the smartphone as something with human-like features, comparable to a friend. The last part of the study concerned if smartphones can be seen as a new entity of our own system, comparable to an organ. The result suggests that this depends on the individual use, if the technologies is used to sustain health, the value it provides, and it is also a matter of the users ontological believes. The concept of physio-digital convergence is proposed as a new concept to analyse the development of increasing use of mobile technologies further.

Keywords

Foreword

This thesis is dedicated to my dear grandmother Gertrud “Iron lady” Villius, whom at the time of this writing lies in the hospital. You fostered my curiosity by always discussing with me for ours, everything between heaven and earth, between the world and all the books and thoughts within it. Your strength and ability to raise after every fall will always inspire me. It is also dedicated to my dear inspirer Patrik, thank you for always believing in me.

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“Computers no longer interface with humans—they interact, and the interaction will become steadily deeper, more subtle, and more crucial to our collective sanity and ultimate survival.”

Alan Cooper
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1 Introduction

This thesis has its starting point in the digitalization of society focusing on the rapid development of mobile technology and the increasing interplay between humans and machines.

The use of information and communication technologies (ICT) is extending at a fast pace, affecting all parts of society. It affects not only at the societal and organizational level, but also the everyday life of most individuals (Bradley 2010). The development shows an increased dependency of information (Webster 2006), faster flows of data and an increased interconnectivity (Barney 2004). The increased use of ICT also means an interconnectivity and constant flow of information between different spheres of life. This makes phenomena like work, private life, and social life to converge into one multidimensional life sphere (Bradley 2010). Closely related to Bradley’s thoughts on converging life-spheres, are Floridis (2007) thoughts on the blurring of online-offline world. This is conceptualized as re-ontologizing of the infosphere, the infosphere being the sphere of information and emphasizing the change of the ontology – the very nature of something. Floridi (2007) describes how the boundaries between offline and online are blurring, and he predicts that humans are becoming something he calls “inforgs” a sort of informational connected beings. However, the use of mobile technologies was not as widespread as today at the time of Floridis (2007) article. At that time, connecting to the infosphere was place-dependent and often demanded for a computer, whereas currently people can easily access the infosphere with mobile devices.

The fast progressing development of smartphones and their accessories, such as smart watches and wristbands, is creating new trends and concepts like quantified self; self measuring and health tracking (Nafus & Sherman 2014, Jadad, Fandino & Lennox 2015). According to some of the largest providers of information and communication technologies (Apple 2014a; Apple 2014b; Apple 2014c; Microsoft 2011; Google 2014) we are moving towards a trend where mobile technologies can register an increasing number of physiological features, and connect to the physiological system in a number of ways (Nafus & Sherman 2014, Jadad, Fandino & Lennox 2015) This creates a range of new possibilities within health and medical research, but it also creates new challenges and the need for new knowledge. During history communication and interaction has been a process between humans (human-human). The progressing development with ubiquitous computing and sensor technology enables new ways of interaction and communication between machines and humans (Tan & Wang et al. 2010).

1.1 The study of natural systems and computational systems – relating humans to technology

*Human beings* shall be in the centre of the development development of Information and Communication Technologies (ICT). This was one of Bradley’s (2010) main points, after decades of extensive research on human beings and their psychosocial life environment during the computerization of society. She emphasises in particular the word “human beings” instead of words such as stakeholders and agents (Bradley 2010). Bradley (2010) also developed the Convergence model that describes the on-going changes in society focusing on the increased use of ICT. What is more, she points out that cross-disciplinary research is crucial to take advantage of the on-going changes in the society.
One standpoint behind the current study is that in order to understand the development of mobile technologies and to put us as human beings in the centre of it we need to increase the understanding of what these technologies mean to us as humans.

Floridi (2007) provides a useful and insightful contribution to this fast evolving area and he discusses the societal development with increased use of ICT and interconnectivity at a conceptual and philosophical level, describing how the boundary between the offline world and online world is disappearing. The use of digital technologies is, according to him, re-ontologizing the infosphere. The first concept expressing how the very nature of something (the infosphere) is evolving. The concept of infosphere involves the whole information environment (internet being just a sub-region). Examples of this transmission are the decreasing friction of information, the blurring lines between offline and online spheres, and the convergence between the processor and the processed. What is more, Floridi introduces the concept of inforgs which implies that the development of technologies and digitalisation of society changes not only the society, but also the development of humans. We are on the verge of turning into connected informational organisms. To sum up Floridi’s main points, what we should look for to define if we are living as he predicted, is aspects of the infosphere becoming increasingly synchronized (time), delocalized (space), and correlated (interactions). He also mentions being connected to the infosphere more then 8 hours as a magical limit. (Floridi 2007).

Bradley’s (2010) thoughts on converging lifespheres as well as Floridi’s (2007) descriptions of the re-ontologizing infosphere imply that the environment around us is changing due to the digitalization. Further on, Floridi’s (2007) concept of inforgs implies that the very nature of humans might be changing, not in the perspective of how we look but how we act in our environment. This might be seen as a re-ontologization of man. One way of studying this ontological perspective is to use a system-based approach to explore humans and technologies in relation to each other. Systems theory focuses on explaining the nature of things (entities), how they act and their relation in a greater context (Bertalanffy 1973; Reynolds & Holwell 2010), and it can thereby be suitable to study the relation between humans and mobile technologies. It is also applicable in the situation of interaction between humans and technology since we both might be analysed as systems; humans as natural systems (biological/physiological) and technology as computational or digital systems. 

Bertalanffy (1973) founded the systems approach in the mid 1900s as a way of unifying different scientific fields. His theory was named General System Theory (GST). This theoretical approach has also developed and branched (Reynolds & Holwell 2010). Bertalanffy (1973) argued that this approach, studying entities as a part of a system instead of separated units, could be applicable in a range of different fields from biology, technology to social sciences (ibid). Similar thoughts and the strive to unify different fields of science when studying different kind of systems have driven researchers from different fields through the years (Navlakha & Bar-Joseph 2011). The similarities between computational and biological systems has inspired researchers for decades, and has made natural systems an important role model for the development of computer systems (ibid). Navlakha & Bar-Joseph (2015) advocate for increasing the amount of interdisciplinary studies that connects computer systems with the study of natural systems, to the advantage of both biological insights and computational thinking. They further argue that these type of studies might provide better understanding to why systems act as they do (ibid).
Navlakha and Bar-Joseph (2015) further argues for more bi-directional studies relating biology to computational/digital systems. However, they discuss the systems approach and the relation between natural systems and digital systems from a computational perspective. Within different fields of research there are different approaches that relate humans to technology, but most of them focus on the possibilities or the effects of interaction rather than the relation. Specifically, there is a lot of research from the last few years that describe smartphone use and its implications, both in physical and psychological/behavioural perspectives.

*The physical perspective* in previous research includes effects on the human body as a consequence of extensive use of smartphones, including negative effects such as musculoskeletal symptoms (Borelo and Wells et al. 2011) and effects from radiation on nerve cells or organs (Salford & Brun et al. 2003; Huber, & Treyer et al. 2002).

There is also research describing the health benefits of using mobile technologies related to smartphones. Studies in this area include how mobile technologies containing sensors might be used to manage your body and keep track of your physiological information. Examples are health tracking and diagnostics including the popular so-called quantify self movement where private persons with the possibilities of mobile technologies can keep track of vitals and manage their health in new ways (Nafus & Sherman 2014, Jadad & Fandino 2015). Some studies also investigate the possibilities of tracking contagions (Lee, Nah & Choi 2015; Freifeld & Chinara et al. 2010). This includes the upcoming field of participatory epidemiology where users can be more actively involved in public health reporting by the use of mobile technologies (Freifeld & Chinara et al. 2010). Later studies also involve possible health benefits from using mobile technologies in a supportive way to increase social equity in health perspectives or during recovery from a range of diseases. Such studies are conducted by Kaplan 2006, Milošević & Shrove et al. (2011), Boulos & Wheeler (2011), Patrik & Griswold et al. (2008) among others.

*The psychological perspective* describes issues such as obsessive use, pathological use, dependency and cognitive problems (Lee & Chang et al. 2014; Harwood & Dooley et al. 2014; Lin, Yi-Tsuan & Qiao lei 2015; Xi, Watanabe & Qingbo 2011). Harwood et al. (2014) published an interesting study relating the constant interconnectivity humans have with their mobile technologies to mental health issues such as depression, anxiety and stress. The result of this study suggested that it was the nature of the relationship a person has with their smart-device that is predictive of psychological disorders, rather than the amount of use (Harwood et al 2014). Walsh, White & Young, (2010) further argued for separating frequency of use (quantitatively measurable) from the involvement with the phone, described as the psychological relationship. The latter involves both cognitive aspects (thinking about the phone) and behavioural aspects such as keeping it close, being very aware of where it is, checking it compulsively and get anxiety if immediate responses (to messages etc.) is not provided (Walsh et al., 2010). The cognitive approach to human-smartphone interaction is also studied by Barr, Pennycook, Stolz and Fugelsang (2015) who describes the effects on cognition. Their findings include that smartphones are used as an extension of the mind, and that people are relying on the Internet (by their phone) when solving demanding problems. They argue that people are transferring their thinking capabilities to technology, and this type of meshing of mind and media is important to encompass when trying to understand human experiences and cognitive perspectives in the modern society. These studies and
the strong relation humans have to these devices indicate the need to further investigate
the relation between humans and technology.

Except for the aspects of dependence mentioned above, not much seems to be written
about human-technology relation, and the studies provided focus primarily on the
effects - on the body or the mind and behaviour. What is more, there seems to be a lack
of research with a holistic approach to the human-technology topic, i.e., studies that
explore the relation including both body and mind. The extensive effects and influence
over behaviour as well as physical well being, motivate further research and the need to
problematic the relation people have to these technologies. To better understand the
relation users have to their mobile devices could also shed some light on the use and
interaction. And why these small devices have such power over humans and their
behaviour, thus the significance of mobile technologies in the contemporary society.

1.2 Purpose and research question
The purpose of this study is to explore the relation between humans and technologies
from a systems perspective. By using General System Theory as a theoretical
framework to analyse the relation between mobile technologies (computational
systems), and humans (as natural systems and living organisms) this study aims at
improving the understanding of our relation. However, the level of analysis is not the
computational functions but the relation between the users as physical beings as well as
their mind, i.e. the psychological part of the relation. The latter involves both
behavioural and cognitive aspects, how we act as users and how we understand and
relate to technologies. Human-technology relation is here studied in the context of
smartphone-use.

The research question is:
How are users and smartphones related in physical and psychological perspectives?

By exploring this area, the aim of this thesis is to provide concepts and new
perspectives that can be used to analyse and discuss the complex phenomenon of the
increasing human – technology interaction and its implications. An additional aim is to
provide a frame for analysis which supports reflections and critical thinking on this
issue.

1.3 Focus and delimitations
This thesis focuses on the relation between humans and mobile technology from a
physical and psychological perspective.

Physical in this context focuses smartphone use, and the tangible part of the
relationship. This involves the physical use in aspects of time (frequency of use), space
(interconnectivity) and relation to the human body (physiological system). Use in a
health perspective is included here and briefly discussed but is not in focus.

The psychological aspects might also be described as user involvement in line with
Walsh’s (2010) thoughts. This involves users emotions and cognition (how they
perceive their smartphones). The users behaviour in relation to their smartphones is also
defined by Walsh (2010) as a psychological aspect, however, in this thesis it is also
related to the physical side –how the practical use is expressed.
Thereby the physical and the psychological aspects are not separated, but seen as two intertwined dimensions of the same phenomenon – the relation between humans and mobile technologies. The view on human beings as a system (sometimes described as a physiological system, or a living organism) also includes both these sides. The human body/the physiological system describes humans in the physical world. The mind/psychological side is not separated from the body, but seen as a part of it (the mind is thereby included in the term physiological system).

The term Mobile technologies focus on smartphones in the present study. But related wearable technologies, (also described as accessories that connect to the smartphone) are also briefly discussed. Such examples are smart watches, wristbands, and other sensor technology that can be used together with the phone.

1.4 Target audience
The target audience for this thesis are those interested in the development of mobile technologies in relation to human beings. Primarily those interested in technology/systems science or informatics in relation to humans and their health. This study might also be interesting to people active or interested in the natural sciences such as biology/physiology/medicine, or psychology and human behaviour in the modern society.

The abstract and philosophic nature of this study makes it interesting for those who search food for thought and appreciate philosophy, problems of ontology and metaphysics, and applications of conceptual systems thinking.

1.5 Disposition
This thesis is structured into six main chapters:

1. The Introduction
This chapter starts broad by describing the context (the societal development), and narrows down to the research problem and the focus of the study. It includes a general description of the theoretical framework, as well as a review of previous research and how this study can contribute to the existing research. The chapter ends with the purpose, the research question and the focus of the current study.

2. Philosophical and theoretical framework
This chapter describes the worldview and philosophical assumptions behind this study, and the theoretical framework of Systems theory. It further explains the specific theoretical concepts used in the study, how these are to be used, and how these concepts are related to the framework of General System Theory.

3. Research design and methods
In this chapter the worldviews and paradigm is embodied in the choice of design and methods to explore the research problem. The methodological choices of how and why are explained and motivated, and the use of interviews and questionnaires is described. In some cases suggestions on alternate approaches are made.

4. Empirical findings
This chapter involves the empirical findings from two different groups. The largest group was the users - consisting of both Swedish and Albanian students. They were
approached to gain more insight into the user patterns (the physical aspects) within this subject, and the users’ own thoughts on their relation to their smartphone. The findings are presented in themes, where relevant data from both questionnaires and interviews are merged.

The second group consisted of a biomedical doctor, a pathologist, and a former orthopaedic surgeon (shortly referred to as the doctors). They provided insight in how to relate mobile technologies to the human body, both as physical systems and conceptual systems.

5. Analysis and discussion
In this chapter the empirical findings are analysed and discussed in relation to the theoretical concepts presented in previous chapter.

6. Conclusion
This chapter starts with a short summary of the research problem, the research question and approach. It ends with the conclusions, explaining the findings of the study and answering the research question. A few proposals on further research are also included in this chapter.
2 Philosophical and theoretical framework

This chapter provides an overview of the philosophical framework and the theoretical concepts that provides the framework of this study. The theoretical framework in this thesis is System Theory, focusing on von Bertalanffy’s (1973) General System Theory (GST). Other concepts include inforgs and re-ontologizing of the infosphere by Floridi (2007), and The Convergence Model by Bradley (2010). These concepts are described and put into a context, and it is explained how they are applicable on this problem area. The chapter starts by describing the worldview that founds this study, and then goes on with explaining the relation between the theoretical concepts.

2.1 Worldview and paradigm

The ontological beliefs of positivism involve a physical world outside of human minds, available for study. This stands in contrast to social constructivism and interpretivism, which see reality as a construction and not something objectively measurable. In these matters research can be seen as a reflection of the time in which it was produced, including its social values and believes (Grönmo 2006). Post-positivistic approaches, developed after positivism, challenged some of positivism’s absolute ideas and opened up for both qualitative and quantitative research design. Post-positivists are not as absolute in the claims of absolute objectivity as the classical positivists, but rather acknowledge the notion of some subjectivity and do not produce absolute truth claims (Creswell 2014; Guba & Lincoln 1994). The basic assumption underlying this study includes the ontological beliefs of post-positivism that acknowledge a physical real world available for study. A basic idea underlying this study also includes the ontological beliefs that however objective the physical world might be, social reality is less objective and open to interpretation. These beliefs descend from my background within the social sciences.

2.1.1 Critical realism paradigm

Guba & Lincoln (1994) describes paradigms as “basic belief systems, based on ontological, epistemological and methodological assumptions” (Guba & Lincoln 1994, p. 107). In their handbook of qualitative research they discuss four main paradigms, Positivism, Post-positivism (critical realism), Critical theory and Constructivism. But as Myers (2007) describes it, there is considerable disagreement if all paradigms are necessarily opposed, or can be combined within the same study. Smith (2006) also argues for developing this discussion within the IS field. According to him IS research conducted within the classical paradigms, with technological determinism and social construction of technology seen as opposites, has a shortcoming in it’s theory-practice inconsistencies. Smith (2006) proposes Critical realism as a paradigm to overcome this ontological gap within IS studies, and explains that this approach provides more explanatory power. “Consequently, it is a powerful logical argument for accepting this new conceptualization as an improvement upon the former.” (Smith 2006, p. 1).

The worldview that founds this thesis is in line with Critical realism, which is the chosen paradigm of this study. Within this paradigm, the researcher’s ontological beliefs acknowledge the existence of an objective world, but this world is not fully comprehensible. Guba and Lincoln (1994) describe this approach as a modified objectivism, which is an ontological belief in an existing reality, but this reality is only “imperfectly apprehendable because of basically flawed human intellectual mechanisms and the fundamentally intractable nature of phenomena” (Guba & Lincoln 1994, p.110).
Sayer (2004) describes how the language and concepts we use to study, create the meaning of the phenomena under study. However, researchers and their respondents do not create the reality (as in constructivism). Thereby the present researcher is not fully separated from the phenomena under study (as in positivism), and acknowledges the importance of understanding the language and concepts used to understand it. Critical realism thereby does not clearly separate explaining from understanding but strives to understand both one self (by clarifying philosophical assumptions and concepts) and the meaning of the object under study by thematizing and theorizing (Sayer 2004; Stoehrel 2007). In line with this paradigm, and the abstract nature of this problem, a strive in the present work is to thoroughly describe and clarify the philosophical framework and the theoretical concepts that underpin this study.

2.2 Ontology - the nature of things and their relation

Ontology deals with the true nature of things, their relations, and the study of their existence. It is connected to the simplified concept of worldview often used in philosophy of science, since it includes the dimension of beliefs (ontological commitment) and definitions of things (Smith & Mulligan 1982). Here, the concept is used in a broader definition (which includes worldview but is not limited to it) in line with Stanford Encyclopaedias’ description, as a philosophic area discussing the existence of things or entities in the world, and ontology also deals with problems concerning the most general features and relations of these entities. This definition relates ontology to logic and also meta-physics (Stanford Encyclopedia of Philosophy, 2011). The present study relates to these ontological questions, since it discusses how to define and study our entities, such as our wearable digital artefacts, and the relations we – as humans we might be seen as another entity, acting in the physical world – have to them. The physical and digital/online world are examples of different world spheres and different kinds of existence. And how we define us as humans, the artefacts we use, and the relation between us, is partly an ontological discussion. How to approach ontological problems, and which questions to ask is another area within ontological philosophy, often described as meta-ontology (Stanford Encyclopedia of Philosophy, 2011) Using the theoretical approaches provided below is a proposal for how to approach this problem area.

2.3 Theoretical concepts

The theoretical framework in this study is Systems Theory, focusing on concepts brought by General System Theory (Bertalanffy 1973). Other concepts, also used in this study, are chosen since they are perceived as holistic and applicable in system thinking (researchers interpretation). These include the concepts of Convergence (Bradley 2010), Inforgs and Infosphere (Floridi 2007). These concepts are also chosen due to their explanatory power when dealing with ontological questions, such as how to define the world around us and the entities within it, and how to grasp relations that crosses different world spheres. They provide useful approaches and concepts when discussing how to define and study the context in which entities of the physical and digital world spheres meet - the interactions and relations between these entities, and how to conceptualize and describe the nature of these entities.

Common for the chosen theoretical views is also that they are seen as holistic, practicing different dimensions of Systems thinking (researchers interpretation), and presents useful contributions in their way of uncovering patterns and processes relating humans to the surrounding world. Hence, the use of these theories is due to the Critical
realism paradigm of this study. How these concepts are used within a systems theoretical approach is described in the last section of this chapter (2.3.4).

2.3.1 Systems Theory - studying the relation between entities

The use of concepts such as Information Society (Dahlbom 1996), ICT Society (Bradley 2010) and The Network society (Barney 2007), focuses on describing the process of increased interconnectivity and flows of information, where societal institutions and individuals are compared to nodes in a network. This connects to Systems thinking and Systems theory (as described by Bertalanffy 1973), which emphasizes the need to grasp the whole context, instead of studying entities separately. To study phenomena in the increasingly interconnected society, Systems theory could thereby provide useful concepts for analysis. Systems theory focuses on the relations between entities and how they act in a greater context (Reynolds & Holwell 2010) and could therefore be a suitable framework for analysing the relation between users and their mobile devices. In this thesis Systems theory (focusing on General System theory) is used to define the different parts (entities) involved in the problem, how they interact and what this implies about the nature of their relation. In this case humans and mobile technologies are the entities in study, and Systems theory offers a way to understand their relation on an ontological level.

2.3.2 General System theory

In the early nineteenth century, different scientific fields developed separately from each other and the methodological traditions were defined by narrowing down the area of study to a small entity, studied in isolation. As a reaction to this reductionist view of the world, Bertalanffy argued for the need of a theory useful in different areas of science (Reynolds & Holwell 2010). Bertalanffy described that the same principles is applicable for systems in general, independent of subjects, functions and driving forces. He claimed that it is irrelevant whether it concerns biology, physics, information or social systems. “General System Theory” (GST) was introduced as a discipline suited to analyse all kind of systems, and the essential approach was that entities should not be studied in isolation, but studied as a part in its natural environment. Bertalanffy argued that the surrounding environment or ecosystem, affected the functions of separate entities, so studying them separately would not be as interesting as studying them in their environment (Bertalanffy 1973). He defined system as:

“a Set of elements standing in interrelations. Interrelation means that elements, P, stand in relations, R, so that the behaviour of an element P in R is different from its behaviour in another relation, R’.”

(Bertalanffy 1973, s 55-56)

Bertalanffy (1973) further describes how a general definition of systems might be ”sets of elements standing in interrelation” (Bertalanffy 1973, p. 38), but also describes that this definition might seem vague at a first glance. However, he argues that different conditions might be found in different ‘families’ of systems, explored by mathematical reasoning. This approach also contributes in clarifying the properties and relations within systems – both in general and in specific cases. Systems theory is according to him (ibid) described as a theory of interrelations. Further on, Reynolds & Holwell (2010) also describes how conventional thinking (in contrast to systems thinking) might be counterproductive in the way that we isolate separate events, situations and components, and thereby miss the big picture. General System Theory, might be seen as a “hard system theory” within the area of Systems Thinking (Reynolds & Holwell...
In contrast there is, for example, Soft Systems Methodology, developed by Checkland (Checkland 2011). This stands in contrast to the earlier more positivistic view on systems, derived from physiological and biological comparisons (Reynolds & Holwell 2010). Checkland thought that Systems Thinking could be developed not only to explain the physical world and its entities, but as a pattern of thought - a constructivist way of thinking. The Soft Systems approach focuses on how to take action to analyse and improve situations, rather than solving them (Checkland 2011).

Bertalanffy, who was a biologist, applied what might be called an organic view on systems (Reynolds & Holwell 2010). This approach to entities and relations in different kinds of environments or worlds (physical, information, social etc.) might also be seen as a holistic view, making the context essential to grasp a phenomena. The new approach brought by systems thinking is also described as a "system philosophy" in the aspect that it involves a” re-orientation in thought and worldview” (Bertalanffy 1973, s 21). He describes this as a focus on a broader scope, and more on the ‘general’ and whole picture, in contrast to older approaches with mechanistic and causal focus on entities. Bertalanffy (1973) further describes how this meta scientific and philosophical aspects of GST is applicable on different type of systems (making it very general), but also includes an aspect of ontology - systems ontology. When studying entities from a systems perspective, the first step is to define what we mean by system – i.e., the nature of the system from an ontological perspective. Such examples could be real systems (physical) and conceptual and abstracted systems, the latter constructed by mental factors as perception, or social reality. There is however no clear difference between these types of systems, since definitions of physical systems also depends on the conception of the observer (ibid). These viewpoints relate Systems theory to Critical Realism and the post-positivistic traditions rather than classical positivism (present researchers interpretation) with its claims of objectivism and reductionist traditions. In the context of this thesis, both real (physical) and conceptual systems are discussed.

Systems theory offers a number of approaches that can be applicable to analyse the complex and many dimensions of this theme. And it also provides a framework for how to define us as humans and the digital systems that we use, thus the relation between us.

2.3.2.1 Open and evolving systems – defining the human body
Bertalanffy (1973) defines organisms as open systems, open in the sense that they can exchange materia or information with the environment surrounding them. In this process, open systems are constantly evolving by the exchange with the environment. He further describes organisms (such as humans) as physical and open systems. Bertalanffy (1973) describes equilibrium principles as an important explanation of physiological processes, i.e., physiological processes aim at increasing the equilibrium. Equilibrium is also called steady state or homeostasis by Bertalanffy (1973) and is described as a state of complete balance. However, since physiological systems are open and dependent on exchange with the environment, the whole organism could never be in a complete state of equilibrium (only parts of the system). If an open system stopped the exchange with the environment, it would not be developing and thereby the system would be dead. Thereby the state of balance in open systems is described as a quasi steady state (ibid).

In physiological systems, the processes that supports equilibrium are mainly of two types:
1) autonomic processes within the physiological system such as automatic movements of organs or electrical movements in the nervous system; and
2) reactions to stimuli in the environment. Changes in the environment cause fluctuations in the steady state of the system. Thereby, the organism (physiological system) must adapt to the environment to obtain equilibrium. This is a general principle of how open systems behave (ibid).

Bertalanffy (1973) describes how GST is applicable when studying biological/physiological systems, behaviour (within psychology), and social systems within sociology and other social sciences. However, he describes human behaviour as more complex than only striving for equilibrium. Stress, curiosity, creativity and other phenomena could not be defined as only striving for steady state.

In this thesis the human system is defined as a biological/physiological and open system according to the descriptions above. There is no separation between body and mind in this thesis, the nervous system and the reactions of the human mind are seen as a part included in the physiological system. This is also due to the present researcher’s worldview of Critical Realism (see 2.1.1), believing that the human mind is not a mysterious untouchable phenomena, but a product of biology, even though it is not fully comprehensible today. I.e. in theory the mind could be broken down into measurable electrochemical signals,

The parts/entities of this system (the parts of the human body) will further on be described as ‘organs’ according to the inspiration of Bertalanffy and the biological field.

2.3.3 Convergence - how our digital artefacts are affecting our life spheres
A range of different research fields describes the increased use of ICT and how it affects the society and the life of individuals. An important contribution in this area is made by Bradley (2010) whose research focuses on the effects of computerization on humans and society. Her work also describes the effects on human beings and their life roles, as the use of ICT increases. Further on, Bradley (2010) describes how the increased interconnectivity and constant flow of information between different areas also called spheres of life are making them merge into each other; i.e., spheres, worlds or ‘areas’ being the different spatial and/or psychological roles people take on during different aspects of life, such as work life and private life.

At work people might interact with friends or family due to the use of ICT, and at home people are logging into work systems, checking emails and actively interacting with the work sphere. Bradley (2010) has studied and described this development, and also discusses how it might affect societal structures by increased globalisation and competition; also how it might affect individuals, for example related to stress issues. The extended use of ICT increases the flows of information between the different worlds, or spheres that we live and act in, making the line between them steadily disappear. Bradley argues that this makes phenomena like work, private life, friends and hobbies converge into one multidimensional life sphere (Bradley 2010). This insight led to the development of the Convergence model, which describes the convergence of different life spheres supported by the use of ICT. The model includes four levels of analysis - the individual users, the community, the organisational, and the societal levels. She also mentions the social and psychological levels, and how convergence (the process of merging towards a common content) might affect individuals, for example related to stress issues. An important point by Bradley (2010) is to focus on the human
beings. She argues that ICT must be developed for humans and put them in the centre of development (ibid).

2.3.4 Inforgs and the re-ontologizing Infosphere - how information is becoming our ecosystem

Floridi (2007) describes in his article “A Look into the Future Impact of ICT on Our Lives”, that we (by the time of the article) are used to log in and out from the space of information, but this separation between offline and online are soon to disappear. He discusses the societal development with increased use of ICT and interconnectivity, at conceptual and philosophical levels, describing how the boundary between the offline world and online world is disappearing and that these worlds are blurring. He predicts that the digital world is merging with the analog world and the ‘infosphere’ is rapidly ‘re-ontologizing’. The ‘infosphere’ is the sphere that contains the whole informational environment, its entities, agents, their properties, and the interactions and relations between them. It differs from cyberspace (which is a subunit in the infosphere) by also including the offline spaces of information. ‘Re-ontologization’ is another concept that Floridi presents, i.e., a neologism that describes a radical form of transforming something to the point that its basic nature changes. This development is according to Floridi (2007), due to the convergence between the digital resources and the digital tools. Floridi argues that in the re-ontologized infosphere, the available ICTs (such as databases, software, protocols, information channels etc.) is now not only compatible with, but also the same “as the ontology of their objects” (Floridi 2007, p. 60). Floridi (2007) connects the re-ontologized infosphere to Turing’s thoughts, as a state where “there is no substantial difference between the processor and the processed” (Floridi 2007, p. 60) and the digital devices seamlessly computes the digital data. This diminishes the ontological friction, which could be defined as the amount of work needed to process data.

Floridi (2007) mentions nanotechnologies and biotechnologies as something that helps re-ontologizing the infosphere, and further mentions Internet of things as an upcoming change where physical worlds entities become interactive with the environment. This is connected to the emergence of IT entities, described by Floridi (2007) as objects that containing tags/ microchips providing them with an identity and enabling connection to other online artefacts. These IT entities will be able to interact by communicating, learning and advising. Floridi (2007) exemplifies by mentioning that music players soon will be able to give recommendations based on the music the user plays.

Floridi’s basic claim is that:
“Digital ICT’s are reontologizing the very nature of (and hence what we mean by) the infosphere, and here lies the source of some of the most profound transformations and challenging problems that our information societies will experience in the close future, as far as technology is concerned.” (Floridi 2007, p.60)

Further on, he argues that we are on the verge of turning into connected informational organisms, and founds the concept of Inforgs. To define an inforg Floridi (2007) describes a few aspects, a sort of checklist that might be used as empirical evidence that his predictions of inforgs and the merge of the digital and analog worlds, are actually happening. These points are describing different aspects of interconnectivity, and are defined by Floridi (2007) as follows:
Stay connected >8 hours. If you spend more time online than sleeping, you are an inforg according to Floridi (2007).

Google in real life- when we can use a search engine to locate objects in the household, the office or other physical environments. This signals the emergence of IT entities, and the disappearing line between online and offline.

Children of the computer age. As people that grew up with computer games grow older, the amount of people and the age line for those playing online increases. By the time they retire, online players will be living in the infosphere full time (Floridi 2007).

Economy of virtual assets. By the time of Floridi´s (2007) article, the selling/buying of virtual assets (such as game stats. in World of Warcraft) is still not legal. He does, however, point out that sites such as e-bay shows thousands of virtual assets for sale. One example is a High ranked druid (game avatar) at a price higher than the value of a computer needed to access that information (Floridi 2007).

Floridis descriptions of inforgs provides a useful basis for interview questions, and what kind of empirical evidence to look for when discussing the emergence of inforgs. However he studied the societal development from another dimension - the offline and online spheres. The increased use of mobile technologies, sensors and wearables, was not as widespread at the time of Floridi’s (2007) article. To sum up, Floridi’s checklist for empirical evidence, what we should look for is if we are living as he predicted. According to his predictions, we shall be living in an infosphere that will become increasingly synchronized (time), delocalized (space), and correlated (interactions). These aspects brought by Floridi (2007) were used as an inspiration when constructing interviews and questionnaires to the respondents.

2.3.5 Application of theoretical concepts

The concepts provided by Bertalanffy’s (1973) GST is useful when defining the different entities of the problem (humans and mobile technologies), and understanding their relation. However, other concepts could provide value in understanding the societal as well as the philosophical context. The concepts provided by Bradley (2010) and Floridi (2007) are here described in relation to the systems theory approach.

Bradley’s (2010) Convergence concept is useful for understanding the societal context and how the development of ICT affects human beings. The concept of convergence is thereby an essential theme in this thesis, and is used to analyse the problem on different levels, such as the convergence of life spheres and what this implies for the users’ behaviour. In a systems perspective, the convergence between lifespheres that Bradley (2010) describes, is seen as a change in the system environment; lifespheres is here translated to the different environments humans act in. It is also a way of studying the relation between humans and their technologies when studying them as systems interacting. Convergence between systems could in this perspective be described as a process where the system boundaries are blurring or disappearing. Floridi’s (2007) thoughts on the blurring between the physical and online world and the weakening ontological friction are related to this process.
Floridi’s (2007) thoughts about infogs could be described as a state when the human being is connected to the infosphere (the largest digital system) to a point where humans are becoming semi digital and living in the infosphere (connected) all the time. In a system perspective, the concept of infogs is also related to the thought on evolving systems. The infosphere can in a systems perspective be seen as the greatest system of information. In this context the primary focus is on the Internet. When the lines between the offline and online is blurring the ontological friction is disappearing as Floridi (2007) describes, and the digital devices seamlessly deal with the digital data. In such a state we will be living in the infosphere/ the digital systems all the time and our physical actions will have digital representations.

Floridi also contributes to the problem of this thesis by providing an interesting background to the philosophical issue (are we humans or semi-digital creatures?) and to proposals on how to study this empirically. His thoughts have also inspired the research question.
3 Research design and methods

In this section the worldviews and paradigm is embodied in the choice of design and methods to explore the research problem. Within each section, the methodological choices of how and why are explained and motivated. They are also critically analysed, thus, in some cases suggestions on alternate approaches are made.

3.1 Research design - Critical multiplism with a qualitative focus

The Research design in this thesis could be described as Critical multiplism with a qualitative focus. In this study it was performed by a triangulation of methods, using questionnaires and interviews. Guba and Lincoln (1994) describes the methodological traditions within post-positivism/ Critical Realism as emphasizing on Critical Multiplism, a new type of triangulation that involves collecting data by different methods. Critical Multiplism also strives to collect more of the situational data, allows discovery and iterative processes (similar to hermeneutics), and thereby further differs from the strict deductive scientific process that focuses on verifying or falsifying hypothesis. Guba and Lincoln (1994) also describes that this paradigm expands the use of qualitative methods and emic viewpoints to contribute to the understanding of “the meanings and purposes that people ascribe to their actions” (Guba & Lincoln 1994, p. 110). Related concepts are multiple or mixed methods (even though these concepts are often associated with the use of both quantitative and ‘pure’ qualitative methods, while this thesis focus mainly on the qualitative side). Creswell (2006) describes different strategies within mixed methods, such as Convergent parallel mixed methods, where the researcher collects different types of data at the same time, and then converges the data into an interpretation of the overall result, providing a richer understanding of the problem. This strategy is used in this study, where data from questionnaires and interviews are combined and the results from these are merged into joint themes.

3.1.1 Qualitative versus quantitative approach

This study is an example of multiple methods used to explore a phenomena by studying it from a wider approach. Since the data contains both qualitative and quantitative properties, inspiration is brought from plenty traditions. But if it is to be narrowly defined, this study would be defined as a qualitative study, since the data-analysing process involves interpretation and the creation of themes. The qualitative approach was chosen due to the exploratory nature of the thesis topic and its aim to better understand the meaning of a phenomena as experienced by the selected people. The chosen approach might be more subjective, but a strength with qualitative focus is according to Grönmo (2006) that qualitative methods gives greater explanatory power. However, the qualitative focus is not completely clean; some of the data is of quantitative nature, containing numerical properties in order to study patterns of time, space and other quantifiable amounts. It also includes both open-ended and closed-ended questions. But it is important to emphasise that this study does not set out to create statistics, merely explore and discuss by providing different approaches.

Proposals on alternate methods to investigate the problem might be to use quantitative and experimental methods, for example by studying the functions of the smartphone and its connection to the user's body, and compare it to the functions of the body. This might be measured in quantitative amounts of data-transfer, feedback mechanism or similar quantities. However, the aim of this thesis is not to study functions of the smart phones in comparison to the human body, but to holistically explore the relation between
humans and technologies, in the context of smart phone use. Therefore, such an approach would not be suitable.

Checkland and Holwell (1998) describe qualitative, interpretative methods developed as the best available solution in lack of better measuring instruments. But the flexible and iterative process contributes to the possibility of deeper understanding and refinement of methods within every specific project. These methodologies have an important role in most of the social sciences, and with a clear description of the epistemological beliefs and the methods used in the process, some transparency can be achieved. If the researcher thoroughly describes the framework and context in which the results are produced, some generalization might also be possible from qualitative studies. (Checkland & Holwell, 1998). One aim in this thesis is thereby to thoroughly explain and clarify the philosophical assumptions and considerations that underpin this study.

3.2 Data Collection

The methods for data collection in this study are interviews and questionnaires. More specifically semi structured group interviews, unstructured individual interviews, and questionnaires were used. These were chosen due to the purpose of the study and also connected to the present researcher’s worldview and the critical objectivism paradigm, where multiple methods are seen as a strength (see 3.1) The choice of these methods might be seen as a weakness, since people might say one thing and do another, but by interviewing a greater number of respondents from different cultures and different professions, the researcher strived to increase the validity. Thus, using methods where the respondents can describe their experiences were motivated by the possibility to gain a greater amount of data, not dependent by time and place, and thereby take part of the respondents experiences from a longer time. In contrast, observations would not provide data based on respondents’ descriptions of their experiences.

The data in this study consists of both qualitative (such as users thoughts) and quantifiable aspects (such as frequency of use). A proposal for alternate approaches it to pose the same questions to a larger population, and statistically analyse the result to increase the possibility of generalizing the results.

The respondents in the study were divided into two groups, the ‘users’ and the ‘doctors’. These groups were chosen to gain information about both the psychological side of the relation (thoughts, emotions and cognition) by investigating experienced users. And to gain more insight in the physiological perspective - how these technologies can be seen in relation to the human body. Thereby this study set out to explore the phenomena in a wider context, aiming at creating a more holistic understanding.

The users were 46 students from two countries that first answered the questionnaires. About half of them (27 students) took part in interviews that followed the questionnaires. This studies took place face-to-face in a teaching environment, at two different universities in Europe - Sweden and Albania.

The other group of respondents was the doctors/ biologists (described as ‘doctors’ in this thesis) a total of three persons that were interviewed by unstructured individual interviews. Unstructured interviews is described by Grönmo (2006) as interviews without pre-defined questions and carried out more as a discussion.
3.2.1 Sampling
The choice of two different respondent groups (users and doctors) was to gain a more holistic understanding of the phenomena. The users could contribute with their experiences, and the doctors in relating these technologies to the human as a living organism. Students were chosen as respondents to the user group. This was a choice of convenience since they were easy to access and it was also possible to interview them in groups. The choice of students was also due to the fact that most of them are young, which made them more probable as users of smartphones or accessories. No specific individuals were chosen, they were approached as a group and all participation were by own choice. Some students chose to participate, others did not. In total, 11 Swedish students participated in the group interviews, they were separated into three different groups. These students were at the time of the interview enrolled in a course in IT-security. 16 students in Albania chose to participate. They were enrolled in IT and management studies. In total, 46 students from both Sweden and Albania chose to answer the questionnaires.

The choice of respondents from two different countries was to gain a richer picture of the research problem (by using people from two different cultures), thus increasing the validity by choosing respondents that did not have a relation to each other. In this way the present researcher increased the chances of studying the phenomena per se, and not a specific place-dependent culture or views among a group of friends.

The choice of doctors/biologists was made based on their focus area, their specific expertise in physiological/ biological systems. Two of them had experience in the e-health field and also some aspects of their own interest and experiences; they were all interested in technologies or health technologies. Two of the respondents showed interest in the study and proposed that they wanted to discuss this subject further, and were after that booked for individual interviews. The following list shows their area of expertise and work:

- Dr. S, retired orthopaedic surgeon, senior advisor within the field of eHealth.
- Dr. C, forensic pathologist.
- Dr. A, Ph.D. in Biomedical Science, working within the field of eHealth.

The material from these interviews provided ideas in how smartphones and their accessories could be analysed in relation to the human body, thus some thoughts on how these type of technologies might affect the physiology and cognitive aspects of the users.

3.2.2 Empirical procedure
3.2.2.1 Constructing the questions
The data was collected by the use of questionnaires and interviews. The questions to the user group were constructed with inspiration from the literature, focusing on Floridi (2007) and his thoughts on inforgs and re-ontologizing infosphere (See Chapter 2.3.3.), and Bertalanffy (1973) with his thoughts on how systems and entities interact to maintain balance (See 2.3.2.1.). The questionnaire (included in appendix A) was organized by the following themes: Type of use; scope of use (time); spatial positioning, and relation. The first three themes was inspired by Floridis (2007) description of Inforgs (see chapter 2.3.3.) and aimed at investigating the connectivity between humans and mobile technology in the physical perspective. The aspect of health-supporting use (included in type of use) also had inspiration from Bertalanffy
(1973) and his thoughts on balance/ steady state (see 2.3.2.1) The last theme ‘relation’ aimed at understanding the psychological and cognitive part, how the respondents relate to their devices emotionally and how they perceive them.

The interviews focused on the questions in the questionnaires, how the students felt when they filled out the questions, what they thought about the questions as well as how they described their own use.

In the context of the last theme (relation), one additional question was posed during the interviews, a question that was not included in the questionnaires. This was the last question posed to both users groups and included if they thought that the smartphone was an organ or a tool. This question finished the interviews with users in both countries, and was also discussed with the doctors. The inspiration to this question came from the Systems theoretical perspective (relating the smart phone as an entity in our system, or a separate part), and aimed at understanding the cognitive perspective on mobile technologies; if people recognise them as an extension of the body or an ordinary tool, separate from us.

The second group, the doctors, were interviewed with un-structured individual interviews, carried out as friendly discussions. These interviews focused on the development of mobile technologies in general, these products relation to health, as well as how they could connect to the physiological system and the functions of the latter. The focus in these interviews was to relate these products to the human body and the physiological system, but this group also provided interesting aspects about user behaviour.

3.2.2.2 Collecting the data

The user group (the students) were approached in their school as a group. The focus in this group was to gain knowledge in user patterns and user experiences, both in physical matters (such as type, time and space) and cognitive and emotional aspects (such as their perception of the smartphone and emotional aspects). First the students were given semi-structured questionnaires that included both qualitative and quantitative data. The quantitative data was aspects such as: amount of time (for use), space (distance to smartphone), amount of connection to the Internet, and a set of statements to fill in, whether they agreed. Qualitative data on the questionnaires included open-ended questions where the users could fill in for example a short description of their relation to their phone, and how they felt if they had forgot it at home. 46 students answered the questionnaires. When they were finished, those who were interested proceeded to join for a group interview. The interviews were semi-structured and began by discussing their first thoughts after filling out the questionnaires, and went on by discussing the content of the questionnaires.

The Swedish students were interviewed face to face in Sweden. They were divided into three groups with 4-6 students in each group. The interviews progressed as group discussions, semi structured and followed the themes of the questionnaires (appendix A). Semi-structured interviews are based around a couple of themes or questions, but might evolve during the process if the researcher find new areas of interest or want to ask follow up questions (Grönmo 2006). This method suited well to discuss the problem of the study. A total of 11 students were interviewed during one day. The Albanian students were interviewed by the same arrangement, but in a single group of 16. This was seen as a weakness from the present researcher’s point of view. Smaller groups
might have opened up for more vivid discussions. However, the time was limited in this case. These students were also interviewed face to face in a school environment. The researcher visited them at a university in Albania. The Albanian students provided more data by questionnaires, and less data by the interview, which lasted for about half an hour. The researcher took notes and recorded these interviews.

In the doctors group, they did not fill out the questionnaires since the aim with these interviews did not focus on their own experiences as users, but rather provide more depth in the study, and a more philosophical approach to the human body in relation to technologies. These interviews were unstructured and progressed as a discussion with the researcher taking notes. These interviews was not recorded. Two were interviewed by phone, and one face to face at the respondent’s workplace. The respondents knew the problem area of the thesis in advance. The interviews lasted for about 1-2 hours, with the exception for the last one, which lasted for about 30 minutes. The choice of more unstructured interviews suited well for this group, since they had lots of both experience and own ideas related to the natural systems of humans from a philosophical perspective, which the present researcher wanted to explore. They also had interesting ideas, knowledge and experiences in health supporting technologies, such as sensor technologies measuring vitals (fit bit wristbands, smartphones, biosensors on a chip, pacemakers etc.).

3.2.2.3 Data analysis and interpretation
The material from the respondents was analysed by qualitative content analysis. In this method, thematizing is a way of striving to making sense of the data (Grönmo 2006). The data in this thesis were analysed in a set of steps, aiming at step by step making meaning of the data, and thus narrow it down and clarify. Lichtman (2013) explains how to make meaning from the data by analysing it step by step, where meaning that emerges from the data is used when coding and constructing the themes. First the material is coded, and then thematised into larger categories.

The processing and analysis of the data in this study went through the following steps:

First the answers from both interviews and questionnaires were read through a few times to get a sense of the ‘overall picture’. Then they were sorted and prepared for analysis by selecting the material that was most relevant in relation to the problem. Not all of the data were presented since but the focus was on what was relevant for the purpose of the study, i.e., only the material that helped answer the study's research questions is included in the thesis report. This type of qualitative selection of the collected material is described by Creswell (2006). He argues that qualitative data is both rich and dense, so to make any sense the researcher must narrow it down and exclude some of the information.

The material was then thoroughly read again and tagged with different codes depending on the content. These codes were merged into larger categories/ themes. The themes that evolved from the users included: First thoughts & reactions; Time and type of use; Space - spatial relation; Type - any health supporting use? Interactions- active vs. automatic?; Relation- a tool or a part of us?

The themes in the doctors’ group were: Digital wearables from a physiological perspective; Comparing organs and smartphones; The essence of an organ.
Data from the interviews and questionnaires were then intertwined and presented by themes to contribute to the overall understanding of the problem. Intertwining data from different sources and methods is called Convergent parallel mixed methods (see 3.1) and is a strategy described by Creswell (2006) to increase the understanding within designs using multiple methods. Within the chosen themes, the data was presented by summarized descriptions and combined with quotations, to exemplify answers that were common or unique, or of specific interest to the subject.

The second step of analysis was the horizontal analysis, where the answers were summarized, compared and new concepts were developed. The data was further narrowed down by qualitative selection, making it even more crystalized. The last step was analysing the material with the help of chosen theoretical concepts. Using a well defined theoretical framework for analysing the material is an important step in qualitative research (Grönmo 2006), and in this study the different theoretical concepts helped by defining and explaining the collected material.

3.3 Validity and reliability
To ensure that the collected data were the students’ own thoughts, they were asked to fill out the questionnaires before the interviews started. This was to avoid transmission of thoughts from the present researcher to the users. One negative aspect of group interviews is that some respondents might be affected by their friends’ opinions, which might decrease the validity of the data in the way that the opinions that are expressed are not their own but are biased because of the group. However, by letting the students fill in the questionnaires individually before the interviews, it was possible to get some insight in the respondents’ answers without them being affected by friends and / or the present researcher. This could be positive in aspects of validity. Using questionnaires could also strengthening the reliability of the study since it possible both to replicate (re-collect and re-evaluate the data), thus testing it on more respondents. The possible preconception of the present researcher is also important to mention in these aspects. The researcher’s background from the social sciences, thus the interest in medicine and experience from the eHealth field (technologies used in a health perspective) has been useful in interpreting the results. But this might also colour the interpretation in various ways. To exemplify, the present researcher had previous knowledge in how the development of mobile technologies could be used to support health and register physiological information. This was an important aspect when interpreting the result and collecting the data, especially from the doctors’ group. But it might also have coloured the discussion and the result. However these aspects are always present when conducting qualitative research and interpreting results and might be seen as both a strength and a weakness. In this way, research is also a reflection of the researcher and the time it is produced in (Grönmo 2006). The researcher as ‘a smartphone user’ is also of importance and might have affected the interpretation as well as discussions with the users. To avoid transferring these experiences to the other users, the users were asked to fill in questionnaires before the interviews began. This was a way of increasing the validity of the results. In the interviews, the researcher also sought to capture different views and position herself as a listener (rather than an ‘active’ interviewer) listening in to the discussion between the students. The construction of group interviews was here seen as a strength, letting the researcher adopt to a more passive role and listen in, rather than controlling the discussion. The external validity of this study is also worth mentioning. The choice of triangulation of methods, a larger group of respondents, and students from two different countries might increase the strength in this aspects. But it is still a qualitative and relatively small study focusing on students, being young and
educated users. This is a weakness when discussing ‘users’; the result would perhaps have been different if the study had focused on a different demographic group.

3.4 Ethical issues
All participants took part in this study by free will. Age, gender and questions of health information could be seen as sensitive issues connecting to the integrity of the respondent. However, among the users, all respondents were anonymous and no specific identifiers such as name, education level or subject, religion, nationality, ethnic belonging, etc. were asked for. Only larger categories such as gender and age group were recorded. Hence, identification of specific respondents in the user group would not be possible. The doctors’ initials and area of expertise are presented, after their consent. Information gained from these respondents did not concern any patient information or related sensitive information. The focus of these interviews was primarily to learn from their extensive knowledge in more general aspects relating to this subject, thus understand their thoughts and viewpoints based on their medical expertise.

A short section of information and consent was included in all questionnaires, and all participation was by own choice.
4 Empirical Findings

This chapter involves the empirical findings from two different groups. The largest group of respondents was the users. They were approached to gain more insight in the user patterns (the physical aspects) within this subject, and the users own thoughts on their relation to their smartphone. This group consisted of both Swedish and Albanian students. The findings are here presented in themes, where data from both questionnaires and interviews were intertwined.

The second group was the doctors which consisted of a biomedical doctor, a pathologist, and a former orthopaedic surgeon (shortly referred to as the doctors). They provided insight in how to relate mobile technologies to the human body, both as physical-systems and conceptual systems.

4.1 Users – physical and psychological relation to smartphones

The results from the users are reported in the following themes:
First thoughts & reactions; Time and type of use; Type - any health supporting use? Interactions- active vs. automatic?; Space - spatial relation; Relation- a tool or a part of us?

4.1.1 First thoughts and reactions – users reflecting about their use

The first question to the students was if they had any spontaneous feelings, questions or thoughts after filling in the questionnaires. This was an attempt to catch their spontaneous and unbiased thoughts, before the discussion might have coloured their views. Some students reflected upon the questions and subjects per se, others on thoughts they got from filling out the form. The Albanian and Swedish students mentioned terms of dependence or addiction. For example one Albanian student said “I’m dependent but I don't want to be. I don’t want to accept it.” Another one said “I have a relation to my phone”. One Albanian student said that the questionnaire made her realise that “the one who has been sleeping next to me in bed the last years, is my phone”. The Albanian students also described that answering the questions made them think and compare the time before and after smartphones. “If you compare the time before the smartphone, with now, it was nicer then” (Albanian student). Some said that the questionnaire brought up questions that they had been thinking about themselves, others that it raised interesting questions that made them reflect. “For example, it was an interesting question about forgetting my phone at home. It’s like you’re handicapped without it” (Swedish student)

“The claim about ‘the phone being an extension of my hand’ was very accurate”. Some of the Swedish students from different groups brought up the latter as an example that really caught their eye. Many students felt that this claim corresponded well to them, even if they hadn't filled it out on the form. A large amount of students described how filling out the questionnaires made them realize things about their own use and behaviour, the Swedish students described in the interviews that:
“I discovered how addicted I am to my phone”
“I noticed how pathological behaviour I have”
“It made me aware of the extension of my use”
“How many hours I use it”
“It has created an addiction, you spend more time with the smartphone then your friends.
“It feels good at work where phones are prohibited.”
“You are always available”

Other Swedish students reflected upon the general effects that the smartphone has had, “How many good things it has brought about, such as social, networking” “You are more social in the online world than in reality” “It is a whole new type of globalisation, this is an extreme advantage. Stuff is coming out it the open now”

Some Swedish students finished of the discussion by commenting that it was interesting, or an interesting subject. A few said that it was an eye-opening interview and made them think of their use differently, others mentioned that filling out the form made them wake up and realize how much they used it or how dependent they were. The Albanian students did not reflect so much about how filling out the questionnaires made them feel, they discussed their relation to the phone more in relation to the questiones in the questionnaires.

4.1.2 Time and type of use
In the questionnaire, most students from both countries filled in that they were connected to the web 24 hours around the clock. Many of them used the smartphone during night time, some as alarm clocks, others to measure sleep. Some of them also used the phones as entertainment before sleep or if they couldn’t sleep. When asked about “active use” (search for information, interact with friends etc.), some of the students could estimate approximately how many hours the used the phone, other didn't really know. Concerned the type of use, the most important functions that was listed where social and networking funictions, some students also mentioned health or training applications, economical transactions and camera functions.

4.1.2.1 Type - any health supporting use?
In the questionnaires, few students filled in that they had used health applications. However, some results were contradictory since they on later questions filled in that they had used training or sleep applications. In the interviews, this was only discussed with the Swedish students. They mentioned use in health perspectives such as keeping track of results, stress-prevention and mindfulness, heart rate monitor and gps (when running), or searching for health information. Regarding health information, both the students from Albania and Sweden thought this was an interesting field with a lot of opportunities, but they had little experience from it, this was evident from the questionnaires with the Albanians and the interviews with the Swedish students. This area (health supporting use) was the only topic where the students from Sweden and Albania clearly differed in their views. Quite many students from both countries filled in that they could consider to register health information through this type of technologies. But the comments that followed explained more about their thoughts on this development. The Swedish users mostly wrote critical comments concerning security of the information (they were enrolled in a security course at the time of the interviews). The Albanian students mostly wrote positive comments, that health use was a good idea, could be useful and would make the information available and up to date. However they did not seem to have a lot of experience about this type of use, there were more people in the Swedish group that described that they used their mobile devices to support health. Mostly related to exercise, and some had used heart rate monitors connected to their smartphones.
In the interviews, a Swedish student brought up something he had seen on a TV documentary concerning health technologies, and this created a discussion in the Swedish group. The documentary was about big data and predictions within diseases as well as training. This discussion went on for a while and many interesting questions came up from the students, such as - “Do we want to know everything?” They also emphasized the need to be critical to the information we find on the web, especially concerning diseases and symptoms. Too much information might hurt, and they mentioned “Google for symptoms” and “hypochondria”. One student mentioned that it is good to be able to register and follow epidemical diseases, but this might also be a violation of integrity. They also brought up the question on whether enterprises focusing on health information could manipulate results, and went on to discuss if you should share health information or not. “When companies register your data it is wrong but if you actively chose to share it is okay” a Swedish student thought. Further on, they thought it could be interesting to use health information to compare results. But it is not good if anyone else could gain control of your information.

4.1.2.2 Interaction - Active and automatic use
Active vs. automatic use was explained as taking an active decision to use the phone and being aware of it (for example searching for information etc.). Automatic use was exemplified as using the phone without an active deliberate choice, touching it or interacting with it without really being aware of it, or knowing why. In the questionnaires as well as the interviews, some students said that they didn't really know, others knew that they did it more or less. Some Swedish users mentioned 2-4 hours active use. One example of automatic use I brought up in the interviews with the Swedish students was “when someone starts using the phone during a movie or during a conversation with a friend, without being really aware of it”. Everyone understood what I meant and recognized this behaviour. Some of them said that they sometimes used their phone like this, other recognized it from friends behaviour. But they also explained that they didn’t like when people behave like that in social situations. Many students seemed to agree on the explanation from a Swedish student who said “I start using the phone with a specific need, but then it just goes on”. Some of the Swedish students said that they definitely use it automatically and they believe it is the same with family and friends. “It is okay if you don't have to much to talk about”. “It feels more and more natural - everyone does it.” Most Swedish students said that they used it both actively and automatic. This was not discussed for long in the interview with the Albanian students, but when the question about automatic use was posed, ten out of sixteen agreed that they use the phone automatically.

4.1.3 Spatial relation
Almost all of the students in both Sweden and Albania filled out in the questionnaires that they kept the phone close to them. Mostly in connection to their bodies, in their pocket, or in the same room within reach. One of the Swedish students described that he used the phone as soon as he felt lonely or bored, when waiting for something, travelling the bus etc. Another Swedish boy mentioned that having access to the smartphone changes “awkward social moments”, when people run out of things to say they immediately bring up their phones so they don't have to sit in silence. He went on to explain that it is almost so that people don't have to make any effort to talk to each other anymore. One Swedish girl said that it was nice to be without the phone, for example at places where it is prohibited. Others felt that they were “out of reach” and that the day was ruined if they didn't have it with them.
One Albanian student mentioned that filling out the questionnaire made her realize that she has her smartphone with her in every single part of her life, even during the nights. In the interviews with the Albanian students, fourteen out of sixteen students agreed on that they kept the phone close to them. Ten out of sixteen felt that they were dependent on their phone. One Albanian student wrote in the questionnaire “I feel sick. It is a serious problem, they are more dependent (we?) sometimes I wish it didn’t exist.” In the interview, the Albanian students also brought up an example of how people use their smartphones out in the society everywhere “at the coffee shop everyone is surfing and posting”.

One question in the questionnaire brought up how they feel if they forget the phone at home. Some didn’t care too much, some thought that it was dependent on the situation, but quite many had strong reactions. This was similar within both Albanian and Swedish students. The answers are listed further down to provide some example. The answers are clustered in two groups from 1. Positive or neutral reaction, 2. More dramatic/negative reaction.

   “It depends: Long travel=Panice, school = It doesn't matter” (Swedish student)
   “ It doesn't matter too much.” (Swedish student)
   “ It depends on the situation, but mostly no problem.” (Swedish student)
   “No big deal” (Swedish student)
   “I don't care, I manage without it.” (Swedish student)
   “No big deal”. (Swedish student)
   "Sometimes I wish I had it with me, (if it’s needed for me to do something)
   sometimes I feel more comfortable” (Albanian student)
   "Some minutes upset and then I think I need some times apart from it (Albanian student)
   "I don’t make a big deal out of it but it feels strange cause I always carry it with me” (Albanian student)
   "I always leave it at home” (Albanian student)
   "I just get back and get it” (Albanian student)

2. “Tough, des-oriented.” (Swedish student)
   "I feel cut off from the rest of the world” (Swedish student)
   “That’s a shame” (Swedish student)
   “I don't feel updated” (Swedish student)
   “Panic, and empty.” (Swedish student)
   “ Damn!” (Swedish student)
   “Naked, it is like being without a watch.” (Swedish student)
   “Daaaaaamn!” (Swedish student)
   “Handicapped” (Swedish student)
   “It's chaotic, people must be able to reach me, and I them.” (Swedish student)
   “Tough” (Swedish student)
   “Panic” (Swedish student)
“stress” (Albanian student)
“I never forget it!!!!” (Albanian Student)
”I become nervous” (Albanian student)
”I didn’t forget it anytime (Albania student)
”Very bad, completed” (Albanian student)
”I never forget it, if I do, I go back home to get it (Albanian student)
”I have no words to describe that experience. It would be a terrible thing because I can’t stay much long without communicating with people. I will feel lost.” (Albanian student)

Some of the Swedish students said in the discussions that they agreed with the proposition of “the phone being a natural part of my hand” but they didn’t fill it out in the form.

Further on, in the interviews the Swedish students described that it depends on what they are doing/where they are going - how they react if they forget the phone. Some described the feeling of being “naked” “alone” or “cut of” if they don’t have their phone. They felt that they missed out on the things happening online. Some of the Albanian students described in the interviews that they never forget it. An interesting thing that was pointed out by one Swedish student was that it is not the phone itself or a specific phone model that was important, but the connection to Internet. A follow up question was posed concerning if they felt that they were addicted to the access to information, and the students answered yes, without anyone opposing. One Swedish student also commented that she had used the phone for so long so she doesn’t remember how it feels to be without it.

4.1.4 Relation - a tool or a part of us
The students were asked both on the questionnaire and in the interview to describe their relationship to their smartphone, or some analogy that describes it. The following comments provide some examples of the student’s answers:

“Marriage” This example came up both during the interviews and in the discussions, in both countries.
“Best friend” This example came up plenty of times, both in the Swedish and Albanian questionnaire answers.
“Gossiper” (fr. sv “skvallerkärring”) (questionnaire, Swedish student)
“Tool, it simplifies, mostly contacting.” (questionnaire, Swedish student)
“An extension of the arm” (questionnaire, Swedish student)
“Source of information” (questionnaire, Swedish student)
“You are very tightly bound to it, but it does not have a personality. But you feel handicapped if it disappears” (Interview, Swedish student). A few of the students agreed on this.
“I didn’t fill it in but I feel a bit naked without it” (Interview, Swedish student).
“I get a bit of anxiety when I’m without it (Interview, Swedish student).

The last question that was brought up with the students was how they felt about the concept smartphone as an organ. This concept was not brought up in the questionnaires or in the beginning of the interviews, to avoid affecting the students thoughts or opinions when they were answering the other questions.
Some students agreed on the concept, others didn’t. Some felt that it was a subject for discussion, and also depended on how one defines an organ. The following comments came from the Swedish students:

“Unfortunately it is probably true that it is a digital organ. It is more and more developed in that direction.”

“No, you don’t need it to survive. But maybe some people do. If they are dependent on it, or are mentally ill”

“It is debatable. Many people have it to cope with their everyday life”

“No, not an organ. I can live without it. Compare with a heart.” Some students agreed with this.

“On the other hand, you don’t need both your kidneys to survive.”

“But if you see organs as assistive tools it is one” (hjälpmedel)

“Many people are dependent on it”.

“A pacemaker to the brain”

“I understand the metaphor, but I don’t know if I agree.”

“An extra organ and source of information”

“Vague, a lifeless gadget.”

“The functionality it provides”

“To have information with you all the time could be seen as a digital organ ‘the organ Internet’ but not a specific model of a phone.”

“I would define it as an extra brain”

They also mentioned that it depends on how someone uses their phone. One Swedish student felt that his own use didn’t imply that he would call it an organ, but he could definitively agree that some peoples use would imply that, for example those who used the phone to sustain their health, remember medicines etc.

The Albanian students said that the concept made them scared and that they did not want to accept it, and most seemed to agree of this feeling. But almost half of the students felt that it was an accurate description, and the Albanian students said that we seem to be headed that way with the development.
4.2 The physiological perspective - relating mobile technologies to humans.

In this chapter the human body is discussed as a system. Two medical doctors and one biomedical doctor (also called the biologist) was interviewed. The themes presented in this section include: *Mobile technologies from a physiological and health perspective; Mobile technologies and behaviour; Lifeless tool or a part of our body; conceptualizing the smartphone – a tool, or an organ?*

### 4.2.1 Mobile technologies from a physiological and health perspective

It is clear that medical professionals discusses the fast ascending development of mobile ICT, and how it may affect people's health and behaviour. Dr. C, the pathologist, mentions an example they have been discussing at work. According to him people using wristbands can have their whole lifestyle mapped out. With the right algorithms you can use the data generated by these bands, trace it back, and know exactly what a person is doing and when. Like eating, sleeping, having sex or traveling. A somewhat scary thought according to him.

Dr. A, the biologist, believes that systemic functions and increased interconnectivity is where we are headed with the ICT development. In the case of biosensors and samples, we copy how the physiological system works. And the smartphone helps us to transform our body’s data to information. The step from having a sensor on your wrist, to having one inside you is not far. Dr. A believes that this development -Nano sensors an ICT that connects to your physiological system, and using the smartphone to inform you or warn you - is about to explode. We will probably see millions of applications to support this process. Dr. C believes that the future development might involve us having sensors in our bodies connected to databases that create statistics of the public health.

Dr. A talks about the general development mostly in terms of the possibilities when using the technology at the micro level. She mentions sensors and biosensors, using the possibilities of both technology and biological tissue to analyse samples. Printed biosensors have the size of a credit card and can I analyse the data in a second. This takes lab two days. They call this development "lab on a chip". The biosensors can also connect to your smartphone - transferring your vitals into health information displayed in a second, without the health care as a middle hand. In terms of "Internet of things” this is also an interesting development according to Dr. A, we are now connected directly with our physiological system to the digital systems. Soon we might not even need physicians? Biosensors act as small receptors and they can be mass-produced at a low cost, making it available for the masses. A lot of diabetes patients already use this solutions today, but the health care has not developed to handle the information yet. The individual users are leading this development. As for the general development, Dr. A also mentions the possibilities of printing out organs with 3D-printers. This can now be done using biological material, the organs printed out are made of cells. These can replace a physiological organ as a topical structure, but the researchers have not yet solved the issue with blood supply. This means that 3D-printed organs have a cosmetic use, but still not full functionality. However, the blood-supply issue is close to being solved. In terms of digital organs or creating new organ to ourselves, this is an interesting aspect to take into account. What does it mean if we can create new parts to ourselves digitally? Should we define this units as organs?
4.2.2 Mobile technologies and behaviour
Dr. C also reflects upon the behavioural part, how it will affect the brain and cognitive functions of people using smartphones extensively from their early ages. He believes that the smartphone acts as a "helping brain". And that the constant availability to information and stimuli will affect the users possibility to concentrate, focusing for a longer amount of time, or develop a "deeper" thinking. He thinks that this might affect the users ability to think for themselves, develop constructive thinking and problem solving. What Dr. C has noticed during the last years increased use of smart phones, is that especially younger people seem to be bored if they don't have new information in every two seconds. It is as if they have anxiety of missing something, it might be some sort of "information anxiety".

Dr. S also reflects on the development where mobile technologies are used more and more in younger ages and how this affects our relationships to these technologies. He believes that it is very interesting to study this phenomena related to humans ability to adapt. He believes that the most interesting thing is how we relate to the smartphone, and at what age. We do not do everything perfect from the beginning, for example walking or talking. But after a while this goes automatic. Dr. S also discusses some people’s excessive use of smartphones as obsessive

Dr S finds this discussion important, about how we are relating to the machine is relevant since artificial intelligence is increasing and some people are afraid to become too much integrated. Maybe they are afraid to be controlled or maybe an addiction. Dr. S relates the use of smartphones to gaming addiction, proposing that some people might need a "digital fast". Dr. S poses questions like "is the smartphone an organ"? "Or a drug"? Do we get withdrawal symptoms when not using it? What will happen when people get even more control of their health with this thing, and the ability to measure everything? These are interesting aspects and our relation to this thing is important to study further according to Dr. S.

4.2.3 Lifeless tool or a part of our body
Dr. C compares the phone with a small helping brain, a memory and information module, Connecting to our Central nervous system (CNS). He does not relate to it as a part of the body, since this thing is not living and not supporting the homeostasis. (balance). He claims that this might be a romantic view, but the human body is a living organism with living tissue. Smartphones and other mobile technologies are dead tools in comparison.

However he believes that the definition is up to the individual and depends on how we use it and relate to it. “For example someone that uses the smartphone to measure heart rate and have a chronic heart disease could probably relate to this thing as an organ since his life could depend on it. Someone with diabetes.” But he poses the question about need and necessity, do we really need this gadget or is it only fun thing to use it? Compared to the physiological system of humans, the physiological organs do not have the luxury of having unnecessary functions. Another thing Dr. C mentions is the physiological system as automatic. The organs function without you taking action, and without your awareness. They work by receiving and sending data or take necessary actions to support the system. Dr. C also describes how they work by striving for harmony and helping to sustain the homeostasis (balance). Dr. S also comments on the subject of homeostasis, and means that if the smartphone helps you increase the homeostasis of the physiological system, for example by sending you an alert or
reminder, this might count as a supportive function, comparable to the function of our own system. Dr. A comments on this subject by mentioning the biosensors that can alert the user and send data to the smartphone. She gives an example "if you have a digital solution that warns you when your blood pressure is too high and tells you to take a walk, it is absolutely helping you remain healthy."

Dr. S discusses the entities of our own system in relation to smartphones by categorizing them by function. For example: Sensory organs - who communicate and register data from the surrounding world. Action/Effect organs - who performs an action, for example the legs. Analysis organs - for example the brain, controls input and output and transforms sensory organs data to information. Dr. S believes that the smartphone offers all these functions, making it comparable to many of the physiological entities. It has both sensory functions, action/effect functions, and processing functions.

Dr. S also gave an example on humans ability to adopt, as in the case when one organ is hurt or lost. Another organ or function might try to contribute to replace loss of function. In this way humans, and their organs are highly adaptable. Dr. S also makes an analogy to instruments when we as humans use something as an extension of ourselves and this works automatically. Automatically in this context means a process where we don't have to think, we just move our fingers, we can become "one" with this instrument. Dr. S describes humans as having a high adoptability, being able to converge into one with the instruments that we use. However, this takes a phase of development just like other functions. However, the "extension of one self" is only viable if the use can be automated. If you lose or hurt a part of the body at a higher age, it might not regain the full function, the use will not be automated. In this context it is interesting to study smartphone use related to age according to Dr. S, when we start using them might affect our relation to these products.

4.2.4 Conceptualizing the smartphone – a tool, or a part of our body?

Dr. C exemplifies a more romantic perspective to the issue, and focus on the human body as something living, and this an essential difference from the technological entities that we use. Thereby the smartphone should be seen as a tool according to him. But this is also depending on the use and the value it provides to user (for example in health issues). The need or necessity of these devices is also important to discuss according to him. Is this just a fun gadget or do we need these technologies to sustain health? Dr A also though that the human body is living and in that way technological devices are not comparable to the entities of our bodies, but she also focused on the functions and emphasized the increased interconnectivity between technology and biology, by the development of for example biosensors - combining the possibilities of two worlds, biology and technology. This connects to Dr. C thoughts on living tissue, and shows that in some aspects, technological devices are developed with living tissue. The new solutions that are used (in connections to our smartphones) to support us, and connect to our physiological spheres - are not only getting organ-like functions, but also getting biological material. Dr. S, the orthopaedic surgeon focused on the functions, describing the similarities between the organs in the human body and the smartphone. He also emphasized on the aspect of humans ability to adapt and use instruments automatically, as an extension of the body. However, this was also a question of age and extension of use.
5 Analysis and discussion

In this chapter, the empirical findings is analysed and discussed in relation to the theoretical concepts

5.1 Open and evolving systems

Bertalanffy (1973) describe human beings as living organisms, interacting with their environment. They might also be described as a system, containing entities with smaller subsystems (such as the organs, the central nervous system/ the brain), and acting in a systems environment. The main system might be described as a natural system, a biological or physiological system. What is most important is to focus on human beings as open systems, which emphasises the interaction with the environment. According to Bertalanffy (1973) are open systems dependent on their environment and they are therefore also adaptable and have the ability to evolve with the environment. The users described how they have changed when interacting with these technologies, and also described how they sometimes used it without being conscious, as an automated behaviour. This aspect was also discussed with one of the doctors, describing human bodies’ ability to adopt. One concept that was used to investigate if users are evolving, was the concept of inforgs provided by Floridi (2007). Most users fitted the description of inforgs. Many of them were children of the PC-age as discussed by Floridi (2007), and they were living in the infosphere almost all the time. The extent of interconnectivity is probably greater than Floridi might have imagined 2007- users do not only have connection to the Internet 24/7, they carry it with them and also connect and measure themselves. This also strengthens Floridi’s (2007) prediction about the increasing infosphere. We now live in 24/7 and also connect ourselves to it. Floridi describes being connected more then 8-hours (more then we sleep) as an important limit. We are now not only connected longer than we sleep, we are connected in our sleep, measuring ourselves and entering the infosphere as we sleep. Floridi (2007) also describes the market of digital assets. By now the most important digital asset are the users themselves. This was however one of the negative aspects brought up by the users. Some of them (the Swedish users) were afraid to register too much when it came to health information, and a bit worried about who might have access to the information.

The concept of inforgs implies humans as being semi-digital creatures. This is related to the thought on convergence between the online and offline world, as well as the convergence between the physical and the digital systems.

5.2 Converging environments

As the amount of connection increases, the boundaries between online and offline are blurring. Floridi (2007) describes this process as the re-ontologization of infosphere meaning that the infosphere is converging with the physical world. Bradley (2010) describes how the lifespheres are converging with the use of ICT, but focus more on the physical environments we move in, and the roles we have in those environments. The convergence between online and offline implies that the physical world is also converging with the digital world. These spheres could also be seen as the system environments.
Many of the users described tendencies towards dependency and stress related to their use. In the context of smartphone use, it was not so much due to work or school always being present (due to their converged environments). Rather, it was described as the fear of missing out, being cut off from society or miss important information, the main point being the access to internet. Some described that they felt more relaxed or calm in places where smartphones were prohibited. Some students described their use as pathological, as dependence or obsessive. These aspects were also described in previous research (Lee et al., 2014; Harwood et al., 2014; Lin et al., 2015), but in the current study, the users themselves described their use as obsessive or pathological, which was an interesting aspect. The doctors also mentioned information stress, the need for constant stimuli and new information as an obsessive behaviour. It was also discussed if information is a new type of drug. The users described that it was not the smartphone as a physical object that was of importance, but the access to Internet and the access to information. This implies that it is the access to the infosphere (as described by Floridi 2007) and access to all the lifespheres that is of importance. Many of the users also described that they mostly used their smartphone to access information or to support ‘networking’. Networking might be interpreted as connecting with the other lifespheres, such as friend or family spheres. When they did not have access, when they forgot the phone or lost Internet connection, they felt cut off. Some described this as a relief, but most students got stressed or afraid to be left out. It seems as their access to all of their life environments was of great importance. When they only had access to their physical environment, there was a loss of /or a change of balance that caused an emotional reactions of stress, anxiety, or sometimes relief.

The convergence of life-spheres or life environments, and the blurring between the physical and the digital world, is in line with both Floridi’s (2007) and Bradley’s (2010) thoughts. The users in this study described living in the infosphere constantly and having access to all of their life spheres as a normal state. Being cut off is an anomaly and causes strong reactions in most of the users. The students were so used to have access to all kinds of information, all of their life spheres, and have parallel focus all the time, being cut off from one life sphere (such as the friend sphere) was an anomaly. Some got stressed or even felt panic, others thought of it as a relief. It seems as if convergence between physical life spheres as well as the physical and digital environments is a normal state rather than a possibility for these users.

5.3 Converging systems
The increasing connection between mobile technologies and the physiological system was an important aspect in the future of health care, according to the doctors. This might be seen as one important aspect in how these devices can provide a value to our own system. The biologist also described how sensor technology is combined with biological material, when developing biosensors. This development, combining technology and biology, is an aspect that might imply that technology is no longer clearly separable from the biological and the ‘living’. A few of the users used their smartphone in a health perspective. It mainly included using the smartphone to register sleep or measure vitals when exercising. However, the focus in this thesis is not the information transfer between the body and the smartphone, but rather the conceptual level, how these systems might be seen in relation to each other in a (systems) philosophical perspective.

Some statements that were included in the questionnaire included analogies such as “being a natural part of my body”, and “an extension of my hand”. These questions
were used to explore how users relate their smartphones to their bodies. Some of the students filled in these alternatives, and a few others brought it up in the interviews and found it to be a good description. This might imply that they relate to the smartphones as an extension of their body, or a natural part of themselves. This might imply that their ontological beliefs are changing – some of the users do not perceive a clear difference between their bodies and their technologies. In this aspects convergence is an interesting concept to apply in discussions on how our own biological system might be related to the digital system.

Another interesting aspect also came up when the users where asked to describe their relation to their smartphones. A surprising amount of both Swedish and Albanian users described (mostly in the questionnaires) their relation to their smartphone as a marriage or friendship, implying that it was human-like. They also described their smartphone as something with human-like features. Examples that came up included friend, best friend, gossiper, partner, marriage, etc. If convergence is to be described connected to users’ emotions, the application of human qualities on these devices is one important aspect. Of course, not all students recognized their phone like this, someone wrote ”tool”, others ”useful”. But the amount of users describing it as something human-like was surprising, especially taken into consideration that nothing about human features was included in the question (it was posed ”how would you describe your relation” in the questionnaire).

The aspect of convergence between systems could also be described as the weakening of the system boundaries – between the physical and digital worlds, as well as the natural system of humans and the digital systems we have created. This might include both the increasing interconnectivity by space and time (the physical perspective) as well as the possibility to connect it to our bodies. It might also include adopting to the smartphone and relating to it as if it is human (in a psychological perspective).

The weakening system boundaries and the convergence of physical (or physiological, depending on the focus) systems and digital systems is here merely a philosophical thought that may describe some of the tendencies of our relation. In comparison with Bertalanffy’s (1973) thoughts on different kinds of systems, the relation between humans and mobile technologies can here be seen as ‘conceptual systems’, evolving and converging with each other. This thesis does not provide proof for this thought, merely a way of approaching this area. Further on, the level of convergence will probably always be different from one user to another, just as the relation between users and their mobile technologies will differ. The concept of convergence between physiological and digital systems is in the context of this thesis seen as a proposal on a perspective to further investigate the area of human-technology interaction, rather then an explanation or a proof. *A proposal is to conceptualize this as ‘physio-digital convergence’ or ‘human-technology convergence’ depending on the focus.*

5.3.1 Convergence of entities – the smartphone as a tool or a part of us

Conceptualising the smartphone as a tool or a part of our system, is way of investigating our relation to mobile technologies from a cognitive perspective.

The mobile technologies clearly have the power to affect user behaviour, this is described both in previous research (Lee et al., 2014; Harwood et al., 2014; Lin et al., 2015), and confirmed by findings of this study. What is more, the users’ description of smartphones as having human-like features was a surprising and interesting aspect when
exploring the relation between humans and technology. Some users also stated that the smartphone might be ”an extension of my hand”, ”a natural part of me”. This implies that users and their mobile technologies might be converging also in the cognitive perspective – how we understand and relate to these devices in our mind, where smartphones might be seen as natural parts of our own bodies (entities of our system).

To further investigate this perspective, the last questions posed to both the users and the doctors, was if these devices are becoming a part of us, exemplified as ”is the smartphone becoming a new organ”? This question could be seen as a way of relating mobile technologies to our physiology, but it could also be seen as a way of understanding how we relate to these devices both emotionally and cognitively. This question might shed some light on the strong effects technology, in this case smartphone, have on users as well as the power it has on our behaviour. The concept of ”organ” is here related to the systems perspective, organs being the entities of our own system.

Among the respondents, some agreed on the proposal that the smartphone might be seen as an organ, others did not; and some thought that it was up for discussion. Some thought it was depending on parameters such as dependence, and which functions (for example health supporting) that is being used. This was also mentioned by one two of the doctors; if the smartphone was sustaining health, it might be considered as an organ for that individual. Otherwise, it could be described as an extra brain or information module; both the users and the doctors mentioned this. Both the doctors and the users made comparisons to pacemakers and life supporting products, discussing the smartphone in concepts of dependence and connecting to use in aspects of health/illness. These views seemed to emphasise how the smartphone supports and connects to the physiological system of the human, making these conceptions related to a hard ‘functional’ approach, and relating to Bertalanffys (1973) thoughts on how entities work to support a larger system. The answers did not differ in any noteworthy way between the Swedish and the Albanian students. What stood out in particular was that the students overall had many negative thoughts about their use when they started to reflect. They also mentioned negative feelings when asked about the term “smartphone as an organ”. They found it to be both scary and provocative, but an important discussion. The Albanian students said “unfortunately” it seems to be heading in that direction. They also said that they did not want it to be like that and sometimes wished that it did not exist. Among the doctors, the question did not seem to raise such a strong emotional reaction, but led to more rational reflections, comparing the human body to mobile technologies. One of them (orthopaedic surgeon) thought that smartphones could be described as organs due to their functions being comparable to the functions of the human body. The pathologist claimed to have a more romantic view of the human body as something unique and living, and consisting of living tissue and adapting to maintain the homeostasis. The biologist also thought that the difference is that we are living and technology is not, but she also emphasized the functionality and the increasing connection between physiological and digital systems in the development of mobile technologies.

5.3.2 To summarize

To summarize, the users as well as the doctors described an increasing connection between humans and mobile technologies. Both in physical aspects – how it might be related to the human body and provide value to our system; time-space aspects, the increasing connectivity and blurring of system boundaries between the physical and digital systems. And the psychological aspects – the effect on users behaviour,
dependency and tightening relation, the emotional bond as well as perceiving the smartphone as partly human, and to some, a natural part of us, such as an organ. This implies that we may discuss human-technology relation as converging. Most users described that they are changing due to the interaction with these technologies, but this tightening and converging relation does not seem to be positive according to the users’ reflections. Some seem to converge involuntarily and describe their use as pathological and frightening.

The checklist provided by Floridi (2007) to investigate the concept of inforgs, fits most users in this study, and probably most people who use smartphones extensively today. But even though many users attach human-like characteristics to their mobile device, to reverse the scenario and ask if humans might be changing into partly digital creatures (such as implying the smartphone as a part of us) was a provocative thought. Some people agreed, others did not, but most of them found this thought to be frightening.

This cognitive perspective was found to be interesting when studying human-technology relation. The physical possibilities when using these devices are enormous both in health perspectives and in efficiency (we can take part in all life spheres at once, for example) and the possibilities to improve ourselves. The thought of humans evolving becoming semi-digital and converge with our mobile artefacts to the point where they become a part of us might be interesting, positive and exciting. But most respondents described it as negative and frightening. We are keen to apply human characteristics to our technologies, but not as keen to describe ourselves as changing. Why the increasing use and possible convergence between humans and technology is related to negative emotions and fear, is a proposal to investigate in future studies.

5.4 Methodological reflections

The Research design in this thesis is described as Critical Multiplism (a form of triangulation) with a qualitative focus. This was related to the paradigm of Critical Realism/ Post-positivism (as described by Guba and Lincoln 1994). This approach was found to be useful and provided rich empirical material. The choice of a qualitative approach was also useful due to the flexibility, but this also weakens the ability to generalise the result. The external validity could here be seen as a weakness, in comparison to larger quantitative studies with a random sampling. It is also important to emphasize that this user group was young and also educated. This makes the result less interesting to other demographics (such as older users). It also seemed as if education affected the result, since the Swedish users were more prone to reflect on integrity and security issues.

Alternate approaches to this topic might be a survey design, including a larger group of users. An important aspect in qualitative research is also the researchers preconceptions (as discussed in 3.3). In this context it might be seen as a weakness as well as a strength that the present researcher had previous experience from the eHealth field, and an interest in how mobile technologies might affect health. This might have affected the result and discussion, especially with the doctors. The present researcher also had experience from smartphone use. However the main conclusions are drawn from the users, and the doctors in many ways helped in increasing the understanding and interpreting the results from the user group. When investigating the users the present researcher started with questionnaires with the aim to avoid colouring their views. This approach was found to be very useful. The users had many thoughts and reflections on their own use after filling out the questionnaires, and the discussions between the
students was vivid. Using group interviews was also a success since the users discussed their different opinions enabling the researcher to stay more neutral. However the size of the groups was of importance. The Albanian users (sixteen persons in the same group) were clearly too large and did not provide much material in comparison to the Swedish groups. A weakness in the questionnaires was the possibilities to choose multiple alternatives on some statements (due to them being overlapping categories). This made it difficult to see how many students that had answered each question in the summarized result. Since this was not a statistic study, it is of less importance. Strength with the questionnaires was the combination of closed questions (asking about frequency) and open-ended questions. The comments explained their choices and provided a lot of interesting thoughts and reflections.
6 Conclusion

The use of information and communication technologies (ICT) is extending at a fast pace, affecting all parts of society, and the everyday life of most individuals. This includes the different environments of life converging into a multi-dimensional life-sphere, and the extension of Internet with the help of mobile technologies, making information within reach anytime anywhere. The fast progressing development of mobile technologies (smartphones and their accessories/ wearables) is creating new trends. These mobile technologies can register an increasing number of physiological features and is available to the public. This creates a range of new possibilities within health and medical research but it also creates new challenges and the need for new knowledge in how we relate these devices to our bodies. In the psychological perspective, smartphone use is increasing and previous studies imply that these devices are affecting our behaviour, our mental health as well as our cognitive functions. This implies for a need to understand the relation we have to these devices also in a psychological perspective, focusing on emotions and cognition. There is however few studies available that describe the relation humans have to these technologies from a holistic perspective, involving both body and mind.

This study set out to investigate the relation between humans and smartphones from a holistic perspective, including both body and mind. By using General System Theory as a theoretical framework to analyse the relation between mobile technologies (computational systems), and humans (as natural systems-living organisms) this study aimed at improving the understanding of our relation. Human-technology relation was here studied in the context of smartphone use. The purpose of this study was to explore the relation between humans and technologies from a systems perspective. The research question was: How are users and smartphones related in physical and psychological perspectives?

By exploring this area, the aim of this thesis was to provide concepts and new perspectives that can be used to analyse and discuss the complex phenomenon of increasing human – technology interaction and its implications. Thus, the most important contribution of this thesis might be to get people to reflect and think critically, providing a frame for analysis. The methods used in this thesis were questionnaires and interviews with two different groups. The largest group was the users, consisting of students from two European universities (in Sweden and Albania). They were approached to gain more insight in the user patterns (the physical aspects) within this subject, and the users own thoughts on their relation to their smartphone. The second group was the biologists/ doctors. They provided insight in how to relate mobile technologies to the human body, both as physical- and as abstracted/ conceptual systems.

6.1 Conclusions

It stands clear that the relation between humans and mobile technologies is evolving, and many of the respondents finds this topic to be important. The very nature of the relation between humans and technological devices is changing into a relation defined by co-dependence and converging systems. Most of the respondents in the user group described being close to the smartphone most of the time, having an extensive connection by time, space and the level of connection to the Internet. Some users also described their use as obsessive or pathological, other as healthy. Some users also
described panic and distress when being separated from their phone. The users described that it was not the smartphone as a physical object that was of importance, but the access to Internet and the access to information. They wanted to feel connected, and network with friends and family. This implies that it is the access to the infosphere and all the lifespheres that is of importance. This was analysed as users living in the infosphere all the time (making them comparable to inforgs), with access to all of their life-spheres. The convergence of lifespheres and the convergence between the physical and digital worlds was a normal state to most of them, and loosing access to the digital environment or any of the lifespheres was an anomaly.

The concept of convergence might also be used to analyse the relation between the users as physiological or living systems and the digital systems that we use. In this aspect the value of these products in a health perspective is briefly discussed. The development within the health area shows an increasing amount of use in this perspective; this is described in previous research as well as discussed by the doctors. How mobile technologies might support the balance of our own system is an important aspect to further investigate. Only a few of the users had experience from health supporting use, mainly when exercising. But the emotional relation and interconnectedness is also interesting in this aspect. Many of the users described their relation to their smartphone as human-like, as a marriage, or describing it as a relation to a friend or best friend. This was evident among both the Swedish and Albanian users. This imply that users compare these devices to humans or living objects, making the concept of convergence between humans and technology interesting also in this perspective. This might be conceptualised as convergence between humans (as physiological or physical) and digital systems, or ‘physio-digital convergence’. In this study the relation between these systems is discussed philosophically and not measured at the computational level. It is thereby a proposal on how to further study this relation, rather than an empirical proof.

The cognitive relation to mobile devices was further investigated by the comparison between our bodies and the smartphone; both the users and the doctors were asked if smartphones was a tool or becoming a part of us, like an organ. This would be the final state of convergence – a convergence between entities if these devices are transforming to become a part of our system. The opinions differed in this matter. Both the doctors and the users described it as depending on type and extension of use, thus relating it to the possible health supporting aspects, the value to our system. It was also a matter of ontological beliefs – some emphasized the human body as living and technologies as lifeless tools, other focused on the functionalities it provided. Most of the users (and also the doctors) did neither strongly agree nor disagree to the comparison, but many found this comparison to be both frightening and considerable, placing the use of these devices in a new perspective. Some interesting thoughts were connected to the value the smartphone provides – the access to information and the feeling of being connected, proposing that the information or the Internet is the organ.

*How are users and smartphones related in physical and psychological perspectives?* In a physical perspective the users as well as their physical environments could be described as converging with the digital systems. The need of being connected and have access to all life-spheres at once seems to be an important driving force, implying that users are dependent of information and a converged life-style. In a psychological perspective, the emotional bonds seem stronger then the actual physical needs. The perceptions of smartphones as human-like entities imply a convergence also on the
conscious level. The smartphone as an entity in our system (an organ) was not recognized by the majority, but described as an important and thought provoking aspect to have in mind when discussing this development. Thereby an important aim of this thesis was fulfilled, to get people to reflect and think critically about this development.

6.2 Proposals for further research

Proposals for further research include investigating the relation between humans and mobile technology further. Why the increasing use and possible convergence between humans and technology is related to negative emotions and fear, is a proposal to investigate in future studies. Is it a question of fear of technology, or related to integrity and security?

When focusing on relation from a holistic perspective, both the physical and psychological aspects are complex and intertwined, making it impossible to dig deep into any of the aspects in one study. In this thesis the concept of physio-digital convergence is proposed. This concept could be further concretised and described, and a proposal is to explore methods to investigate and measure this evolving relation, for example at the computational level.

More concrete questions to pursue might involve: how far can the process of physio-digital convergence be developed? Can we program ourselves? Maybe the individual user can have more effective ways of sustaining health, or feel more empowered in managing his/ her own health, if the smartphone is developed further to become a part of us. Or maybe users can become more integrated in the pro-active and regulatory processes of tracing contagions in the upcoming field of participatory epidemiology. One important question for the future might be, what will happen if and when we can do more than interpret physiological data with our smartphones, and send data the other way? Will the individual user have the power to program the physiological system?
7 References


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You and your Smartphone

By completing this form, you give your consent to your answers are recorded and can be used in a study at masters level. The results can be published in a scientific context. All responses will remain anonymous and you do not write your name.

All participation is voluntary. If you are under 18 must have parental consent to participate.

* Note that many alternatives are formulated as statements, some answers may thus overlap. This means that you select the option you think best applies to you, or more options if indicated.

Age:
- Under 18
- 18-26
- 27-40
- 41-50
- 51-65
- 66 +

Gender:
- Female
- Male

Type of Use

Do you have equipment / accessories containing sensors to your smartphone? Enter the type / model in the text box.

Ex: Fitbit bands, smart watch, pedometer, accelerometer, heart rate monitor etc, containing sensors that records and can send data to your smartphone. (Headphones are not included.)

- Yes (specify below)
- I have not, but I would like to use this kind of equipment (specify)
- No
- Do not know
- Other: 

8 Appendices
Appendix A - Questionnaires
Do you have a mobile smartphone?
* Smartphone, such as iPhone or Android phone, with touch screen, support for apps and the ability to connect to the Internet
  ○ Yes
  ○ No. Thanks for your participation! You do not have to answer any more questions.

Why / why not? What do you use them for?
Enter variety and the use you are interested in brief / alternatively justify why you are not interested in this kind of accessories.

What do you use your smartphone to essentially?
Mark all the statements that apply to you:

- Social / Networking
- Calendar / memory functions
- Administer Health / fitness
- Play / Games / Entertainment
- Surfing, find information
- I use the phone for the most part in everyday life
- Other: __________________________

Have you used your smartphone in health promoting purposes?
○ Yes
○ No
○ Maybe / Do not know

What kind of use?
Select the options that apply, fill out the "Other" if you are going for something more.

- Training
- Food / calories
- Measuring sleep
- Register / Measuring vital signs (blood pressure, pulse, respiration, etc.)
- Register / administer public health information
- Remember medications
- Finding health symptoms (eg through Google)
- Other: __________________________

Can you imagine to record health information via your mobile phone or its accessories?
○ Yes
○ No
○ Maybe / Do not know
Scope of use

How much (do you) actively using your mobile?
Select the statement that best.

- Only when I phone / Texting
- Rarely, a few times per week
- A few times per day
- I use the latest one of the day
- Do not know

Approximately how many hours per day you’re (usually) connected via your smartphone / accessories? (Via mobile network / WiFi):

- A few minutes a day or less
- about 2-4 hours / day
- 8 hours (or more) per day
- My mobile / accessories are connected to any network around the clock
- Do not know

Do you use push notifications?
* (Reminders, email etc that sends notifications without you actively need to update and retrieve)

- Yes (if you have any push notes activated)
- No
- Do not know

Are you using your mobile even at night?
If you answer yes or sometimes, even reply to question B.

- Yes
- Sometimes
- No

Do you agree to any of the following statements?

- I measure sleep / movement activity even at night
- I am connected to a network and the mobile phone turned on and handy
- I have push notifications on even at night
- I turn off the sound
- I have the cell phone on, but keep it in another room
- I often check the cell phone at night if I'm awake
- I use the apps / games at night I can not sleep
I use the phone sometimes.
I use the phone as a wake clock
I use the apps to make it easier to fall asleep (sound, soothing music, noise, etc.)
No I do not agree to any of the above

Spacial positioning and relation

Where do you position / keep your smartphone in relation to yourself?
Select the option that best

- Close - Usually on me or in my hand / I wear it most often with me
- Rarely at me, but often available in the same room
- I keep it mostly at home, taking the rarely with me.
- Other: [ ]

Do you bring your smartphone whenever you leave home?

- Yes
- No
- sometimes
- Do not know
- Other: [ ]

Please describe briefly how you experience it if you forget it:
[ ]

Select the statements that applies to you.
If I forget the cell phone at home I experience the following:
- It does not matter
- I prefer to bring it, but there is not a priority
- I turn back if possible, I have to have it with me
- I get stressed or nervous if I do not have my smartphone
- I do not know how I will cope with the day without mobile
- I feel naked without phone
- I think it’s nice, but the phone
- I do not agree with any of the above
- Other: [ ]

How do you describe your relation to your smartphone?
Write short:
[ ]

Select the statements that best applies to you:
You can mark several options

☐ It is not so important for me
☐ It is good to have some practical things, but not necessary
☐ I have difficulty getting everyday work without my smartphone
☐ I feel insecure if I do not have it handy
☐ My mobile is a natural part of me
☐ My mobile is like an extension of my hand
☐ I can not imagine living without my mobile
☐ I do not agree
☐ Other: 

Do you have mostly planned, or automatic use of you phone?

Select the options that apply to you, please mark several options.

☐ I use only the active cell phone when I need something
☐ I am well aware of when actively using mobile phone
☐ I have no idea how much I use mobiles
☐ I do not know if I use the phone without thinking about it.
☐ I use / fingers on the / check cell phone often without thinking about it (automatic use)
☐ I use functions on mobile phones / accessories, which automatically registers my movements (eg, geographical, physical activity, sleep, other parameters).
☐ Do not know
☐ Other: 

Additional Comments?


Thank you for participating!