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The Smart Home as a Place of Control and Security
An Analysis of the Domestication of Smart Technologies
for the Making of a Home

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Abstract

Home is variously conceived as place of security and control, of domestic practices and identity. Smart homes, in contrast, are often portrayed narrowly in technical or functional terms for their capacity to enhance comfort, convenience, energy management and security. Studies of smart homes that are concerned with control and security issues generally do so to improve usability of smart home technologies or to dismount barriers for broader adoption. In this study, I draw on the concept of home as a place of security and control to examine how people living in smart homes perceive and use the home technology to create and maintain a secure domestic space where they can feel in control of their environment. The findings suggest that how the relation between householders, smart home technology and external factors is imagined and experienced might be an important factor for whether people feel in control and secure in their homes.

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Table of Content

ABSTRACT	III
ACKNOWLEDGMENTS	V
INTRODUCTION	9
1. RESEARCH FRAMEWORK AND METHODS	14
1.1. THEORETICAL FRAMEWORK	14
1.1.1. NOTIONS OF HOME AND MAKING A HOME	14
1.1.2. SCOPING THE SMART HOME	16
1.1.3. SMART HOME AND ISSUES OF CONTROL AND SECURITY	19
1.2. DATA COLLECTION AND ANALYSIS	21
1.3. REFLECTIONS ON MY ACCESS PROBLEMS	25
2. SETTING THE SCENE: CONNECTED HOMES	27
3. SMART HOME TECHNOLOGIES, VISIONS AND MARKET	32
3.1. SMART HOME TECHNOLOGY: A MONITORING TECHNOLOGY?	32
3.2. THE SMART HOME IN THE VIEW OF THE ELECTRIFICATION AND AUTOMATION OF THE HOUSE(WORK)	35
3.3. CHALLENGES IN THE SMART HOME INDUSTRY AND MARKET	38
4. BUILDING A SMART HOME	41
4.1. REASONS AND DESIRES FOR GETTING HOME AUTOMATION	42
4.2. PLANNING AND INSTALLING A SMART HOME	46
4.2.1. DELIMITING THE SMART HOME	47
4.2.2. IMPLEMENTING SMART HOME PROJECTS:	
PROFESSIONAL AND DO-IT-YOURSELF INSTALLATIONS	50

<u>5. LIVING IN A SMART HOME:</u>	
<u>ADAPTING THE TECHNOLOGY AND ADAPTING TO IT</u>	54
5.1. DIVERGING EXPERIENCES OF THE FIRST WEEKS WITH THE SMART HOME	54
5.2. LEARNING TO CONTROL AND LIVE WITH THE SMART HOME	55
5.3. FINETUNING THE SMART HOME SYSTEM	60
<u>6. AUTOMATION AND CONTROL:</u>	
<u>FEELING CONTROLLED OR FEELING IN CONTROL?</u>	64
6.1. SWITCHES, REMOTE CONTROL AND AUTOMATION	64
6.2. FEELING IN CONTROL: A QUESTION OF RELIABILITY AND AGENCY	69
<u>7. SMART HOME SECURITY & DATA SECURITY</u>	73
7.1. SELLING THE SMART HOME AS PLACE OF SAFETY AND SECURITY	74
7.2. THE SMART HOME AS A PLACE OF SAFETY AND SECURITY	76
7.2.1. SECURITY AS SIDE EFFECT?	76
7.2.2. DEALING WITH THE THREAT OF AN UNSECURE SMART HOME	82
<u>8. CONCLUSION</u>	86
<u>BIBLIOGRAPHY</u>	90

Introduction

“Advanced home control systems go by several names, including smart home, home automation and integrated home systems. By any name, these systems conveniently control home electronics and appliances including audio/video, home office, telecommunications, intercom, security, lighting, HVAC, and lawn sprinklers. Control systems can also provide information – residents can find out how much electricity they’ve used on specific appliances or systems, and utilities can read meters remotely. The systems can be accessed from remote locations by phone or computer, allowing residents to turn on the heat, for example, on their way home from work.” (Home Energy Magazine Online 1998 cited in Aldrich 2003:21)

The idea to live in a smart home might be seductive for some, but not so for others and for still others it might already have become reality to a certain extent. In discussions of smart homes, a tension seems to build around different visions of smart homes. Smart homes have been depicted either as dreamlike or as technological nightmares in media and popular culture. Technology has been imagined to increase convenience and efficiency in the house through new options for controlling, managing and controlling the house and, potentially, the people in it. At the same time, this raises the fear that such technology might take over control or start surveying the inhabitants (Albrechtslund 2007). In these different visions of smart homes, the issue of control seems to be a key theme and it is also reflected in some definitions of smart homes like the one above. This description of smart home systems is arguably not the most current, yet it shows well how smart homes have been envisioned – among other things – as control systems.

Numerous studies have been conducted on the issue of control in smart homes from technology- and user-centered perspectives (e.g. Davidoff et al. 2006). It strikes me as odd that these focus almost exclusively on questions about design, acceptability or usability rather than utility and transformations of daily life and homes. More, discussions of control issues with respect to the concept of home as place where people can feel free, secure and in control of their life and environment are missing. It is further surprising that only a handful of studies have been conducted with participants who actually live in smart homes and not in testbed houses or with participants testing prototypes (e.g. Bernheim Brush et al. 2011; Heusinger 2004; Mennicken 2016). Against this background, my research aims to add to the limited number of studies conducted with people who live in smart homes and examines their perception and use of smart home technology with the idea of home as a place of security and control in mind.

There is scientific debate about the concept of a “smart home”. The notion of smart home remains uncertain and changing also more than 30 years after it has been first officially used by the American Association of House Builders (Harper 2003:1). Ideas of what a smart home is differ, referring to a range of connected information technologies distributed throughout domestic spaces and to varying degrees of automation and computer intelligence. Smart homes have been envisioned in many ways – as enhancing comfort, security and lifestyle (Amphoux 1990), as capable of anticipating inhabitants needs (Webb 2011) or as empowering people to reduce energy consumption (Strengers 2016; e.g. Holohan et al. 2011:146). Hence, there are multiple ways of understanding and conceptualizing smart homes.

My personal interest in smart home technologies, its uses, the ideas behind it and its implications for everyday routines grew out of a discussion with my boyfriend, a software engineer, about his plans for a learning and speaking home system. I did not (and still do not) feel very comfortable about the idea that my house might greet me whenever I enter it or remind me that the laundry is done and finally needs to be hanged up. I realized I asked myself questions about data security that could also appear in technological horror scenarios – would it be safe? Could anybody outside the house access the system? What would happen to the data that such a system constantly generates? Still, this technology, as little as I knew about it, really intrigued me. I did some initial research about what products were available and what they were presented as a solution for. Then I started to search for social science studies on the people’s views of smart homes and potential impact of such technology on the people living *in* smart homes, on their practices or social effects. However, studies with people who have lived for some time in such homes seemed to be scarce.

Studies on smart home have been conducted by researchers from a range of disciplines, under a variety of perspectives and on various purposes. Early research was mainly carried out under a technical perspective focusing on the technical feasibility of smart home technology. Later socio-technical research turned to include human-centered or, maybe more precisely, user-centered perspectives (although mostly based on research in laboratory settings or with prototypes) (Mennicken 2016:24f). Over the last three decades the number of publications on smart home use has grown exponentially. In their literature review of smart home studies exploring user-experiences, environmental social scientists Charlie Wilson, Tom Hargreaves and Richard Hauxwell-Baldwin point out that over 60% of the studies come from computer science, engineering and mathematics, while the remaining studies come in about equal

numbers from social sciences and medicine and health studies (20% and 19% respectively) (Wilson, Hargreaves, and Hauxwell-Baldwin 2015:464).

According to Wilson & colleagues (*ibid.*) and Gram-Hanssen & Darby (2016), questions of control, privacy and security figure among the central topics of many smart home studies. For example, functional views of smart homes consider the potential of control and automation smart home technologies offer for enhancing lifestyle or resource management. But studies also suggest some uncertainty about what forms of control and automation “users” might wish for (Wilson, Hargreaves, and Hauxwell-Baldwin 2015:467, 473). Researchers like Davidoff & colleagues point out that extending smart home functionalities might lead to the inhabitants experiencing a loss of control instead of increased control over their home (Davidoff et al. 2006:19). Whether smart home users feel in control has been studied from a technical and functional perspective in terms of barriers for broader adoption of smart home technology. Davidoff & colleagues suggest that discussions of control in the smart home context should examine control not only in terms of “usability” but also in terms of utility, “likeability” and meaningfulness. They further suggest that control should not just be thought of as operating objects or tasks and that researchers and designers should pay more attention to support the coordination of messy family life (Davidoff et al. 2006:20f).

Smart home studies have approached the control issue in contrasting and potentially complementary ways – control over technology and control through technology, control over messy domestic lives, automation as control and automation as loss of control, control as security, etc. (e.g. Davidoff et al. 2006; Randall 2003). Wilson & colleagues, however, emphasize that individual studies define control problems too narrowly. They call for studies to take all these different issues into account and to examine them across the technical level of hardware/software, the user-oriented field of usability and the level of home and household and the process of domestication (Wilson et al. 2025:473).

For a long time, smart home studies have taken the domestic space for granted. Social scientists have pointed to the necessity for studying the way smart home technology is being domesticated, its implications and consequences for individuals and households living in smart homes. It has been suggested that smart homes might have the potential to transform our relation to houses, building services, and our home and impact on households’ everyday life. Even though recent studies have begun to take the complexity of homes into account, to include ideas of what homes mean to the inhabitants or of homes as contested places, the

concept of home as discussed in social sciences has largely been neglected (Gram-Hanssen and Darby 2016:1; Wilson, Hargreaves, and Hauxwell-Baldwin 2015:368). There are diverse meanings associated with home such as “home as a place of security and control”, “home as place for activity”, “home as related to social relations” or “home as reflecting social status, identity and self” (Gram-Hanssen and Darby 2016; Mallett 2004). These concepts might be useful to throw some light on how smart home technology is integrated into a home and made sense of with respect to these different aspects. Social scientists have pointed to the necessity for studying the way smart home technology is being domesticated, its implications and consequences for individuals and households living in smart homes (e.g. Kennedy et al. 2015; Nyborg 2015). Such an analysis could be linked to the concept of home in productive ways, investigating the transformations of domestic practices and routines, examining the smart home as a sign of identity or, as it is the case here, examining the use and understanding of smart home technology for controlling and securing the home.

This study is a first attempt to fill the gaps identified by Wilson, Hargreaves & Hauxwell-Baldwin (2015:473) and Gram-Hanssen & Darby (2016). It investigates perceptions of and interaction with smart home technology of people living in smart homes taking the many dimensions of control issues into account and linking the analysis of smart home to the concept of home and the idea of making a house (in this case filled with smart home technology) feel like a home. I will do so by building on and interrogating the concepts of home as a place of security and control and domestication. My interest is not one of evaluating the usability and effectiveness smart homes offer in terms of active, passive or automated control but of examining different visions of smart homes with respect to ideas of control and the concept of home as place of security and control. My interest is centered on how people living in smart homes perceive smart home technology and how their perceptions (and related imaginaries) are reflected in their relation to their smart homes and how they interact with that technology. This research intends to add to the few studies conducted with people who already live in smart homes and to those on the domestication of smart home technology. Another main concern of my research is how a smart home or, more correctly, smart home technology fits and is made to fit such an idea of “home”.

This study describes inhabitants’ perceptions and domestication of smart home technology. It focuses on issues of control and security and attempts to explore how these perceptions influence their decisions about what technology to use, for what and how to interact with it.

What values and imaginations about dwelling and home do they attach to smart home technologies? What does security or control mean to them? How does that link to their idea of home and the smart home? In order to answer these questions, I have visited and interviewed 11 individuals and couples who live in smart homes and complemented these with interviews and informal conversations with smart home professionals. The interviews have taken place between November 2016 and March 2017; they were recorded and transcribed for a thematic analysis. While the focus lay on people living in smart homes, I added and compared their views and experiences with those of the professionals wherever it seemed fruitful.

The remaining chapters briefly look into technological aspects and the cultural context, but focus on smart home owners' perception, experience and interaction with smart home technology. In the first chapter follows a consideration of my theoretical and methodological standpoint. I further report how I approached the search for research participants and the challenges I encountered. In the next chapter, I attempt to show what a connected home might look like and present the participants' smart homes in a condensed form. Chapter 3 presents the technological elements and cultural and historical context of the development of home automation systems. In chapters 4 to 7 I analyze and discuss my data. Chapter 4 and 5 deal with initial and continuing domestication processes in the different households. The first examines the motivating and limiting factors that shaped the different smart homes and the relation between homeowners and external technicians (integrators) or providers. The next chapter looks into the continuous iteration process through which smart home technology is fine-tuned to the inhabitants' wishes and to the households' domestic practices and systems of meanings. It further presents this continuous grappling with the technology as a hobby. Chapter 6 considers issues of controlling and being (or feeling) controlled. Here I describe how my participants interact with their smart home technology and argue that their view of how agency is distributed between themselves and the smart home is a key factor for why they (do not) feel controlled by the smart home technology. Chapter 7 turns to questions of (private) security and data security as experienced and imagined by people living in smart homes and professionals. It does so by comparing the industry's promises on heightened security with the inhabitants' practices for protecting their homes and the people in them and questions the idea of control as security. I then conclude by reporting the central findings and drawing together the analysis of the different dimensions of the control issues reported by the research participants.

1. Research Framework and Methods

This chapter details some of the points mentioned in the introduction. It discusses relevant literature and concepts and attempts to scope the term smart home as it is used in this study. It introduces how I approached the research and the people interviewed as well as some of the difficulties encountered and some limits.

1.1. Theoretical framework

The introduction already included a short literature review that pointed to the various perspectives from which smart homes have been studied and that studies that approach smart homes as homes in social science terms are scarce. Before we can ask ourselves what a smart home is or should be, I recapitulate here some of what has been written on the concept of “home” and the labor of making a home as studied by anthropologists and sociologists. Then I will scope the term “smart home” as it is used in this study and introduce and question the issues of control and security as discussed in smart home studies.

1.1.1. Notions of home and making a home

Everyone has their ideas about homes and houses have been important sites for ethnographical research for a long time. In our western society conceptions of “home” rely essentially on the idea of a physical structure, a building. There is broad consensus among social scientists that this physical dwelling is, however, only one aspect of home (Mallett 2004:63). I will therefore in this thesis try to distinguish between the terms “house” as shelter and “home” as meaningful, inhabited space.

The notion of home goes beyond the material, physical and visual dimension of a building and includes ideas of family and social relations as well as feelings and atmosphere. One common way for conceptualizing home is the idea of “home as haven” or refuge (Mallett 2004:70). It depicts home as private, familial space where people can retreat, feel comfortable and secure. The contrary of home would then be a diffuse, controlled and potentially threatening public space. This dichotomy between public and private spaces has been criticized for perpetuating an idealized view of home. Critics point out that it is a historically and culturally grown ideal, that there is no clear line between public and private spaces or that for a significant number of people home is not experienced as safe and secure place (e.g. in the case of domestic violence) (e.g. Hareven 1991; Wright 1991). Also researchers studying networked homes and new communicative and entertaining technologies in homes have questioned this dichotomization (Gram-Hanssen and Darby 2016; Mallett 2004; Pink 2003).

In this research, I am mainly concerned with the relations between house – the physical dwelling –, people and intelligent technological appliances and the work that goes into making a secure home. I retain the concept of home as a place that can provide a sense of security, safety, comfort and order as useful for my analysis of how control and security issues are played out in smart homes. However, I do not think that there are any clear lines or impermeable boundaries to the home and my discussion of their use of remote control and fears of hacking or surveillance will demonstrate that.

Houses, apartments or other forms of dwellings need to be designed and built, which in our society is mostly done by professionals. But as Tim Ingold (2013:48) argues, this process is never actually completed even when the professionals have finished their work on the building. There are holes to be plugged and damages to be prevented or limited. Thus, when a house has been built and people moved in, the work of keeping the house working for the family life and daily chores, updating it and making a “proper” home of it starts. This kind of work is not limited to the materiality of the house. It is also essentially about making the house feel like a home (Dupuis and Thorns 1998:31; Mallett 2004:83).

While engineers and designers envisioned home automation technology to be convenient and time saving, research has shown that a considerable amount of work has to be done to adapt it to everyday life. This process has been conceptualized as “domestication”. The domestication of technology by households is a typical topic in anthropotechnological and media studies (Haddon 2006; e.g. Lie and Sorensen 1996; Silverstone 1994). This field of research investigates how new technologies are experienced, encountered and what role they come to play in everyday life. Early domestication research was limited to the moment of adoption; however, later research suggests that domestication continues to be an ongoing process after the initial adoption (Haddon 2006:196; Kennedy et al. 2015:410). With respect to home automation, studies interested in the technology’s domestication have been conducted by researchers from both technical and social science fields and in collaborations. For example, a team around sociologist Peter Tolmie and computer scientist Andy Crabtree has developed the concept of “digital housekeeping” (Tolmie et al. 2007) to describe the effort and necessary skills with which intelligent appliances are incorporated into home networks and domestic routines to become a larger part of the everyday management of a house(hold). In a later article they have introduced the parallel concept of “digital plumbing” to describe ‘the actual work of installing digital technologies in a setting’ (2010:181). By using these two concepts, Tolmie & colleagues emphasize that there are different

knowledge, skills and practices involved in the initial and continuous phases of domesticating smart home technology. Kennedy & colleagues (2015) further elaborated on the knowledge aspect in terms of an acquirement of expertise. Another example of a study of smart home domestication is that of anthropologist Sophie Nyborg (2015), who conducted a market research for a Danish utility. Nyborg takes a practice theory approach, investigating the interruption and transformation of everyday practices. Although Nyborg and Kennedy & colleagues took different approaches and focused on different aspects of domestication, both studies suggest that expertise or control are not evenly distributed among the members of a household. This is interesting as it suggests not only different degrees of control over the technology but also of control within the household.

For my analysis of smart homes' making as secure homes where inhabitants can feel in control, I consider it important to retain that some household members might have more control over specific practices, objects, technologies or persons than others and that the modification or move from a "conventional" house into a smart home might transform both practices and the distribution of control within the household and between people and technology. I am somewhat limited in presenting my data in terms of domestication as, when I set out for the interviews, domestication was not my main interest. Contrary to the domestication studies just presented, I did also not accompany the participants during their first weeks and months in their smart homes. Nevertheless, the difficulty of knowing what might be useful and the continuous work of adapting and updating the smart home system was a recurrent theme in the interviews that caught my attention. It will be discussed as part of the work of making the smart home a 'proper' home in chapters 4 (initial installation) and 5 (continuous adaptation) respectively.

1.1.2. Scoping the smart home

Smart homes are generally understood to offer a variety of control options and conveniences such as remote control and automating functions. Smart homes are also spoken of as wired homes, automated homes or smart living environments. As the technology evolves, so do the visions of what a smart home can or should be. For clarification of the term as it is used in this paper, I present here two simple conceptualizations of smart homes.

There have been few attempts to conceptualize smart homes. For example, psychologist Frances Aldrich and sociologist Dave Randall present a classification of smart homes that

goes from houses with single artificially intelligent objects to (future) houses capable of anticipating residents' needs (Aldrich 2003:34f; similar classification in Randall 2003:230):

- 1) *Homes which contain intelligent objects* – homes contain single, standalone appliances and objects which function in an intelligent manner.

Example: A house that is equipped with electric shutters which are automatically raised or lowered depending on a calculation of the position of the sun at any time of the day or that has a smart TV or smart kitchen appliances.

- 2) *Homes which contain intelligent, communicating objects* – homes contain appliances and objects which function intelligently in their own right and which also exchange information between one another to increase functionality.

Example: Automated heating that can be controlled via smartphone or tablet and interrogate an online weather service in order to lower energy consumption on days when sunlight might be enough for warming-up the rooms.

- 3) *Connected homes* – homes have internal and external networks, allowing interactive and remote control of systems, as well as access to services and information, both from within and beyond the home.

Example: Lighting, shading, heating, other building services, sensors and controls are networked (see chapter 2).

- 4) *Learning homes* – patterns of activity in the homes are recorded and the accumulated data are used to anticipate users' needs and to control the technology accordingly.

Example: If someone enters the bathroom every day at 7am and this is recognized as pattern by the computer, the system heats automatically in time to warm the room to the persons preferred temperature and turn light on just before 7am.

- 5) *Attentive home* – the activity and location of people and objects within the homes are constantly registered, and this information is used to control technology in anticipation of the occupants' needs.

Example: The lighting "follows" the residents around the house without the need of interaction.

These types of smart homes are conceptualized as hierarchical in respect to the amount of technology and its complexity. The attentive home was thus described as ideal view of smart homes – at least in the early 2000s when Aldrich and Randall presented this conceptualization (Webb 2011:19f). This categorization of smart homes allows me to describe the type of smart home this study deals with based on the degree of complexity of the technologies and information networks and on some defining functionalities: for example, remote control and access to internal and external information and services for the connected home. It refers only to technical aspects as defining elements. Another way of seeing it could be as a range of different visions of the digitalization of building technology services and how interaction

and the relationship between human and smart home technology is imagined. The categories of learning and attentive homes could be considered to be linked to ideas of technology as not just taking over tasks but also reasoning, while the connected home seems to reflect other ideals, more based on the idea to offer new forms for controlling the home and empowering the inhabitants.

In the early 2000s, many researchers and experts from the industry assumed that smart homes would bring about radical change in human technology interaction. It was expected that technology would take over responsibilities and reasoning from the inhabitants and let them be “dumb” (Harper 2011:3). This did not come true, of course, and neither have learning or attentive smart homes materialized. While some might have abandoned the idea of the attentive home other projects still aim in that direction. Smart homes of the connected home type described by Aldrich have been built and new ones are built every year. All but one of the people interviewed in this study lived in a smart home of that type.

Barlow and Gann, who do research in the fields of technology and innovation, on the other hand, conceptualize the smart home based on the level automation of the home environment which can range from fixed “pre-defined and pre-established operations”, to “programmable applications”, to “fully flexible and automated applications” that share information with other devices. Their vision of a smart home includes ideas of information technology that can exchange information within the home and make use of external information services (Barlow and Gann 1998:7). The question of automation is interesting as automation is sometimes perceived as giving away control and one might ask how much control are people comfortable with handing over to an intelligent device or system. These ideas have also shaped the smart homes visited for my research, they are focused on facilitating and automating the control of a panoply of functions. On the other hand, making use of external information services for the home system was generally limited to one or two online services.

These two conceptualizations of smart homes are based solely on the technological infrastructure and the complexity of the systems functioning, leaving aside the socio-political and economic context in which it is negotiated and integrated. Relating these to the inhabitants’ concerns, practices or the already mentioned digital housekeeping seems important. Researchers from the social sciences such as Heusinger or Taylor, Harper & colleagues have, in my eyes absolutely righteously, questioned the notion of a smart home. The people in it, and how they organize themselves and their environment, are already smart not the home

technology, they argue (Heusinger 2005:3; Taylor et al. 2007:384). Harper emphasizes social connectivity of domestic technology, locating the real issue with connecting people in the household and beyond instead of in an all connected home system (Harper 2011). If I still use that term it is because it is so widely used by professionals, users and in research and as a synonym for the “connected home” described earlier. However, it is not to be taken as a classification of a “smart” against a “dumb” home or a “smart” home versus “not so smart” inhabitants. Changes to home and the domestic life might take place in subtle, even banal ways. Ethnographic research is well suited for shedding light on to this.

1.1.3. Smart home and issues of control and security

Representations of intelligent homes in popular culture range from ideas of a dreamlike home that knows all the inhabitants needs and wishes to the nightmare of “Big Brother” constantly surveying individuals even in the privacy of one’s home (Albrechtslund 2007; Orwell 1990). There is some potential of being surveyed or of an abuse of personal information when a system is hacked, just as it is with computers. Albrechtslund and Ryberg (Albrechtslund 2007; Albrechtslund and Ryberg 2011) speak of surveillance in respect to smart homes, referring to an idea of Janus-faced surveillance between care and control. In the surveillance studies “surveillance” has been defined as systematic attention on objects and/or people for managing, regulating, administering or securing (Klauser 2012:4f). It links, among other things, control and security to the concept of surveillance. Surveillance might be a possibility for discussing social control mediated by smart technologies or the sharing/analyzing of data with/by service providers, yet less so for the idea of control as interaction with the home technology (control of, over or through smart home technology). Still, the surveillance seems to focus on institutional power dynamics and not on household relations or human-technology relations. Moreover, connected home systems are not necessarily directly networked with other houses, external services or state agencies. I therefore refrained from discussing control and security with respect to the theoretical concept of surveillance.

Dictionary definitions of control comprise: to check, test, or verify, to exercise restraining or directing influence or to have power over something or someone. Regarding home automation researchers speak of control in a variety of ways. Control can be linked to security (e.g. access control), remote control and the wish to check out the home from afar, automating functions and to what extent people are willing to give control away to smart devices. Wilson & colleagues ask for more research on how smart home inhabitants relate to and deal

with questions of control and privacy. They argue that technology studies have considered these issues only in terms of how design needs to be changed for better acceptance (Wilson, Hargreaves, and Hauxwell-Baldwin 2015:472). Control can also mean caring for something (Albrechtslund 2007:8) and can be considered central to family life (Randall 2003:231). It links up to questions of power relations within and beyond the household: Who has control over whom or what and to what extent? How is control distributed between people and devices?

The question of security grew out of one of these multiple meanings of control – controlling access, lighting or other things for security reasons. Security is described in the dictionary as the quality or state of being secure, such as freedom from danger or from fear. Something that secures is a measure to guard against various risks. Home or private security then refers to protecting the domestic environment from intruders, the protection of property and persons (and the feeling of security itself). When thinking of connected homes, that continually produce, gather and process information, concerns about security sometimes extend to the protection of this data. There is a variety of security goods available such as alarms, bars, gates, and video cameras. In the smart home industry “security” is not only a label to advertise alarm systems or smart video cameras, it refers also to different forms of monitoring the condition of the house and those who are in it. Are windows open? Is there still light on?

Sociological research on private security is mainly concerned with the private security industry, how it shapes security consumption and how that might be linked to different forms of state governance. Some other studies examine the access possibilities for unequally situated people to security resources. My interest in security lies in what is sold as security goods, what inhabitants chose to secure their home and what that means for them. These questions are influenced by criminologists and sociologists Goold, Loader & Thumala (2010) who examine “security consumption”. They point out that security goods ‘may like others [*sic!*] goods be desired, compared, talked about, shopped for, used, enjoyed, displayed, discarded, traded on e-Bay or replaced and up-graded’ (*ibid.*:6). They also suggest that security goods may at the same time be a source of pleasure, reassurance or comfort and protection.

Home is central to our well-being. It is ‘a place of familial relations, intimacy, and emotional ties; a place for personal life and privacy from others; [...] a sanctuary that offers security and safety from the wider world’ (Kitchin and Dodge 2011:159). This has been discussed in

terms of “home as (secure) haven” and “ontological security”. Sociologist Anthony Giddens (1984) speaks of ontological security as the security of ‘being-in-the-world’, the confidence in the world as one sees it and one’s own identity. And home can be considered a space where one can feel secure in that sense. I do not wish to discuss the ontological security concept more in detail here, as I am not directly building on it. What is interesting is the link Dupuis and Thorns make between feeling in control of one’s environment and feeling secure in it (Dupuis and Thorns 1998:25). It is thus crucial to inquire into the social meanings, uses and effects of security goods and means for controlling the home.

1.2. Data collection and analysis

For this study, I followed a case study approach to users’ and professionals’ perception(s) of smart home, issues of control and (home) security. The first article on smart domestic technology by social scientists I came across, was “Kitchen Manifesto” (2002) by anthropologist Genevieve Bell and information scientist Joseph Kaye’s. There, they criticized that engineers and designers of smart (kitchen) appliances notoriously ignored the future inhabitants, their sensations and habits. This is a recurrent critique made by researchers in science and technology studies (STS). This field of shifting ideas and understandings of and expectations toward smart home technology between producers/designers and end-users/inhabitants seemed interesting for my own research. Initially, I hoped to do the research for my master’s thesis with and for a Swiss producer of smart home technologies. The product manager of a local company whom I contacted for a possible collaboration seemed very interested in my research proposal and would have been keen to know more about end-users’ perception of different options for controlling smart home technology. He had promised me an internship in the marketing department, which he had to withdraw weeks before I would have started. I then decided to concentrate on inhabitants’ perception of their smart home rather than how the understandings of smart homes diverge between designers/producers and users.

I received three contacts from the before mentioned company’s customer consultants; however, none of the persons contacted was willing to participate in my research project. Similarly, unproductive were my emails to other Swiss enterprises (producer, integrators, real estate agency) asking for customer contacts. Producer companies often don’t sell to private costumers and thus have only few contacts to end-users; integrators argued for the privacy of their clients (as some reference images suggest they have very wealthy clients); the real estate agency I contacted and where I could talk to the head of strategy and visit two model

apartments, had its first project under construction. Getting to know people living in smart homes was more difficult than imagined.

Not knowing anyone with a smart home, it was not obvious where to start my search if not with the help from professionals. How do you recognize a smart home? It's not like there is a signal outside saying, 'this is a smart home'. When observing a house for several days you might be able to tell, whether stores or lights are automated, but more than that probably not.

Eventually, I managed to get three contacts from an independent customer consultant, whom I also interviewed. Two of them participated in my research. Three friends of friends were also willing to show me their smart home and answer my questions. Additionally, I decided to post a call for participation on a Swiss online forum on house building and gardening. However, I refrained from posting it on providers' forums which concern mainly people who program and manage their home automation system on their own in order to prevent too much of a bias in that respect.

Between January and March 2017, I conducted eight semi-structured interviews on with individuals and couples living in smart homes (ten people in total). These interviews focused on the interlocutors' motivation for making a smart home and how they went about it, how they feel about, use and negotiate the use different ways of automating and controlling the home and security measures and gadgets. All but two of them took place at the participants' houses which helped me to get a better idea of how they lived and what their smart home was like. The other two interviews took place on the phone. In most cases participants showed me around their home and/or showed me the floor plan of their house on a visualization device. I took notes on the house, the people and the interview. I also added some observational notes on the neighborhood for each case. Furthermore, I participated in an end-user seminar where I met a man who had recently moved into a connected apartment and with whom I was also able to speak about his frustration with inexperienced professionals, his wish to learn simple programming of his home system and experience with alarm systems.

Other studies have already shown, many of the people who today live in smart homes are tech-savvy and consider the smart home system their hobby (Mennicken 2016:81, 86). This was generally also the case for the participants in this study. All of my interlocutors (with one exception) considered themselves to be technophilic and most of them worked in a technical profession (I might thus as well have recruited more participants on more specialized

online forums). They had been living in their smart homes for between sixteen years and only a few months – most of them for two or three years. In five cases the smart home technology requiring extensive wiring had been introduced during the building process, in three other cases it coincided with major renovation projects and one case was somewhat exceptional as it was a rental where no such rewiring was possible and (often WIFI-connected) devices were added spread over several years. Some basic information on the participants and their living situation is summarized in table 1.

It is noticeable that only two interlocutors were women. In some cases this was because the men I interviewed lived alone or with their children. In another case, the girlfriend was not interested in the smart home thing and left it to her partner to answer my questions. This has clearly influenced my findings, as in most cases the men were the ones who had taken over the main responsibility for the home automation system. The interview with the couple of household 3 most clearly showed me how household members use and feel about it differently. It would certainly have been enriching, if I had been able to talk to more women.

In addition to the end-user interviews, I talked to several professionals – customer consultants, heads of marketing, an integrator and a software programmer – conducted interviews (see table 2 for presentation of interviewees) and visited four show rooms and a small exhibition space in a ‘building and living faire’. In the interviews with the professionals I concentrated on how they view their customers or end-users and their assessment of security issues. During the analysis phase, I recontacted three professionals for a few follow up questions, mainly to learn about where they had their visions from, and received responses from two of them.

Household	Participant (age, gender)	Occupation	Housing	Other members of household
H1	Gabriel (37, m)	Mechanical engineer	Detached Minergie-P house	Wife, two children
H2	Beat (56, m)	Self-employed business economist	Old, renovated villa	Two children
H3	Lukas (31, m) Lea (29, f)	Businessman Assembly-line worker	100-year-old detached house	Newborn, two cats
H4	Ursi (58, f) Daniel (55, m)	Teacher IT programmer	Semidetached house	Adult child
H5	Markus (32, m)	In family-owned electric shop	Detached (Minergie) house	Girlfriend
H6	Tom (47, m)	Self-employed in IT	Semidetached house	By himself, one cat
H7	Jan (28, m)	Project manager (IT)	Apartment	Girlfriend
H8	Nick (32, m)	Project manager electrical engineering	Detached house	Currently by himself, separated from wife
H9	Peter (62, m)	retired draftsman	Apartment	Wife

Table 1 Participants living in a smart home

Participant	Occupation	Company
Mr. Tanner (58, m)	Self-employed customer consultant, teaching, board member of two professional Swiss home automation organizations	One-man business
Mr. Meyer (46, m)	Customer consultant, teaching, business owner	Family business consulting private house builders, programming
Mr. Schmid (42, m)	Software Engineer	Swiss market leader for electrical installations
Mr. Studer (47, m)	Head of marketing and teaching	Leading provider for electrical installations
Mr. Vogel (37, m)	Head of company development and marketing strategy	Real estate agency

Table 2 Participants working in the smart home industry or related fields

For a traditional ethnographic research, it is generally not just about interviews but equally about opportunities to conduct participant observation. Maybe I was not brave enough in this respect, not asking participants for possibility to stay with them for some days or weeks. That would have felt too intrusive for me. Instead I limited myself to some home tours where the participants accepted it. Another option would have been to ask participants to do self-observation. At the point the interviews took place, I could however not identify any clear objectives and dropped that idea as well. Only towards the end of the research period did I find out about the seminars that some producers offered for their clients. I participated in one such seminar which should enable users to make easy calendar related automations on their own. This might have been another entry point for my research, if I had found out about this form of seminars earlier and if there were more participants than just one or two as it was the case in the seminar I attended.

The data for this research consisted thus mainly of interviews with people living in smart homes and others working in the smart home market or a related area. The transcription of the interviews was an important part of early analysis during the months of data collection. Transcribing all the interviews helped me rework the interview guide and reflect on my interviewing technique and role as an interviewer. In addition to the interview transcriptions, my data consisted of observational and analytical notes, and flyers and other information I had received from the professionals. Furthermore, I received brochures and specialized journals from the professionals I had interviewed. Also, I read through some threads on the forum where I had contacted three participants. These were particularly those on which my interview partners from the forum had commented and a handful of other threads which seemed to be interesting with respect to the question of how people secure their homes.

From the start on, I tried to anonymize all my notes and transcripts. I did so by using codes and numbers, which was easy to work with but not very readable. Therefore, I have decided

to give them names. In order for the reader to be able to easily recognize the names as either appertaining to a participant living in a smart home or a professional and distinguish them from those of researchers I refer to, I use first names for smart home inhabitants, last names (respectively, Mr. XY) for professionals. This reflects also my relation to the participants insofar as I was on a first-name basis with most interviewees who lived in a smart home. The names for the participants used hereinafter are made up and the places where they lived were anonymized. Household H4 is the only exception to this as their case is famous in Switzerland. Ursi and Daniel had moved into a testbed smart home, the FutureLife house, as early as 2001 and it was their job to test smart home technologies during the three years the FutureLife project was on. The family has been in the media and they have agreed to be presented with their names.

A first approach to the interviews consisted of a global analysis and the elaboration of case profiles as described by Uwe Flick (2009:319, 328). To the case profiles of the users, I added a more technical sheet which consisted of a list of the connected components of each household's smart home system, changes made or planned and problems if there were any. This gave me a better overview and understanding of the specific cases and parallels between them. This step was followed by another wave of reading before I felt ready to tackle the fine analysis. For more in-depth analysis, I went through further rounds of coding. Thematic coding, I felt, was most adapted to my aims of exploring the range of individuals' perceptions of and experiences with smart home technology. Also for comparing users' and professionals' views this seemed most appropriate. This allowed me to carve out broad steps in the construction and domestication of smart homes and to compare contrasting positions on and practices relating to different aspects of control and security issues.

1.3. Reflections on my access problems

Here, I'd like to share some of my reflections on my difficulties in recruiting participants at an early stage of this study. What helped me through the struggle of searching participants were my friends who introduced me to people they knew had a smart home, my supervisors' challenge to be more insistent – I admit this cost me some effort in the beginning. An article by Sherry Ortner on “access problems” (2010) also worked as an eye-opener. Reading about her difficulties in entering a new “field” was comforting. She asserts that while many anthropologists experience more difficulties than expected in entering a field “at home”, “anthropologists have always had access problems; it is part of the very nature of fieldwork”

(Ortner 2010:212). I made this my moto and, eventually, I managed to gather enough participants and data to build my study on. The possible reasons for my access problems are manifold.

Firstly, there is no smart home inhabitants' community. The professionals are, of course, well networked and form some sort of community. This is not the case for the residents and it was not central for my research – it might just have made it easier to identify them. As mentioned earlier, there are online forums where people interested in smart homes connect, learn how to program specific functions or discuss their problems with this or that device. These forums might be an interesting object of study for a further research but were not so in the present study.

Secondly, homes are generally considered a private, intimate place. For some, my explicit wish to meet them in their homes might have been good enough a reason to deny an interview. This can be seen in the case of one of the interviews in this study. Markus, who had contacted me on the forum, was happy to discuss his vision of and experience with smart homes with me. However, he asked for a telephone interview as his partner did not want him to invite me – someone met exclusively on Internet – to their home.

Thirdly, securing the home (or data) is a delicate issue. Another participant, Tom, stated, when asked about whether he would be willing to answer me some questions about home security, that he might not answer all my questions about (data) security out of security reasons. Explaining me in detail how he secures data flows in his home and what protocols he uses, would have been like unveiling his protection.

Finally, interest or curiosity in the research or in what I as a researcher can offer is crucial as others have pointed out (Ortner 2010:217f). In this research project, the people willing to participate in the research all had an interest in the results of my study. The users were generally curious to learn about others' experiences with smart homes and their home solutions and the professionals were interested in learning about different perspectives on their work and their clients. Therefore, I discussed possible forms of a return with them from the beginning on. Most of the participants had studied themselves and that was probably also a plus insofar as they could relate to the format of a master's thesis. Their interest in my research and their trying to understand the interest in such a research also helped me to further develop my research question.

2. Setting the scene: Connected homes

In the previous chapter, I have tried to scope the term smart home defining the participants' houses as a connected home. But what does such a smart home look like? What technologies are there in smart homes? In order to give the reader who is unfamiliar with smart homes a better idea of what such a house might look like, I will present a connected home, its smart devices and how they can be used in the everyday life. It is a hypothetical example, a mix of my observations from the different homes I have visited for this study. This hypothetical example is followed by brief descriptions of the interviewees' smart homes.

Imagine a couple, let's call them Andrea and Marco, who have built their single family detached house three years ago in 2014. It's a modern house with big windows, flat roof and a small fenced-in garden where they live with their two children.

Entrance/hallway The intercom at the front door has a small camera integrated. This way they can see who's at the door – thanks to a smartphone application – also when they are not at home. Some people might wonder what this could be good for; Marco appreciates the possibility of speaking to the person ringing the door via the app. For instance, he can tell the postman to leave the packet at their neighbor's when he's not at home. Furthermore, a fingerprint reader unlocks the door for the family, so there is no need for a key.

When entering, you push a button next to the door and the house's status is changed from 'absent' to 'present'. Thereby the alarm system is turned off and the lights come on in the hallway and the kitchen (for if you come home with full hands from grocery shopping). This works also the other way around: If you are the last to leave the house, you can push the button and the status is changed to 'absent'. Thus, all the lights in the house are turned off, the heating is set to a slightly lower temperature and the alarm system is on. Andrea, Marco and the kids use it all the time. Near the door, there is a touch screen panel fixed to the wall. It is one of two central interfaces for the home system. Through this panel you can control all the devices and services connected to the system, you can make some basic configurations to the system, you can check whether all the windows are closed when leaving the house or change the status to 'holiday' if you are all leaving for a few days. The 'holiday' status starts a presence simulation, opening and closing the shutters, turning the lights on and off letting the house appear occupied.

Living/dining/kitchen This is where the family life takes place – cooking, eating, entertainment. The space was designed to be open and big windows on two sides provide a lot of natural light. The windows heat up the room easily when the sun is shining. This is very welcome in winter times and helps minimizing heating costs (the heating is linked to a weather service and will not heat as much as normally if there will be sun). On the other hand, in the summer this effect is not welcome and the family is glad the shutters and sun-blinds go down/out automatically if the weather station indicates a certain degree of brightness.

Normally the sun light is sufficient during the day for cooking, eating and the children playing. On very cloudy days or in the mornings and evenings the lights in the kitchen, over the dining table or in the living room will go on (and off) automatically when sensors register movements. After 9 pm, when the children are in bed, the lights in the living room area and the corridors are automatically dimmed. Of course, there is also the possibility to light the light or open the shutters manually via 12 digital switches. Two of these have a “scene” attributed to them, that is, several actions are coordinated to reproduce a certain atmosphere. One of the scenes closes the shutters in the living room, dims the lights, turns on the TV and activates the ambiance lights behind the couch. The other scene-command they use occasionally when they have friends over for dinner – lights over the table and RGB lighting¹ on the far wall of the living room come on and the music system is tuned to a jazz radio station on a very low volume.

Marco and Andrea do not have any kitchen appliances that are connected to the home system. The stove and oven are programmable and “know” a series of recipes, but they are not connected to the rest.

Basement/laundry room In the basement there is a small engineering room with the mini-server and all the wires running together. A very tech-laden room, the center of the smart home but not much used. There is also a room for the laundry and some storage space. There are no push-buttons for the light, it is entirely worked by motion sensors or, if it does not work as wished, by an app on the smartphone. The washing machine and the tumbler are both connected to the system and send a message when they are finished or the remaining time can be checked from the central panel and the app.

In the above example, I have tried to describe a smart home with its functionalities and technologies and as a place where people live. It does, however, not intend to show how daily practices form around the technology or how this is negotiated. Questions like these are the topic of the remaining chapters. There is not just one way of integrating a smart home technology in houses or apartments, which can be seen by looking at the families and their houses I visited for this study. Opinions differ on how much connectedness, intelligence and automation is required in order to classify a house as “smart home”. The following short descriptions of the house(hold)s visited show a range of connected homes and are intended to provide the reader with an insight in the participants’ homes.

¹ RGB lighting (Red, Green, Blue) can constitute any color of light from orange to purple or cool blue.

Household 1

Gabriel lives with his wife and their two girls in a small industrial town in the canton of Solothurn. Their Minergie-P Eco² house was built in 2013. Gabriel had equipped it with Loxone³ by himself because it seemed affordable, possible to do it by himself and compatible with some KNX⁴-products that he preferred for their cost-value ratio. He wanted a modern home and it was clear to him that it would have to be automated, even though his wife was initially skeptical about it. The shutters are automated, they have lighting scenes, the lights work primarily via motion sensors but in most areas they preserved switches as an alternative control. They have presence simulation and a DIY burglar alarm. The aquarium, too, is integrated into the system, but Gabriel has not yet been able to integrate the heating and air conditioning.

Household 2

Beat considers himself a technophile. He and his two kids live in a five-storied villa near Zug, which was completely renovated in 2007/8. At that point, a smart home system based on KNX was implemented, the house completely rewired with several kilometres of cable. Some years earlier, Beat had already had his holiday house augmented with automated shutters, temperature control, networked light and music and remote control. For both projects he worked with Mr. Tanner, who established a set of rules and set up the calls for proposal for the projects. In the villa heating, shading, lights, music, as well as home office, home cinema, pool control and control of the wine cellar are all integrated into the system. Beat made a point of planning for future use and technologies. The system is prepared for integrating a solar power system and there was already a special socket for an electric car.

Household 3

Lea and Lukas live with their baby and two cats in an old house in the canton of Solothurn. They have started to renovate the house floor by floor for four years ago. Their new heating came with the option to remotely control it, either via the provider's solution or if integrated into a smart home system. After some research, they opted for Loxone, connecting heating, lights (no programmed "scenes") and a solar thermal system. Temperature sensors also work as fire detectors. Saving energy and thereby money is of value to them, specially to Lukas. A visualization app tells them, how much energy was produced and used or whether the dishwasher and washing machine should be run in "solar" or standard eco mode. The renovation process has reached the top floor, where they plan to add further devices and functionalities such as window sensors, automatic shutters, and light scenes.

² Minergie presents itself as a 'Swiss standard for comfort, efficiency and the conservation of value'. Minergie certified buildings stand out due to low energy demand and high percentage of renewable energy. Buildings that follow their construction requirements can be certified as Minergie, Minergie-P referring to ultra-low energy housing, and Minergie-A for maximal energy independence, respectively. Eco is one of their extra certificates. It guarantees the use of health-conscious and ecological materials (Minergie NN).

³ Loxone is an Austrian producer/provider of smart home devices based on their own standards and protocol. Loxone aims at producing affordable smart home technologies for house- and apartment owners and renters. They propose two lines of products, one communicating via Wifi, the other hardwired (Loxone NN a).

⁴ KNX is an international communication standard for smart home devices. See p. 29.

Household 4

Ursi, Daniel and one of their adult children live in a semi-detached house in Hünenberg am See (canton Zug). In 2000, the family applied to participate in a pilot smart home project and were chosen. For three years they worked full-time testing new smart home technologies in everyday life and welcoming hundreds of visitors, while living in the other half of the two-families house. They participated in the planning process for the construction and automation of the house. From the front door through lighting, HVAC, kitchen appliances, music to the garden irrigation system, everything is connected. When after three years the testbed-project financed by the Beisheim Holding was stopped, they bought the house and moved in to completely live there. Over the years, several changes to the house and the system were made. Some technologies were dropped, others added. For example, sustainability is important for Ursi and Daniel, but not for the initial project. Therefore, they later added photovoltaic modules and a geothermal probe.

Household 5

Markus and his partner built their home in 2014/15 doing as much as possible on their own, realizing their dream home. It's a modern low energy house in Solothurn's country-side. Markus made a point of saving energy and having a house that regulates itself as far as possible. Lights, shutters and ventilation have been integrated. When unlocking the door (fingerprint), lights come on in the entryway, the stairs and the kitchen on the first floor. There is a wood stove for heating and solar panels were to be added, but have not yet been as this was too expensive.

Household 6

Tom updated his semi-detached home near Zurich with homematic⁵. This was partly due to the malfunctioning of the existing shading system of the sunroom and because the light switch in the bedroom was not where he wanted it to be. Partly, it had to do with a professional interest – among other things he sells such products. He made a point about data security, which is why he spent a considerable amount of money on a good firewall (not just for the system, but mainly because of his servers). Encryption for remote control was also an important point for him. Although Tom does have several IP-cameras connected to the system, none of them show living areas. Also, some of the projects he realized were just in order to see whether and how he could make them work (e.g. control via Apple's Siri voice control program or the house greeting him when he enters or leaves).

Household 7

Jan and his girlfriend live in a rental apartment in a small city in the canton of Solothurn. Jan considers himself an early adopter and links his interest in new technologies to his job. However, he does not want to spend a lot on it. Instead he is interested in doing it by himself using open source programs, imported controllers and 3D-printed bodies. As it is not easy to realize a connected home in a rental, home automation is here emerging as single projects, mainly in his home

⁵ Homematic is the smart home line of Germany based eQ-3-group. The homematic line counts about 80 products and is based on radio communication, no hardwiring of all the smart components is required (eQ-3 NN a).

office, 'his own little kingdom' as he refers to it. Jan's girlfriend is not against smart home technology, but she wants it to remain practical and does not want to feel over technologized. For now, Jan has not yet found anything particular he considers really useful besides remotely controlling his coffee machine via an app or through a voice control device from Google.

Household 8

Nick and his wife built a house in 2016/17 in the canton Basel-Land, but currently only he lives there. Having studied building technology, he wanted to try something out in his own house. It was essential for him to be able to automatically control the shading and room climate. Security through presence simulation was more his wife's interest. Nick opted for digitalSTROM⁶, which builds on the power line communication, because it is open source based and seemed to offer a good cost-value ratio. In theory, it should have been easy to integrate other systems, but Nick did not yet manage to integrate the heating and air conditioning and was rather frustrated.

Household 9

Peter and his wife, who both have retired, had decided to sell their house which had become too big for them, and bought a new apartment in Appenzell. They had a KNX system installed by their electricians. Peter was disappointed and upset because he felt they had not done a good job, were not well trained and not motivated to do it any better. He had needed support from the producer company several times. They had lights, shutters, heating, and an alarm system.

This chapter set out to introduce the smart home (technology) and to give an idea of what it might consist of. As the brief description of the participants' houses shows, there is not the one smart home. What is integrated and automated differs and, as I will discuss in chapter 4, reflects various desires and priorities (and, potentially, recommendations from professionals or other people who live in smart homes). Of the houses presented only three had professionally installed smart home systems, while the others were implemented by the one of the homeowners with some technical knowledge (generally men). These short texts also reveal that in several cases there have been changes to the system since the installation and that not everything has been realized or is working as it was initially planned. Smart home technology and functionality is adaptable, yet carries potential to cause problems and frustration.

⁶ digitalSTROM (literally, digital power) is entered the Swiss and German smart home market in 2011 with a product that allows to connect digital and analogous devices via power line. Because its intelligent luster terminals allow for communication via existing power lanes, no changes to the building structure or the electric installation is necessary (digitalSTROM NN; Simeon Lutz 2016a: 47)

3. Smart home technologies, visions and market

3.1. Smart home technology: A monitoring technology?

In connected homes like those described in the previous chapter, a number of intelligent devices are integrated into one system which enables them to communicate with each other. Hereinafter, I present different elements of a smart home system and sketch out on a very basic level sketch out how these can communicate and for what ends.

Home automation systems consist of a bus system which connects controllers with input/output-devices and allows them to work in relation to each other. “Bus” refers to a connector system transmitting information between digital control units which can be used by all the connected objects (Lackes and Siepermann NN). The networking needs a communication channel, which allows for bidirectional communication, for example, wire or radio communication, and corresponding interfaces on all the participating objects (Heusinger 2005:91). A protocol (which consists of a set of rules) ensures stability for consistent communication and compatibility. This enables a central controlling device to control various other automation devices also when these are from different producers. There is a multitude of protocols, which led to some insecurity in the European market on which one might establish itself on an international level. Therefore, some associations that had released a protocol have merged. This has been the case of the European House System (EHS), the European Intelligent Bus (EIB) and BatiBus. They have founded the Konnex Association in 1999 and established the KNX-Standard (Heusinger 2005:119). All the professionals interviewed in this study and the three households with professionally installed smart home systems (H2, H4, and H9) build on this standard. The following chart shows some of the prevalent standards, including KNX, homematic, Loxone and digitalSTROM used by the participants in this study.

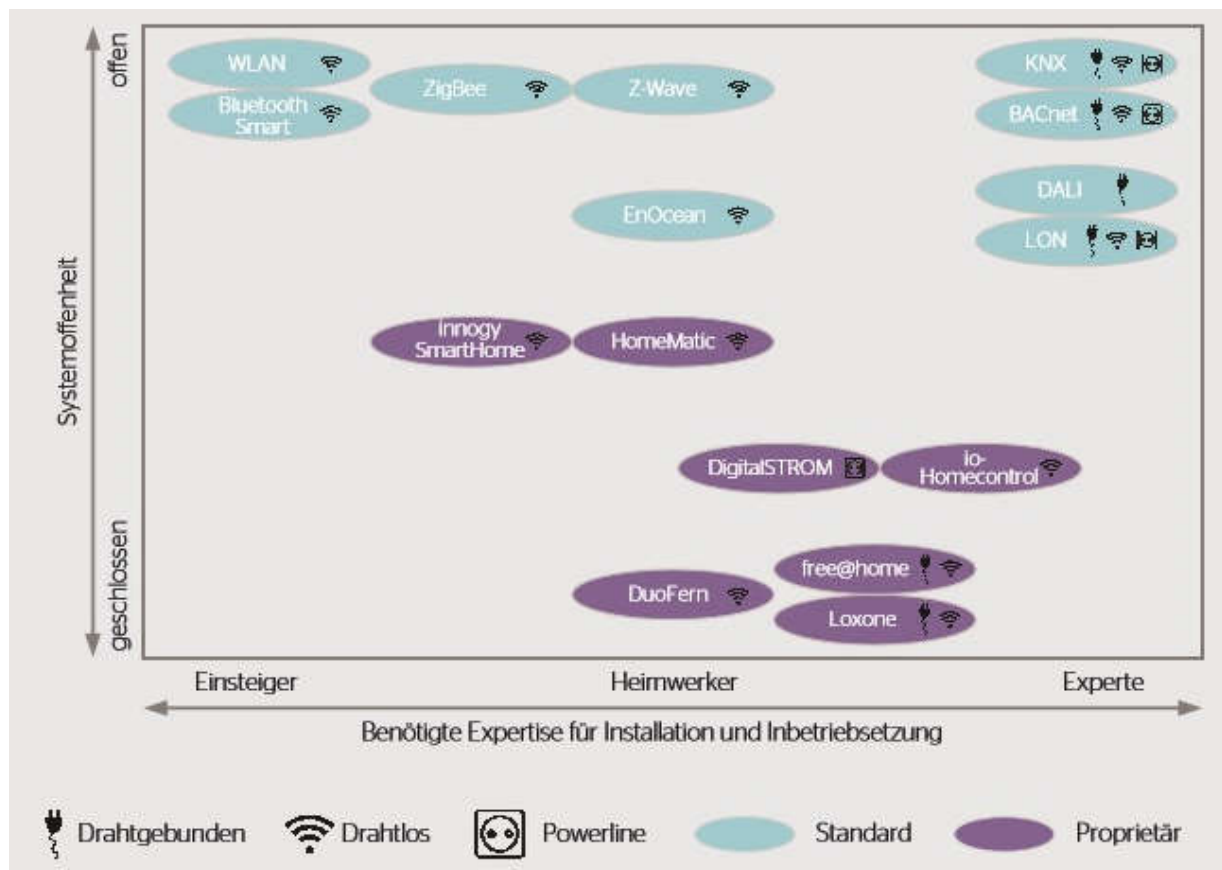


Figure 1 Smart home systems according to their openness and the necessary expertise for the installation and setup.
Source: Steiger and Kaufmann 2017:21.

The authors of this chart classed the systems the study participants had between DIY and expert solutions with different levels of openness, that is, allowing for more or less external devices and devices of various producers to be connected and to communicate via their system. They also differentiate between (international) standards that are used and promoted by many producers of smart devices and proprietary systems (see chapter 3.3.). The chart shows also whether systems are available for hardwired, wireless or power line systems, this implies that physically such networks can take different forms. In existing housing, the telephone wire is generally only in specific places and therefore does not offer itself for a house network. When building a new house, the additional network wires can be taken into account and can rather easily be added in the infrastructure. If this (or in the case of an existing house, rewiring) is not an option, an alternative solution can be to use the existing power-line or radio communication technology. Of the households interviewed only one, Nick, had a smart home system built on power line communication. Two others, households H6 and H7, built mainly on Wifi, and the rest had a special wired bus-system (households H1, H2, H4, H5, and H9) or combined that with Wifi (household H3).

The underlying technology of a connected home is automation. The Encyclopaedia Britannica defines automation as “the application of machines to tasks once performed by human beings or, increasingly, to tasks that would otherwise be impossible. [It] generally implies the integration of machines into a self-governing system” (Groover 2017). Automation is based on the construction of constraints that make it possible for machines to execute repetitive processes and furthermore to react flexibly upon a given number of situations without permanent control by humans (*ibid.*). With digital technologies automation relies on coded constraints. Programming automation requires lived reality to be simplified into workable units and sequences. Programming an automation, for example, of presence simulation is constructed on experience and anticipation of situations and events and might thereby inform future experience and practices (Klauser 2016:149). In this regard, social scientists have pointed out that automation requires specificity and rigidity which does not reflect chaotic domestic life adequately (Strengers 2016:66).

For a smart home system to execute automations, it needs code to define what should happen when as well as the physical means to detect/sense its environment. Heusinger suggests that only when a house is capable of monitoring its environment and deriving actions from the gathered data that seems reasonable, it can be considered “smart” (Heusinger 2005:3). Sensors, which are integrated into the system throughout a room or house, build a network of information sources. These can be scanned, evaluated and actions derived. Inputs can measure temperature, humidity and brightness or whether a device is on or not. Additional information for controlling specific objects such as the sun-blind can equally be provided through internet services, for example, a weather service (Heusinger 2005:27). Output-devices, also known as actuators, control the opening or closing of valves or switches. Controllers have input and output capacities controlling signals and sending commands to devices.

Core functionalities of a smart home are keeping the room climate within a certain range and controlling lighting depending on presence, brightness or time. When speaking of controlling the environment, one can distinguish between open- and closed-loop controls. In open-loop systems a command activates something or puts something into working, e.g. one pushes a switch-button and the light goes on, one opens the heating valve and it starts heating and will only stop when closed again. In contrast, a closed-loop control system tries to achieve and keep a certain value of, for example, brightness or temperature. In order to achieve that, it constantly compares actual and desired values and adapts accordingly (Heusinger 2005:21f). Home automation builds on such closed-loop control, but can also

manage simple controls. At the same time, a connected home can be considered itself the object that needs to be regulated, managed and controlled. Connected homes, even learning or attentive homes, need initial deployment, structures and functionalities. They need to be programmed and adapted to the households' and individuals' desires, expectations, changing lifestyles etc. From time to time intervention or maintenance work is necessary and reliability is sometimes an issue (see chapters 5 & 6). Everyday interaction with and operation of connected devices happens through presence detection (either motion control or (infrared) cameras) and dedicated interfaces. These include digital push-buttons, visualizations on built in touch panels, apps, voice or gesture control, and finger print readers (in the case of automated doors). This list is not supposed to be an exhaustive list but to provide an idea of the different ways one can interact with such a system.

Some of the smart devices might look just like their analogous counterparts – smart stoves, washing machines, or digital switches. They are at the same time very similar – they perform similar roles – and inherently different. Digital, coded objects generally have more functionality and additional ways for interaction. They are often programmable in complex ways (Kitchin and Dodge 2011:5, 174). For example, humidity and temperature sensors can be used to detect hazardous situations such as water in the basement or high temperature as a sign of fire. Humidity or temperature information can, when interpreted as flood or fire, be used as constraints for further action sending a message to the homeowners, starting a siren or directly contacting the firefighters.

3.2. The smart home in the view of the electrification and automation of the house(work)

Here follows a short outline of the historical and cultural development of the electrical mechanization and the later automation of houses and housekeeping. I consider how new technologies have altered social relations between humans and technology and everyday practices and how this same technology is a manifestation of science models and popular culture.

In the beginning of the 20th century, the electrification of houses and new domestic technologies lead to what Schwartz Cowan called the “industrial revolution in the home” (1976). In the USA, 80 percent of dwellings had been electrified by 1930. This trend did not only mean that gas or oil lamps were changed for electric lights, but more importantly new electric domestic appliances were introduced into the house. Some of these were the electric iron, the electric washing machine, a gas or electric stove, or the refrigerator (Schwartz Cowan 1976:4–7). Around the same time most households got central heating, which allowed for

running cold and hot water. Around the same time, personal hygiene routines changed with the industrialization of the bathroom industry in the 1920s as prices for sanitary fixtures dropped considerably. This was paralleled by an overall growing concern with cleanliness of the home (*ibid.*:6f, 14).

As a result of all the technological change in the houses of the 1920s and 1930s, Schwartz Cowan speaks of it as an "industrial revolution" in the home. She suggests that technological changes in industry and house have equally eliminated jobs or tasks and created new ones, which often necessitated new skills but took about the same time to do (1976:9). The changes the mechanization brought were not the ones expected. For example, it was expected that electric domestic appliances would bring about the liberation of the housewife. While the housewives needed no longer assistance from servants, they had to handle all the chores of the household by themselves (*ibid.*). Furthermore, a new theory of child care expected them to do new things such as sterilizing their children's bottles and ensuring they ate nutritionally balanced meals (*ibid.*:13). The introduction of electric domestic appliances and, later, entertainment media changed not only practices and housekeeping routines but also the perception of dwelling, housekeeping tasks and family entertainment.

Today, fridges and washing machines have become normal and so has electricity in all the rooms of the house (Frick and Tenger 2015:21). Since the 1980s there has been a shift from analogue technologies to digital ones. For example, with telephones, cameras, and TV transmission (Barlow and Venables 2003:252). While still similar to the analogue predecessors, the digital technologies open up new possibilities: "the nature of a significant number of these objects are changing as they increasingly become infused with software. Domestic objects are gaining capacities that extend their technicity and enable them to do additional work in the world" (Kitchin and Dodge 2011:159). The migration of the PC and networking from the office into the house did not bring work home to the extent expected (Bell and Kaye 2002:51; Harper 2011:3, 7). Although early versions of smart homes have existed since the 1970s, the development of home automation technology depended on the slightly more recent dissemination of computers and networking technologies into the houses. A smart home system is a form of building automation or building management system and has migrated from office and other functional buildings into private houses like the computer.

Although building services such as heating, lighting or water are traditionally stand-alone, home automation has been promoted and advanced by the HVAC (heating, ventilation and

air conditioning) sector. Today, different HVAC solutions are automated. For example, central heating needs some degree of automation, but it may not necessarily be considered smart if it is an “island solution” not connected to other services and cannot be controlled remotely (Heusinger 2005:109). The traditional separation of these systems and professions in turn, calls for improved communication and work across the professional gaps to realize a fully connected smart home. This might require reorientation in various work areas. From my own observations, I can tell that it is generally electricians who prepare the installation and either them or specially trained integrators, who have a deeper knowledge of programming, who set up the system, connect devices and define functionalities. This later process might, however, also require further knowledge about HVAC.

An important part of automation is programming. Forsythe in a study in artificial intelligence laboratories and, more recently, Kitchin and Dodge in relation to an exponentially growing number of coded objects have pointed out that code is a manifestation of the programmers’ lab or work culture, of a system of thought (Forsythe 2001; Kitchin and Dodge 2011:26). A coded object and its functionalities thus become an expression of a model of the world. In analysis of the visions of smart homes, social scientist Yolande Strengers (2016) emphasizes that the smart home agenda is not neutral as it seeks to intervene, to optimize, to render more efficient or more energy saving. She distinguishes three visions of the smart home:

- “The quantified home” is shaped by a numerical logic produces masses of data, assuming that this allows for better management and empowers “consumers” ‘to “take control” of their consumption and make “informed choices” about how they use energy” (Strengers 2016:64f)
- As “automated home” the smart home embodies automated control, that is, the house is told what it should do in this or that situation and the it is let to the smart home system to monitor and act, replacing human labor (*ibid.*:65-67)
- Advocates of the “enhanced home” view automation as supporting and enabling inhabitants’ needs like a modern, silent servant (*ibid.*:67f).

Kitchin and Dodge describe smart homes as "the latest incarnation of a longstanding modernist fantasy of technology capable of producing orderly domestic spaces and maximizing leisure time" (2011:176). For example, research – developing and analyzing new technologies – often assumed that technology directly influenced working time by reducing it. This in turn was assumed to increase free time (Wajcman 2008:66). This becomes visible in terms

like time-saving or labor-saving technologies and time-using or time-consuming technologies. While the first terms refer to domestic appliances that are considered to free up leisure time by reducing the time (or labor) needed for specific tasks, the second refers to entertainment goods which take up free time, seemingly improving it (Aldrich 2003:20). Webb suggests that electronic time saving home appliances had allowed for big progresses in saving time in the beginning, whereas new appliances generally do not save much time compared to older ones (2011:22). On contrary, Schwartz Cowan argues that time- and/or labor-saving technologies did not make up for a considerable change in the time and labor allocated. As an example, the early electronic washing machine did “save” labor. Washing was not the same hard work anymore (although the hauling and lifting of the wet wash continued to be energy-sapping). However, it was not saving much time as the machine had to be supervised, stopped, (re)started and soap added because it did not yet go automatically through the different cycles (Schwartz Cowan 1976:5). What is more, today, some appliances such as the dishwasher or the washing machine might even take longer while being less energy intensive and thereby saving money. Social science research emphasizes that “[r]ather than simply saving time, technologies change the nature and meaning of tasks and work activities, as well as creating new material and cultural practices” (Wajcman 2008:66).

Considered from the perspective of the electrification and digitalization of the home, home automation can be seen as new field of intervention in the domestic space transforming technologies, appliances and practices. Like earlier interventions it reflects ideas of efficiency (labor-/time-saving) and improvement of leisure time. At the same time, more recent, contrasting ideals and policy about saving energy are also reflected in the vision of smart homes as enhancing resource management. Whether smart homes, as they are envisioned and available today, will become normal like the electric washing machine or fridges did and what impact they might have on domestic life remains to be seen.

3.3. Challenges in the smart home industry and market

The smart home market and industry are growing, but it has not yet taken up and, according to the research institute Gartner, appears to be still at a stage where mostly early adopters have smart home technology (Gartner 2017a). Though, Gartner suggest that this year the smart home market will make first ‘baby steps into mass market adoption’ (Gartner 2017b). Every year there are new providers offering smart home solutions. Big tech players such as Apple (HomeKit) Google (Nest, Google Home) and Samsung (SmartThings) have also entered the market following with standalone and networkable, smart objects and apps. More

and more plug-n-play smart home devices⁷ like Philipps' Hue lamps become available in electric shops.

Some industries are faster in taking up the smart home trend than others. The evaluation of the Swiss smart home industry by the professionals I talked to corresponds to recent market research studies of Berchtold (2016) and Frick and Tenger (2015). They all suggested that electricians (only partly), architects and, especially, the building industry are slow in taking up and pushing this trend themselves. AB, who works in the institutional apartment building and housing industry, agrees with this critique. He sees a significant pent-up demand in this area and laments that real estate agencies just see the initial costs and as housing demand is high there is no need for such investment. According to a survey by Frick and Tenger from the Swiss trend study institute Gottlieb Duttweiler, smart home technologies are a relevant part of daily business for about 50% of the electricians, architects, building services technicians and real estate agents in Switzerland (Frick and Tenger 2015:10). It is slightly more so for electricians and building technicians than for architects and engineers. But architects, engineers and real estate agents, too, do acknowledge the importance of home automation technology in the future. However, Frick and Tenger suggest that there is still some uncertainty about what that will mean and what will (have to) change. Still, they found that demand lags behind the offer (*ibid.*:10,13).

Patrick Berchtold, who analyzed the Swiss smart home market in his Master thesis and developed a business plan for a start-up in the smart home industry, assumes that currently only early adopters have smart home technology (2016). According to the results of a 2010 US-based online survey by the market research institute GfK, millennials and, especially, Gen Y are most likely to make their homes smart in the next few years (GfK 2017:30).

Smart homes are often promoted in functional terms: for convenience and comfort, for security and energy consumption management. At first, smart homes were only available for people who did not necessarily need to save money. Putting potential energy and money saving benefits to the front, might appeal to homeowners and governments or utilities for idealist, economic or political reasons (Webb 2011:22, 23). Yet, many researchers have pointed out numerous difficulties for the adoption of smart home technology by a wider public – necessary infrastructure and infrastructural changes, high acquisition costs and little

⁷ This means, when plugged in and linked to the network, they need no physical configuration or intervention to assure interoperability.

perceived benefits among other things, missing worldwide standard (Aldrich 2003:22f; Bernheim Brush et al. 2011). Also the privacy and security questions have been discussed mainly as barriers for broader adoption and researchers asked what information people might (not) be willing to share and respective implications for the development of new smart home technology (e.g. Komninos, Philippou, and Pitsillides 2014; Zafiroglu, Patterson, and McCreary 2016).

Participants of Balta-Ozkan & colleagues' comparative research on the European smart home market perceived smart home technology as 'prohibitively expensive' (Balta-Ozkan, Boteler, and Amerighi 2014:73). Additionally, Bernheim Brush & colleagues argue in their analysis of potential barriers that the cost of smart home ownership might be high not only in terms of money but also in time, especially so in the case of DIYers. Furthermore and surprisingly, they found that their participants, who all lived in smart homes, did not put much value on automation functionalities (Bernheim Brush et al. 2011:2119). This points in the same direction as the conclusion of the market research institute GfK. They see a need in communicating benefits of smart home appliances more clearly (GfK 2017:28).

My professional interlocutors all agreed that over the past decade prices have dropped and that smart homes have become affordable for more and more people. Berchtold and Mr. Tanner observed increasing acceptance and interest from builder-owners, but pointed out that adoption is still very much a question of finances (Berchtold 2016; Mr. Tanner 2015).

Another problem might be that there is not one worldwide standard for communication protocols. There are several. The problem there lies with ensuring interoperability of devices from different producers. Heusinger considers the establishment of the KNX-Standard through the merging of three associations or the Open Service Gateway Initiative as steps in the right direction, for grater compatibility (Heusinger 2005:124). KNX is today well established in the Swiss smart home market and many national and international producers like Siemens or ABB sell compatible devices. Still, there remains some insecurity about whether a single protocol-standards will prevail at some point and, if so, which. Mr. Meyer laments that some producers follow a double strategy in respect to that open question:

‘What there is, too, is just that there have always been companies, mostly in the industrial sector now, like a ABB or a Feller in Switzerland, that additionally to their world standardization [products] which they have in home automation, [they] build also proprietary solutions, company-specific solutions’⁸ (Mr. Meyer 2017)

Messrs. Meyer, Tanner and Studer are committed to, promote and count on the KNX standard for its openness, while proprietary systems are seen as threat and as a sign that the companies are not yet ready to completely commit to and thereby strengthen the KNX standard. Companies like the ABB and Feller, mentioned in the quote, position their proprietary systems as simpler solutions – simpler principally for the electricians who install them (Mr. Schmid 2016).

All the estimations suggest that the smart home industry and market will continue to grow also in the light of the barriers mentioned. Most of the barriers for adoption mentioned here were also of some relevance for the people living in smart homes interviewed in this study. Some of their negotiations around the acquisition and implementation of their smart home technologies deal with the topics considered here and are discussed in the next chapter.

4. Building a smart home

Integrating a full home automation system can be a rather complex and expensive project. At the same time, potential benefits and possible changes it might provoke are not always evident. This chapter focuses on the domestication⁹ of smart home technology into houses. Early domestication research focused on the adoption (or nonadoption) of new technologies and suggested that

‘Such domestication processes include the effort before acquisition to imagine how technologies might find a place in the home and a role in people's lives. They include any household discussions, where relevant, about the decision to acquire these ICTs or not. After acquisition, the effort continues in terms of locating these ICTs in domestic routines and spaces’ (Haddon 2006:196).

In smart homes that are hardwired like most of the interviewees’ houses, the decision over where the devices should be located needs to be taken before the hardware and software is acquired. Therefore, I will here consider the households’ and interviewees’ interests and

⁸ ‘Was auch ist, dass es halt immer wieder Firmen gegeben hat, die... vor allem im Industriebereich jetzt, wie... wie eine ABB oder eine Feller jetzt in der Schweiz, die zu ihrer Weltstandardisierung, die sie in der Hausautomation haben, noch proprietäre Lösungen bauen, firmenspezifische Lösungen.’ (Mr. Meyer 2017)

⁹ I introduced the notion of domestication under point 1.1.1. It refers to the ‘taming’ of ‘wild’ technology to bring it into the home.

motivations for acquiring smart home technology and the challenges of installing it. The few researchers who have studied the domestication of smart home technology in the initial stage, the process of planning and installing, emphasized the knowledge and practical work that goes into the making homes “smart” (Nyborg 2015; Tolmie et al. 2007; Tolmie et al. 2010). Their studies focus on the installation of a few devices and technologies for testing or market research. This study includes families who had decided to install smart home technology for multiple reasons and, besides the former testbed house of household 4, none of these smart home projects were linked to (official) market research or other studies, but simply for living.

In a first step, I present the research participants motivations and aims. I then turn to the arguments and challenges that shaped their smart home projects during the planning and preparation process, touching also on the installation of the smart home technology. The process of adapting the technology (and adapting to the technology) that follows the initial installation will be discussed in the next chapter.

4.1. Reasons and desires for getting home automation

The previous chapter mentioned a series of barriers for smart home adoption by a wider public. Also, several of my respondents stated that they had known shutter (and light) automation offices or universities. They were rather ambivalent if not to say critical about these systems, stating they had had discussions with their colleagues on their meaningfulness or that they were rather ‘stupid’. What made them still want home automation?

Smart home technology is generally considered and promoted as new and modern. Many believe that it will become a normal feature of housing. I think the homeowners I talked to widely share this opinion, but only three of them – Gabriel, Beat, and Peter – stated this explicitly as their motivation. They all considered it an obvious choice when building or renovating a house these days. Gabriel and Beat further stated that with a smart home installation they hoped to keep options for future expansion open. Gabriel even spoke of smart home technology as though it were already standard in new housing: ‘just more to hold options for the future open, actually, and certain convenience features where I think, if I build something new, then like I have the feeling you would do it today.’¹⁰ (Gabriel 2017). Gabriel

¹⁰ ‘einfach so mehr die Optionen offen halten für die Zukunft eigentlich und gewisse Bequemlichkeitsfeatures, wo es mich einfach dünkte, wenn ich schon neu baue, dann so wie ich das Gefühl habe, würde man das heutzutage machen.’ (Gabriel 2017)

had built a “Minergie-P Eco” house¹¹ a few years ago. While his wife was initially sceptical, for him smart home technology was a given. Others recognized that smart homes were not the reality for many and two, Beat and Jan, identified themselves as early adopters.

While only one of the houses visited was Minergie-certified, several other participants stated saving energy as a main interest. For household H4, who had been living in a smart home for more than fifteen years, their concern for sustainability had led them to add solar and geothermal plants for alternative energy generation. Lukas, Markus, and Nick, who had also planned to add solar and/or geothermal plants, hoped to optimize their household’s energy consumption and thus to lower their expenses thanks to the home automation system¹². Lukas argued that they had already paid attention to lower their energy consumption before that, but a smart home system could help them monitoring it better. Motivations for saving energy can be separated into two fields: saving energy to save money and saving energy for environmental reasons. Although all households (except H7, who live in an apartment building) had (planned) plants for alternative energy generation, only a third of them mentioned energy consumption or saving explicitly as motivation for getting smart home technology.

During the interview, most homeowners associated their interest in smart homes with their general or professional interest in technology. Apart from the two female interlocutors, all (had) worked in technical professions. Of these two, Markus and Nick, worked in the electric installation business. Markus recognized that, were it not for his job, he would probably not have had his home automated. Knowing the technology and what was possible was important for him. Daniel, Tom and Jan worked in the IT sector, where Beat also had some work experience. They all described their interest in smart homes in terms of technical affinity and interest in new developments in digital technologies in general. More than that, Tom, Jan, and Nick talked of their smart homes like of a kind of “field study”. Asked about how he had arrived at the idea of equipping his house with smart home technology, Nick stated: ‘And, yes, just influencing the system without, let’s say, the stupid installation you had earlier, which would absolutely allow for all that [...] But I wanted to try something

¹¹ For explanations see footnote 2 on page 29.

¹² Opinions differ on whether smart homes help saving energy or whether they do not rather consume more energy. In a study of the iHome Lab of the University of Applied Sciences and Arts in Lucerne, the researchers found that many smart home devices use more energy than would be necessary and that their permanent addressability uses more energy than can be economized. Battery-operated devices seem to perform better. The researchers suggest that producers should produce more energy-saving devices (Leiva 2016).

out.’¹³ (Nick 2017). What he means, is that for most of the interactions his smart home allowed, there would have been ways for doing so with a “conventional” electric installation, with electro-mechanic instead of electronic solutions. Similarly, Tom explained, he did not use all the functionalities such as the presence simulator, but that he had simply installed it to know, whether it was doable, how it would be and how it behaved. They depicted their smart home projects as a learning process that could be useful for them in their jobs.

As just mentioned, my interview partners were mainly male and it seems that in the cases I studied, it was they who were the driving forces for augmenting the houses with smart home technology. Jan, Gabriel and Nick reported that their partner was initially rather sceptical or did not see any significant benefits and that they valued other functionalities like security aspects. Jan made sure to depict his girlfriend’s doubts not as constraints for his project but as fair concerns, some of which were important to him too. Of the women I talked to, only Ursi presented herself as interested in technological developments and as a driving force. It would have been interesting to learn more about the women’s interests in and reservations about connected homes and how this played out in the negotiation over whether to get smart home technology and how it had been integrated in the household.

Only two informants stated more specific reasons for opting for smart home technology. In the case of household H3, their new heating system came with smart functionalities like remote control and they had to decide whether they wanted to control it via the providers’ app or whether they wanted to connect it to other devices and services. They opted for the second. For Tom, it was the already existing automation of the shutters that did not work neatly that led him to install the first smart home devices in his house. The cases of households H2, H3, H6 and H7 were slightly different from most other cases because theirs were renovation and retrofitting projects, respectively. The smart home devices in existing housing can be networked via Wifi, power line or a special wired bus-system like new houses, however, the hardwired option might require structural changes to embed the additional mass of cable. For H2 and H3, the modification/renovation of their old houses provided them with the unique opportunity to update their building services with hardwired smart home technology. As Tom did not want or need to renovate his house, a Wifi-networked smart home system worked best for him. Living in a rental, retrofitting his apartment was even more

¹³ ‘Und, ja, halt einfach das Einflussnehmen auf das System selber, ohne, ich sage mal, die dumme Installation, die man früher gemacht hat, die durchaus auch alles ermöglichen würde [...] Aber ich wollte etwas ein wenig ausprobieren auch halt.’ (Nick 2017)

difficult for Jan as structural changes were not an option and it had to be possible to dismantle everything. What is also special about Lukas and Lea's, Tom's and Jan's projects had started out from a specific point or building service and developed from there on. They took several years to take their current form because the renovation was split into several stages (H3) or because their idea of a smart home started from one project and developed through a series of other interventions. That way the costs could also be spread over a longer time span.

That there was no specific catalyst for the others does not imply that they had no aim in mind, nothing they hoped to improve with the smart home technology. I have already mentioned the energy saving and several of them imagined that with remote control they could switch off the lights or lower the heating when they forgot to do so before leaving the house. However, the main aim for all participants seemed to have been the possibility to ease control (and timing) of all the technologies relevant to the creation of a pleasant indoor climate – one of the main functionalities of smart home technology. This refers not only to the heating, but also to the shading – especially important in houses with big windows which easily heat up a room – and ventilation or air conditioning, which is not very common in housing in Switzerland. Newer housing more often has complex ventilation systems as building envelopes become ever more impervious and ventilation is needed to avoid mold formation (Markus 2017). Another central desire connected to the HVAC control was that of having all these systems and potentially other devices and services united into one system, so there would be one way to control them all and to make use of potential synergies. The professionals Tanner and Studer argued that a high-quality building envelope and controlled change of air ventilation, along with the use of fossil free energy – important elements of the Minergie building requirements and increasingly popular in new housing – require some sort of home system. Thus, it is conceivable that smart home technology for unifying control of HVAC might become a general interest in new housing, especially in Minergie housing. A smart home system is however not directly required – in Minergie buildings only for large buildings – for controlling and managing energy plants or HVAC.

In recent papers, environmental social scientists Hargreaves, Wilson & Hauxwell-Baldwin (2017) and computer scientist Sarah Mennicken (2016) have identified their participants' motivations as part of bigger studies. Hargreaves & colleagues identify energy saving (as money saving), technological interest, environmental concerns and a general interest in enhanced control for comfort, convenience and control over daily life as central motivations

(Hargreaves et al. 2017:4f). Similarly, in her dissertation Mennicken retains three main motivations for getting a smart home: (1) a feeling that modern homes are smart homes; (2) for saving energy; (3) out of a general (or professional) interest in new technologies (2016:80–81). All these elements have also been mentioned by at least one participant in my study. My presentation of the participants' reasons for getting smart home technology further considers the wish for specific functionalities and particular situations or opportunities like renovation projects or dissatisfaction with the existing building services as catalysts for their opting for smart home technology. Another interesting observation Mennicken made was that the interest in smart home technology seems to be somehow self-perpetuating, that is, that her respondents showed increased interest in the technology and in expanding their home systems ever more (Mennicken 2016:81). My informants show similar tendencies, as the development of Jan's and Tom's projects, described above, suggest.

Over the last few pages, I described my informants' motivations for and aims to achieve through smart home technology. These are widely consistent with previous research. In the case of my interviewees, their decision to construct a smart home was informed mostly by their general technical interest, the view of smart home technology as up to date and/or their hope that the technology would enable them to save energy, to manage the building services more easily or to solve problems they had with the existing services. In order to answer the question raised at the beginning of this subchapter, another element needs to be added: The participants who saw automation in office buildings and universities as problematic or nonsensical made a clear distinction between building automation in public or office spaces and automation in the domestic space, considering home automation as individualized and thus as meaningful. Chapter 5.1 and 6.1 further elaborate on the perception of the meaningfulness of automation and other control options, but first I turn to the decision process during the planning phase that form the smart home projects and their implementation.

4.2. Planning and installing a smart home

From the decision to integrate smart home technology in one's (new) home to the implementation of the idea, it is a long way. Such complex and comprehensive smart home projects with many interrelated needs and technologies requires some planning, many decisions to be taken and a considerable amount of work and (programming) skills for implementing the project.

4.2.1. Delimiting the smart home

In the previous chapter we have seen that financial aspects have regularly been pointed out as barriers for smart home adoption in HCI research. Even though it is often said to help inhabitants saving energy, the motivations for acquiring such a system are generally not economic. Rather, economic reasoning constrains the realization of a smart home project. Not everyone can or wants to afford a smart home. Professionally installed and managed systems cost tens to hundreds of thousands of Swiss francs, depending on the dimensions and complexity of the system and the type of devices. Programmable switches, for example, cost easily about 100 francs each. Although electronic shops now sell several plug-n-play smart home devices such as Philipps' Hue lamps or security devices from Netgear, complex connected homes like the ones described in this research remain cost intensive. It is not surprising that financial issues played an important role in the households' decision over the kind of system to purchase and the products and providers.

In order to minimize expenses, several households decided not to have the system installed by professional integrators but to do it by themselves. Nick explained, 'due to the fact that I can program it by myself I was able to keep the financial expenditures, let's say, within a bearable range'¹⁴ (Nick). Gabriel and Jan had similar points of view, Jan arguing that he was not ready to spend a lot of money on devices that eventually would not satisfy his expectations and Gabriel saying that he had to do it by himself for budgetary reasons. Financial constraints led them all search for solutions they could program by themselves with more or less previous experience in programming. Other strategies for limiting the costs were: not equipping every room with smart technology (Tom) or postponing the installation of a photovoltaic plant for a later moment (Beat, Markus, and Tom). Furthermore, Gabriel and Jan imported some of their smart controls (and sensors, in the case of Jan) from producers in foreign countries (Germany and China). That way, they argued they could save some money. Lukas, however, could not find any of the material he needed for better prices abroad. Generally, he was the only one who thought that it was not that expensive as he would have had to renovate the house, the lighting and heating anyways. Time is also part of the question of cost, but was more an issue for the later phases, when they had already moved in and the system had to be adapted to their wishes.

¹⁴ 'durch das, dass ich es selber programmieren kann, konnte ich dann auch die finanziellen Aufwendungen, ich sage mal, in einen tragbaren rahmen reinbringen.' (Nick 2017)

While the choice for a specific system and how it was installed seems strongly influenced by the household's aims, interests, desires, and economical (financial) reasoning, other issues also play an important role. One point that seemed important and challenging was that of anticipating what technologies and functionalities one would need or make use of. Mr. Tanner observed that 'the challenge [for the builder owner] is to formulate what he would like to have. Because he can't know, because he has not experienced it'¹⁵ (Mr. Tanner 2015). Mr. Meyer refers to the same problem when explaining the importance of showrooms where potential clients can see, operate different control interfaces and see how other devices react: people want to know what they should expect, but it is hard to imagine if you have no previous experience with such technology. This coincides with Mennicken's findings. In her article "Hacking the natural habitat" (2012), Mennicken discusses the challenge that is planning for unknown technology. She reports that some of her participants, while the stakes were high because of the costs involved, had difficulties predicting the potential benefits and changes it would bring to their lives (2012:155).

Knowing and defining one's (or, for the professionals, the household's) needs and desires is essential when planning a home automation system. Gabriel reported as one reason for why he wanted a smart home the fact that it seemed very difficult to decide which switch should control which light before the construction work had even started. This way he imagined he just had to decide where switches and lights were necessary, but could put further decisions on this off until they moved in and that he could change things if necessary. Other participants considered the perceived lack of utility and meaningfulness as reasons for not having installed this or that. For example, Lukas was unsure whether it would make sense to automate the shutters to go up or down at set times or whether it would not be upsetting and coercive if the shutters would always raise and lower at fixed times. Or take the case of Jan who had experimented with different smart home technologies like weather station and IP-cameras, but had so far installed only select objects, as he could not think of anything practical that would actually add value to their living. This shows the difficulty some interviewees had not to identify their needs and wishes but to figure out practical, useful and non-coercive automations. This does not mean that there might be anything like that or that automated processes are a must in smart homes, but it was what they were looking for.

¹⁵ 'Da ist die Herausforderung [für den Bauherrn], zu formulieren, was er gerne hätte. Weil er es ja nicht wissen kann, weil er es nicht erlebt hat.' (Mr. Tanner 2015)

A consideration of potential risks was another element that influenced some of the participants' choices for connected devices or limiting the possibility to control the house from a remote place, even though remote control is often considered as essential feature of smart homes. This was the case for Tom and Markus who described themselves as cautious, even overly cautious, especially, with respect to potential third-party access to their home system and personal data. They deliberately forwent any objects that, if hacked, would allow to see and/or hear the homeowners: smart TVs with integrated camera, microphones for voice control that are permanently 'listening', or cameras in living areas of the house. Although security was not discussed as a primary concern that had significantly influenced the way the smart home was planned. Nevertheless, most families have installed some functionalities that can be considered to serve the prevention of risks and threats (see chapter 7.2.).

Consultant Meyer pointed out that it is indeed difficult for potential users to keep track of the many products available and the functionalities they offer. Those interviewees who did not work with consultants informed themselves with specialized journals and on the Internet (mainly on forums) about the different systems, providers and possible functionalities. On a forum, like the one through which I recruited some of the participants, one can find recommendations for specific systems and compatibility of devices. There are also discussions about whether switches or motion sensors are better for light control or the (non)sense of automated shading. Virtually all households visited made a point of having an "open" systems, which allowed for integrating devices of at least a few specific other standards. Beat and Nick explicitly made a point about not wanting to be dependent on a single provider, while Gabriel was more interested in swapping specific devices with equivalent devices from other producers due to better price-performance ratio. In fact, the systems chosen show varying degrees of openness (see figure 1, p. 33). For Gabriel and Lukas, who wanted to install the technology by themselves (to save money) but had no programming experience, a software that was (relatively) easy to program was essential.

Over all, the participants – homeowners and professionals – shared the perception that today almost any wish one could come up with could be realized with the necessary knowhow and resources. While some homeowners wanted to integrate and automate as much as possible, other households, like H3, H7, and H8, were more concerned with what was useful and meaningful automation. Not that this was not so for the others, but these latter considered fewer functions to be meaningful. For example, Beat and Daniel and Ursi had RGB-lights to create a nice atmosphere in the living room, something that H3 considered absolutely

exaggerated. For some deciding of what was to be integrated into the system or not was mainly a function of financial factors; for others, security reasons and/or the perceived (lack of) benefits and utility played equally and important roles in setting limits to their home automation projects.

4.2.2. Implementing smart home projects: professional and do-it-yourself installations

It requires a considerable amount of skilled work with and on smart home devices and the network to construct a functioning connected home system. The preparation of the infrastructure, if the home automation is to be wired, is generally linked to the construction of a new home or a renovation. Preparing for a smart home is not just about adapting it to the house and the households' needs and desires but also about adapting the house to receive the technology. This refers on the one hand to the masses of cable that need to be embedded, but also to the fact that the householders generally expect the technological infrastructure to be invisible (Beat 2017; Ursi and Daniel 2017). In the case of a retrofitting project, structural changes might be necessary to ensure the necessary space for additional cables and the connection of the devices in specific patterns. For most of the houses visited (except those of households H6 and H7) the network is based on cable. Such houses have a 'tech room' where all the cable comes together and are connected with logical controls and the home server. There might also be the central heating or the ventilation. Beat described the oodles of cable that there are in his six-storied villa:

'I have 40km of cable in this house, *40km of cable*. And in every room, *in every room*, there are at least two connections, two coax¹⁶ and two CAT 5 [cables]. In every room. Whether it is a bath room or whatever. There is, of course, fast Internet on it and it has, of course... this presupposes a plethora of cable. When the structural work in the house was well underway, this area here [the 60m² living and dining area] was virtually completely covered with wiring harness. The whole electric installation was by far the biggest item during this conversion'¹⁷ (Beat 2017)

The cable is generally installed by professionals. Of course, this kind comprehensive intervention must be carefully planned and cannot just be undertaken at any point, any in an

¹⁶ Coax or coaxial cable is a self-shielded cable used to transmit radio frequency signals for radio transmitters, television or computer networks. It has two conductors, an inner and an outer, running along the same axis (The Editors of Encyclopaedia Britannica 2011).

¹⁷ 'Ich habe 40km Kabel in diesem Haus drin, *40km Kabel*. Und ich habe in jedem Raum, *jedem Raum*, hat es mindestens zwei Anschlüsse, zwei Koax und zwei CAT 5. In jedem Raum. Ob es Badezimmer ist oder was auch immer. Also schnelles Internet drauf natürlich und das hat natürlich... das bedingt also Unmengen Kabel. Als das im Rohbau war, war also diese Fläche hier [Ess-/Wohnzimmer], war praktisch voll bedeckt mit Kabelsträngen. Die ganze Elektroinstallation beim Umbau war mit Abstand der grösste Einzelposten' (Beat 2017)

existing building. Therefore, professionals often stressed that it is important to plan ahead for people who maybe just want a central control for their lights or electric shutters, for there to be possibilities to expand the system. The positioning of the devices and cable throughout the building is followed by the setup of the system, the configuration of devices and programming of functionalities.

H2, H4, and H9 had their smart home planned and installed by professionals – either with consultants, electricians and integrators or, in Peter’s case, all was done by the electricians. It proofed to be crucial to work with experienced workers. Beat had had a good experience with two smart home projects but voices concern that there might be only few experts he would rely on for such a job: ‘it is important, too, to have the right people [around you] who remain the same and it is, of course, important to have the right partner and of those there are, of course, not many in Switzerland’¹⁸ (Beat 2017). Peter, in contrast, had had a bad experience and, when I met him, he was very frustrated about the technician, who had installed his home system, not being as much an expert in the task as he would have expected and wished for.

For those who set their smart home systems up on their own (the wiring, where necessary, was also here done by professionals), familiarizing themselves with the technology and the work setting it up meant a significant expenditure not in money but time. This was especially so for Gabriel and Lukas, who had no previous experience with programming and programming for home systems in particular. They stated they read handbooks, watched tutorials and visited provider-specific forums to learn how to program the system and automations and search solutions for their problems. In a few cases, they also asked the providers’ support for help. Even for those with programming experience, installing a smart home system is time-consuming work. Not having previous programming experience, however, meant an additional disadvantage as the homeowners could not count on their experience for troubleshooting (e.g. Markus 2017).

The implementation of hardwired smart homes requires a lot of work that must at least partially be done by professionals. The following setup of the system requires programming skills and software, comprehensive understanding of what can be used for what ends and how and, as I will argue in the next chapter, knowledge about how the rooms are used and

¹⁸ ‘Und da ist es auch wichtig, dass man die richtigen Leute hat, die die gleichen Leute bleiben und es ist natürlich wichtig, dass man den richtigen Partner hat und von denen gibt es natürlich in der Schweiz nicht viele’ (Beat 2017)

the households' and individuals' practices, values and experience of the home. Over all, not all the initial desires and aims were realized. The things that had not been implemented were seen as *not yet* realized, either because it was too expensive (the installation of a photovoltaic plant for H2 and H5) or because the DIYers had not yet figured out how to connect all the services (see description of H1 and H8 in chapter 2), but they were still planned. Those who had their smart home installed and managed did not have to deal with the laborious and time-consuming task of setting the smart home up and could profit from the professionals' experience. However, they were also somewhat dependent on them, which can be problematic in some cases. The DIYers, in contrast, who had installed the systems by themselves, lowered the expenses for the smart home, but in turn had to blame themselves for errors or if they were not making progress.

In this chapter, I presented the participants motivations for and interest in smart home technology along with some issues of the planning of and preparation for the smart home in terms of domestication practices, of “taming” the “wild” technology and imagining, delimiting and realizing it so it could become part of the households' home and practices. Of the few studies on the domestication of smart home technology, only Tolmie & colleagues have tried to conceptualize the planning and implementation of a smart home. Tolmie & colleagues speak of the domestication work in this phase as ‘digital plumbing’ and draw special attention to the specialized skills, tools and knowledge necessary for the planning and installing (Tolmie et al. 2010:185, 188). The knowledge and skills they point out include knowing how to integrate new devices in existing networks, knowing different operating systems and particular software applications, testing and knowing where troubles could be expected, troubleshooting and faultfinding (Tolmie et al. 2010:188). These are mainly programming competencies. In the cases of this study, some of the homeowners had experience with, others put considerable time into learning the basics and others did not have to care about it, as they had outsourced this work. However, as I will argue in the next chapter, this is not the only knowledge necessary if one wants construct a meaningful smart home adapted to those who live in and with it.

Tolmie & colleagues describe the planning process narrowly as deciding what technology should be placed where and preparing the tools for the installation. This description is based on a single and rather special case they observed. The installation they describe was done by

a researcher who installed technologies that use the existing power line and that were for the first time installed outside the laboratory in a “real” home to be tested there. In contrast, my account of the domestication from the decision-making and planning process to the implementation of the smart home project deals with a variety of retrofit and purpose built smart home projects. It shows that planning is about more than deciding what devices should go where. I think, it starts earlier with decisions on what the (smart) home should include, provide or prevent. This chapter also suggests that multiple aspects need to be considered from the needs and desires to the costs, infrastructure and whether it should be professionally installed and managed or not and that these shape the final smart home. (The different forms the smart home projects took, are visible in the description of the participants’ houses, chapter 2).

Before turning to the longer-term domestication, I recapitulate here the participants’ arguments and experiences related to the issues of control and security. Most of them expressed a desire for simpler control over HVAC and other building technologies. They hoped that the integration of all the devices and services into one home system would provide them with that. In the planning phase, this wish for control was concretized by deciding what should be controlled and operated how and what processes should be automated. As the examples showed, it can be difficult to anticipate what is needed, desirable, useful and meaningful to the household and the individual household members. Furthermore, some households voiced concerns about security, data security more precisely. These concerns shaped their smart home system insofar as it led them forgo some functionalities of devices.

Like Bernheim Brush & colleagues (2011), I distinguished between those households who hand their smart home technology installed and managed by professionals and those who had set up and configured the system by themselves. This second group I consider as “Do-it-yourselfers”¹⁹ (DIYers), some beginners and others with previous experience in programming or with building technologies. This results in different relations between my interviewees and their smart home (technology) or between them, the smart home and the professional(s), who planned and installed the technology: Being it either the DIYers or external professionals who manage the system and make fitments. With respect to the fitting Bernheim Brush & colleagues have found that DIY smart homes tend to be more changing,

¹⁹ By DIY I do not mean that these smart homes are cobbled together from a range of unrelated pieces/technologies, but put emphasize their work and the commitment put into the setup and maintenance of the smart home.

whereas “outsourced” installations appear to be more static and less changing (Bernheim Brush et al. 2011:2118). I will consider the (different) adapting and fine-tuning processes in the next chapter.

5. Living in a smart home: adapting the technology and adapting to it

This chapter continues the discussion of domesticating smart home technology considering the incorporation of smart home technology and functionalities in the household and its everyday life on a longer term. As later domestication studies stress, domestication is a long-time process and goes beyond the work involved in bringing new technologies into one’s house, including the making these technologies functional and meaningful within and for the household (Haddon; Bernheim Brush et al.). This chapter turns to the way the households interviewed experienced their home and the ongoing process of domestication.

5.1. Diverging experiences of the first weeks with the smart home

The interviewees mostly remembered their first weeks with the home automation as nothing particular, let alone interruptive for their everyday practices. Ursi explained that home automation did not appear out of nowhere, but that after a long examination of the possibilities the technology offers during the planning and preparation phase they knew more or less what to expect. In the beginning, it was fascinating and they were trying out stuff, but did not experience it as interruptive. The few problems that were noted by and by were to be resolved by professional technicians and integrators or by the DIYers themselves. Some of these early problems were, for example, an unreliably working motion sensor (H1, H3), the RGB-lights (H2), or the finger print reader on cold days (H2, H4).

In contrast, Peter, Nick and Markus, who had moved into their smart homes more recently, told a rather different story. Especially Peter and Nick expressed their frustration with problems in the first few months and that therefore it was not entirely as they had expected it to be. Markus, who had some professional experience with building automation, stated that, on the one hand, he was not dis-appointed when he moved in and not much was working yet, because he knew it would be like that. (Unfortunately, I don’t know how his girlfriend experienced it.) On the other hand, he recognized that if he had moved in at the time of the interview, when everything was more or less working, it would have been quite a change. Nick, on the contrary, went as far as declaring his ‘pseudo-smart home project’ as ‘failed’,

mainly because he did not manage to integrate the heating and the ventilation into the system which was a central aim for him.

How the first few weeks in the own smart home are perceived seems not to be so much a question of whether it was self-made or professionally installed, but rather of the persons' expectations and illusions and their previous knowledge (or lack thereof) that a longer process of "iterating [the system configurations] until it fits" (Mennicken 2016:84) of finetuning the functionalities and automations would follow.

Mennicken (2016:82-85) identifies the iterative configuration phase as one of four key phases in constructing a smart home:

- 1) *initial planning* comprising gathering information, determining needs and sketching plans;
- 2) *preparing the technical infrastructure* which is mostly done by professionals;
- 3) *iterating until it fits* which refers to the adjustment and adaptation of functionalities to the inhabitants needs and desires;
- 4) *reaching (temporary) stability* which does not necessarily imply satisfaction.

The data presented in the previous and the present chapter reflect the same three to four phases – though identifying phases of stability was surprisingly rather difficult. Mennicken describes the iterative phase as phase when inhabitants found out what functions did or did not work for them and which resulted in iterative adjustments to the system (Mennicken 2016:84). She does not discuss these stages as part of a domestication process. I have discussed the first two phases in the previous chapter and the rest of this chapter examines three forms of work, of making the technology and the household fit that occur and co-develop simultaneously in a third phase. My data suggests that the iterative configuration phase is accompanied by learning processes – learning to control the technology and learning and negotiating how to do so in ways that are meaningful for the household and that fit with the householders' identity and worldview.

5.2. *Learning to control and live with the smart home*

In his classic "The design of everyday Things" (Norman 1990) computer scientist and psychologist Donald Norman asks what instructions would be necessary for people living in smart homes to be able to control it and interact with it in diverse ways (*ibid.*:214). Looking back at their first weeks with the smart home technology, my interviewees thought they did not have to learn a lot. They considered the handling of the touch panel or apps on

smartphones and tablets to be self-explaining. However, Beat and Ursi and Daniel recognized that it was maybe not as easy and evident for others as it was for them. For example, Ursi said they once had had a French filming team visiting their home who came to see whether it was easy to interact with the visualization for them too. It was not, a central problem being that functions were named in German. By then it was not yet multilingual which posed quite a problem. Today, visualizations often work with footprint layers of the floors and icons representing lights, shutters, thermostats or other and seem to be easy to read, at least, for everyone who is used to the handling of tablets or smartphones. Understanding the signs for lamps or shutters, might however not be enough to understand how functions can be combined, automations suspended or scenes changed.

Hargreaves & colleagues, who focused on the necessary learning processes in their study on the domestication of smart home technology, found, quite to the contrary, that a lot of work goes into learning to live in a smart home. They distinguished between three types of learning that go into it:

“cognitive: learning about the technology and what it can do

practical: learning how to use the technology

symbolic: learning about and constructing the meaning of the technology and how to incorporate it in identities” (Hargreaves, Wilson, and Hauxwell-Baldwin 2017:3)

The cognitive work can be mainly settled in the planning phase, but the questions about what the technology could be used for might come back at later stages. Nevertheless, what I want to discuss here is rather what they refer to as the practical work of learning how to use smart home technology. I would like to specify this “use” as learning how to operate the home system and what is connected to it, how to interact with it making use of the different possibilities it offers and how to make changes, for example, to the programmed scenes (Beat was the only one in my sample who did not have the possibility to make himself any changes to scenes or other automations). Hargreaves & colleagues’ participants, who tested market-ready smart home technology, reported the technology demanded a significant amount of learning – mainly the cognitive and practical learning where considered challenging (Hargreaves et al. 2017:6). Similarly, my participants considered the planning and preparation – and where they programmed it themselves, learning to program it – by far the biggest part of the work in learning how to use it and live with smart home technology. As regards the

practical learning, it is important to keep in mind that they were mainly the technologically interested ones in their respective households. Also, they had all participated in the entire planning process which probably made it significantly easier for them to control the system, to remember the different functionalities, or to make changes to it, especially when they had programmed it by themselves. Because of the special constellation of my participants living in smart homes, I would like to compare their apparent ease at handling the system with the observations of the customer consultants and the head of marketing interviewed. They, too, pointed to the importance of easily controllable and manageable systems, but they also recognized that an initial instruction is essential for people who move into a new smart home. When a smart home system is installed by professionals, they give a short introduction and hand over a documentation of their work, the functionalities and description of the various parts to the customers. However, Messrs. Meyer and Studer observed that often customers prefer to call the customer call center instead of reading through the documentation. This might be necessary two or three times and then they work out how it works.

There are different ways to make it easier for users to find, for example, the right switch. Mr. Meyer argued that his company's operating philosophy would make it easy to control the lights – not only for the people living there but also for guests. According to that philosophy, there should be hardly any switches controlling single lights but always scenes. The switches could be programmed in order to signal the user with LED-lights which one to push (next) depending on the room, brightness and time. This system seemed to work well for him in his own house. Other possibilities are to label the switches (as switches are generally not at eye level, readability might be reduced) or icons added. The professionally installed and managed smart homes I visited had labeled switches as well as some of the others. Many had no labels at all or had planned to add them but never done so. Similar to the respondents living in smart homes, Mr. Meyer considered the visualization to be self-explaining. Mr. Studer, on the other hand, agreed only partly. He suspected that users normally knew and used only about one third of the possibilities their smart home system would offer. For that reason, his company had started to offer half-day seminars for end users of their visualization once to twice a year.

The end user seminar aims to show users what can be done with their system, how it can be used most efficiently and how they can make changes or create new automations without needing the assistance of technicians. The seminar consists of a theoretical part in which the users are told the advantages of KNX-systems and the difference between three building

systems the company offers; the second, practical part takes place in a laboratory, where each working station has a computer, a tablet, several digital switches, lamps, a motion sensor and a camera that participants can interact with and manipulate. The aims to promote the company's smart home solutions and to empower end users to make more comprehensive use of the smart home technology they have at home, because Mr. Studer and his colleagues have made the experience that not all technicians take their time to show the customers all the functionalities the system offers. It seems, however, that the seminar had only limited success – only few end users participate and they had not yet found a way to attract more users to their seminar.

Focusing on learning how to live with smart home technology, Hargreaves & colleagues analyzed the domestication more as adapting to the system and not so much adapting the system to the house and the inhabitants' needs, aims and desires, although they did consider the integration of the technology in the household in symbolic ways (Hargreaves, Wilson, and Hauxwell-Baldwin 2017). They suggest that besides the "practical" work of learning how to use it, there is also the work of learning how to appropriately use it or what is it appropriate to be used for. This relates to Hargreaves & colleagues' understanding of "symbolic learning". The following examples represent the negotiations that went into defining appropriate use of and appropriate interaction with smart home technology in the case of household 3. I chose H3 as example because during the interview with Lukas and Lea the negotiations seemed to resonate in their interaction and it was one out of two cases where I could interview more than one person of a household.

One thing they said they had often argued about in the past, was the appropriate duration of airing out the house. Lea used to leave the windows open for long hours, whereas Lukas saw in this practice a risk of spending too much energy on heating. They found a compromise over their arguments in the form of a sensor that measure the CO₂-content in the house. Both seem to accept what the technology suggests to be best for their airing practices and state to act accordingly. Lukas' insistence that their airing practice was now based on scientific facts, resonates with the view of the "quantified home" described by Strengers (see chapter 3.2.). H3 was, however, the only household where this numerical, logic vision of the smart home was so dominant. Although Lea and Lukas had no automated ventilation, the airing out happened no longer based on their divergent, personal perceptions of air quality, temperature and energy-saving practices, but according to a scientific model. It is questionable whether

the homeowners did not actually know anything about the theories that dictated their airing practices. Airing out now happened as reaction to a message the system sent them²⁰.

A second example deals with the necessity to check the smart home app before starting the dishwasher or the washing machine. As they had connected the warm water directly with the solar thermal plant, washing without checking the systems recommendation for the program to choose (solar or eco) might end in not getting the stuff clean in times of little sunshine because of a lack of hot water. Lea described this a (minor) restriction to her usual housekeeping practices and that it meant to adapt her practices. Nevertheless, she did not present this as problematic. As she had already adapted and integrated the checking of the app into her housekeeping routine. Her husband considered it rather ‘something you have to pay attention to’ instead of something restricting.

Their discussions about the appropriate way for interacting with smart home technology and what to use it for can be traced back to slightly different priorities in relation to energy-saving, housekeeping and other practices and values. For example, while Lukas described his interest in regularly checking the household’s energy consumption and the state of the solar plant, Lea chaffed him for being a control freak, that he would joke with her in the evening if she used ‘too much’ energy during the day. In this respect they were rather special, the only family that seemed to put so much effort and attention into saving energy.

These examples show not only how smart home technology informs or demands transformations of domestic practices and habits but also a changing relation to previously existing appliances. Hargreaves & colleagues have described this as “re-domestication” (2017:8) of older domestic appliances and an additional challenge to the domestication of smart home technology. As this shows, there are many layers to the work of domestication that can be described as different forms of learning about (meaningful use of) smart home technology and about living with it. This learning, especially that about appropriate interaction and use, takes place in a specific domestic context, in households with their own morals and identities that are constantly negotiated and reconstructed (cf. Nyborg 2015:65). The meaning of and appropriate interaction with the smart home can should thus be considered to be co-constructed by the members of the household.

²⁰ Several households had integrated a messaging system, which sends them alerts in specific situations e.g. when it starts raining (Tom) or when the laundry or dry-tumbling is done (H4).

5.3. *Finetuning the smart home system*

In the beginning of this chapter, I have introduced what Mennicken calls the phase of “iterating until it fits” in making a smart home. It is the process of making the smart home technology work in the house and fit it to the inhabitants aims and desires. It is an indispensable element of the domestication of smart home technology. Here, I will argue that the work of adapting the technology takes place parallel to the learning and negotiation processes described, interacting with them. The following discussion of the domestication linked to the iterative process is mainly concerned with changing parameters for automations to ‘the’ appropriate value for making it unremarkable. It touches also on some other things the households wanted to fix (see chapter 5.1.).

The professionals Tanner, Meyer and Studer agreed that adapting values for lights, brightness, temperature or scenes was an indispensable part of making a smart home. It is not only for laypersons difficult to predict how, for example, the light will appear in a house - it is so too for professionals. Adjusting values is thus an inherent part of the process. Mr. Meyer explained:

‘If I have now a floor plan and I have no lamps installed yet, I don’t know either, also as a professional, well, do I now need 30 or 20% light back there. Because depending on the illuminant, depending on the situation you sense the light a bit differently and therefore, the thing has to be furnished, everything must be in there, you have to look at it there, then you can adjust it.’²¹

(Mr. Meyer 2017)

Professionals can, of course, count on their experience, while for practically all DIYers it was a long process of try and error, or as Lukas put it: ‘...eventually, you have to start somewhere, try how it is and later you realize, no, [it] is not yet quite it’²² (Lea and Lukas 2017).

This is not simply a quest for randomly finding ‘the right’ values. Besides technical knowledge also social knowledge – knowing the household members different needs, preferences and daily routines – seems essential for making it work seamlessly as Kennedy & colleagues emphasize. Values like those of temperature might not be experienced the same by everyone in the household and, once again, might need negotiation. Let us go back to the example of household H3: Their connecting the warm water with the solar thermal plant

²¹ ‘Wenn ich jetzt einen Grundrissplan habe und ich habe noch keine Lampen installiert, weiss ich auch nicht, auch als Profi nicht, ja, muss ich jetzt dort hinten 30% Licht haben oder 20%. Weil je nach Leuchtmittel, je nach Situation empfindet man das Licht ein wenig anders und von daher muss das Zeug möbliert sein, es muss alles drin sein, da muss man es anschauen können, dann kann man einstellen.’ (Mr. Meyer 2017)

²² ‘...man muss mal irgendwo anfangen, probieren, wie es so ist und nachher merkt man, nein, stimmt noch nicht ganz.’ (Lea and Lukas 2017)

meant that in times with little sun warm water might equally be short for the shower. In order to avoid that, the water was always heated to a minimum temperature – just as high as necessary and as low as possible to be acceptable for all. Lukas set the temperature to 40° C, which he considered to be warm enough. But it was not for his wife, Lea. The temperature was then raised to 45° C, which seemed to be acceptable to both. This example and the earlier quotation from Mr. Meyer both point to the importance of being in the place, at best living there. It requires living with it to see what works and what not, what seems appropriate and what not.

Other changes and adjustments were due to programming errors or yet unidentified problems with sensors. For example, in the houses of H1 and H3 there is an ‘unreliably working’ motion sensor for a lamp in each. Especially the wives seem to be upset or frustrated about the situation, but the husbands have in both cases not yet managed to find the problem. Another reason for changes were functions that were perceived to be irritating. Gabriel, again, changed the automation of the shutters, which initially was based on the calculation of the position of the sun, which proved not very “smart” as it worked independently of whether there was sun or fog. Or Tom, who said, he will eventually deactivate the function which makes his smart home greet him or tell him that it rains as it started to get on his nerves. As these examples show, when the problem is not perceived to be one of parametrizing functions to better fit with the sensual perception of the household members and their practices, when the problem is rather associated with reduced reliability or to be nonsensical and irritating, this can entail more drastic changes to the home system replacing devices or deactivating functionalities.

For the households I met, the iterative phase lasted at very least for about a year (H2). For others, it seemed to have not yet ended or that further iterative phases have taken place. As I have not followed the households over a longer time span, it is difficult to say whether they are still in the first or a later iterative phase. It is clear that for households 8 and 9, who have been living in their new houses for less than a year, that the initial adjustment phase has not yet been finalized. (Does moving into a new house or apartment not in most cases – smart home or not – take so much time to make the house a home? At least, this is what all my friends have been telling me since I moved in with my boyfriend a few months ago...) H3, 4, and 5 stated they had regularly contact with their integrator or made themselves adjustments every now and then. (In the case of H4 it had to do with an infrastructural update one year ago.) Lukas described the process as a never-ending one, maybe also because they had

been renovating and installing smart home technology by stages over the past four years. Tom and Jan were special in this respect as their (professional) technical interest led them to constantly think of new functionalities or different ways of doing things and trying stuff out. For them, it has become a hobby, a leisure activity. At the moment of the interview, Beat was the only one who was clearly in a phase of stability, but he too had some projects in mind for next year. H1 also seemed near to a temporary phase of stability – even though there were several things he wanted to change or adjust, without the necessary time currently nothing much was being done. The process of adapting the technology with all its functionalities to make it work, useful and meaningful for the household may be of varying duration and for some like Jan and Tom, who have made it their hobby to make changes to the system, reaching a phase of stability might not even be desirable.

In most cases it seems to be only one person in the household, often the man, who takes over the responsibility for and control over the system. In households with professionally installed home automation systems, the work of making it fit and managing it is generally outsourced, at least for the initial fitting. This means there is a certain dependency of those members of the household who cannot make changes to the system on those persons who can – either within or outside the household. As regards the households who had professionally integrated systems, only Peter described this situation as problematic, which had to do with his frustration with the technician's work and him not feeling expert enough to adjust the system himself. In the other households, the situation was not seen as problematic. However, this might have been different had I not just talked to the men, the ones responsible for the smart home technology in their respective houses. This corresponds to Nyborg's (2015) and Kennedy & colleagues' (2015) studies on the domestication of smart home/smart grid and broadband networks, respectively. They point out that the domestication process is not experienced the same by all members of a household and not all can participate or contribute in the same way.

Now that I have traced the learning and adjusting processes, it is not surprising that my respondents have come to define smart homes in different ways. For some, it is mainly about the visualization for controlling lights and heating (Beat, Peter) or for checking energy consumption (H3). For others, it is the flexibility (and adaptability) of the smart home technology (H4, H5). Still for others it is the automation (Gabriel, Tom, Nick). The interviewees mostly described the life in a smart home as follows: normal, rather simple and easy, comfortable and convenient, energy-saving and secure, with more options for controlling the

house technology, and not having to bother about this or that because the automation took care of it. Members of households H1 and H4 also mentioned that they came to miss the comfort and convenience of smart home technology, principally the motion control of the light, in buildings that did not have such technology. They argue that their presence generally requires lighting and that motion control uniquely (cor)responds to this.

Activities and learning processes involved in long-time domestication, such as parametrization and finetuning of functions or negotiations over appropriate uses of technologies, are an essential and indispensable part of the work necessary to make the smart home work for the household. While material culture studies have analyzed furniture or personal items as linked to domestication through decorating in conventional housing, with respect to smart home, smart home technology can be considered an additional arena for personalizing homes (Holohan et al. 2011:142). Although the householders described the iterative domestication of smart homes essentially as the configuration and finetuning of the system, domestication should not be seen only as a matter of making the technology fit. The smart home technology might equally require adaptation from the people who use it and from the domestic environment more broadly as the example of household H3 suggests. It is as much about adapting to the system and the opportunities it offers, as it is about making the home automation fit in with the home and daily life and with the household's system of values and meanings. The demands that the technology poses on the inhabitants might be perceived as restrictive and interruptive by some, while others do not experience it as such.

Some of the interviewees – all of them DIYers – described the adaptation and configuration of the home system as a never-ending process. They did so either celebrating the flexibility of smart homes or insinuating they would like it to finally reach a (satisfactory) state of stability. For all participants who lived in a smart home – also those who had the installation and maintenance done by professionals – it seems important to be able to make at least some adjustments by themselves, last but not least because needs, practices or wishes might change. Hargreaves & colleagues (2017) and Tolmie & colleagues (2010) both call for designing technologies for easier configuration. Most systems I encountered during my research offer this possibility today. I would therefore rather argue for providers, customer consultants, integrators and other professionals to better inform customers about potential

initial problems, teach and guide them to make basic configurations by themselves and advert customers to what it might take to adjust the system in terms of work and time in order to prevent frustration and disappointment.

6. Automation and control: Feeling controlled or feeling in control?

Smart homes have been imagined, on one side, as offering efficient control and management of household tasks, either through automation or home systems that anticipate users' needs or by empowering users to manage their energy consumption better. On the other side, smart (home) technology has been imagined to have the potential to control the human inhabitants. This chapter attempts to elaborate on the different ways in which smart home control is implemented, used and valued for the control, convenience and security it offers and to examine what appear to be central factors that make smart home inhabitants feel in control over the technology and domestic environment.

In the previous chapters, I have already touched upon issues of control – as interest in easing management and operation of building technology, as learning to control smart home technology in meaningful ways or with respect the question of how control is distributed within the household and between them and external experts. As discussed in the last two chapters, the study participants did not consider smart home technology to pose any particular problems of usability but rather of finding useful and meaningful ways to wave the technology into daily life. Here now the focus lies on how different ways of controlling and interacting with smart home technology are actually used and individuals' perceptions of these new possibilities to control domestic services and devices. I will argue that their perception of (feeling in) control in the smart home has to do with their understanding of and dealing with automation, occurrent problems and how they view the relation between humans and smart home technology.

*6.1. Switches, remote control and automation*²³

In smart homes connected devices can generally be controlled in multiple ways, separately or in a specific constellation (as scene or automated process). I distinguish between control mechanisms that require physical presence and such that do not, that is, between switches

²³ Automation or automated processes refers here to processes that a smart home constantly (or in specific modes) executes such as adjusting shutters according to wind and sun, monitoring room climate or simulating presence in "absent" mode. If not explicitly stated, it does not imply automation as the automatic execution of a number of defined actions that are linked to one command such as "all-out" or programmed scenes.

and motion detection on one side and remote control and automated processes on the other. Another distinction can be made between control mechanisms that need direct human input (switch, remote control, control panel, voice control etc.) and those that do not (automated processes). Most people are probably familiar with both switches and motion control for turning lights on and maybe also with switches for controlling electric shutters. In smart homes, these can be programmed to take over more and more complex commands. For example, switches can be assigned scenes, changing home status or different functions for double or triple clicks. However, what both household and professional participants associated the most with smart homes, were automation, remote control and control via visualization on a touch panel. In what follows, I focus on switches, remote control and automation.

Switches might seem a likely solution for controlling lights, shutters and more in a smart home as everybody is familiar with them. My research participants associated switch controls with a habit and something they had used all their life. Although underneath the surface digital switches do not work like earlier electro-mechanical ones (practically any functionality can be programmed on a digital switch), they keep their familiarity. Switches were said to make the smart home ‘suitable for grandparents’ (‘grosselterntauglich’ [Gabriel, 2017]) and guests. Especially in households H1 and H3 with their young children that need a babysitter (or grandparents doing the babysitting) from time to time, this was an important argument for keeping switches. Asked about their own preferences of control devices, the inhabitants said to rely on a multiplicity of tools for interacting with the smart home (e.g. motion control, control panel, home telephone, smartphone/tablet application etc.). The variety of alternative control options was much appreciated as it allowed for flexibility and independence from control options provided by producers of specific appliances. Gabriel, Beat and Daniel and Ursi stated they used switches only seldom (in some areas of the home) and completely renounced placing any switches in the house’s basement, instead counting on motion detection. Others, like Jan, considered switches the most convenient and practical control option.

It is noticeable that all smart homes I visited had significantly more switches than the house I grew up in (a semi-detached house from the early 1990s). A somewhat extreme example was that of H1. In one place, there was a combination of sixteen switches for lights, shutters and scenes in the open floor kitchen, dining and living area (there were more switches for some of the same controls at other point in the room). In my parents’ house, in contrast, we had 20 light switches in the entire house. Although such ‘batteries’ of twelve or sixteen

switches were rare in the houses visited, single switches were equally rather unusual (except for a “all-out” button next to the door). Combinations of four or six switches were normal. This is probably linked, on the one hand, to the fact that besides the light the electric shutters can be controlled via switches; on the other hand, it might be linked to expectations that lights should be dimmable and scenes “saved” without having to create them every time anew. Professionals like Meyer and Studer, however, advocated installing fewer and uncomplicated combinations of switches. Their argument implies that functionalities should be combined instead of having one switch for every single light and shutter. This would mean that if someone wanted, for some reason, to control a single light, this could only be done via control panel or smartphone app. Hence, the number of switches and ascription of commands can be understood as reflecting different operating philosophies and visions of (smart) homes and habits.

Control via app, in contrast to the before described switches, offers the possibility to control (almost) all functionalities on a single device (though sometimes not all control options are combined in one app). Although control via app might seem interesting, because it allows to activate functionalities without having to be at a specific place or without having to move, it is not as straightforward as a switch. Considering that the smart phone might not always be at hand and that one has to unlock it, to make one’s way through the smartphone menu before entering commands. Most respondents did not use it on a regular basis in their homes. It was of more value for them in another way: monitoring the system. That is as a means for checking whether the system worked correctly after changes to the code and setup had been made. Daniel, Tom, Jan, and Markus stated to use it often that way.

The smart home apps were highly appreciated in their function as remote control. Nevertheless, all respondents except for Jan, Ursi and her husband, Daniel, stated they did not use remote control regularly. Most respondents used it mainly in two occasions: a) if they had forgotten to turn something off or to push the “all-out” button; or b) in order to raise the heating before coming home from some days out of town. (It is not clear whether they did find out about having forgotten to turn something off, because they checked the app anyways or whether they actually remembered it and just used the app to make the command they had forgotten.) Several respondents – inhabitants and professionals alike – saw limited interest in using remote control more often, because (a) they saw now specific reasons for which to use it and (b) they did not see any sense in making changes or activating functionalities when they were not at home. Ursi and Daniel, who stated to use it more regularly, explained that

they too only used it in specific occasions for controlling devices turning them on or off or opening the door to a relative while away. They explained that rather than using it to send commands, they just checked how things were at home thanks to video cameras in and around the house. For example, they would look how their garden was after a storm had passed or checked whether their son was not having some unauthorized party at home. Jan, who had for some time experimented with cameras, also thought that if he still had them on, he would probably check them out from time to time – just by way of curiosity. This corresponds to Mr. Meyer's observation that it is not so much the remote control, but rather the possibility to check whether everything is alright at home that is used.

Remote control thus plays an important role in staying in contact with the house/home, checking how things are and, only if necessary, take action. Remote control extends the boundaries of the home and makes them permeable as it allows homeowners to see whether things are calm at home and to interact with it from afar if necessary. This suggests that remote control is appreciated more for monitoring, for checking that everything is alright, rather than for control in terms of operating the system and sending commands remotely (cf. Hargreaves, Wilson, and Hauxwell-Baldwin 2017:6).

As mentioned earlier and as the term 'home automation' implies, automated processes have been imagined as a key element of smart homes. Automation allows for things to be monitored and operated without human interaction. For example, temperature and weather data are constantly evaluated and shading or heating adjusted according to a set of rules and specific values defined by the inhabitants. Another example of automation would be presence simulation when the home status is "absent". Some of the households interviewed have more things automated, others less or none in the case of Jan. Generally, it can be said that automation is foremost estimated where it is considered to take over some work from the inhabitants, giving them a feeling of not having to care or worry about some of tasks or risks. Household 4, for example, had repetitive tasks of garden work such as watering the garden or mowing the lawn automated. Beat had the tedious work of checking the water quality of the pool and adding chemicals performed by his smart home system. Another example, most households had, would be the "all-out" button which not only offers the comfort of not having to check whether all the electric stuff is turned off or the windows and doors closed when leaving, but also some degree of security – the security that the house was left in a safe state.

As seen in chapter 3, the code behind automated processes relies on a series of rules and conditions. These can be combined to form complex statements and take multiple situations into account, but programming them relies on specificity. Adapting functionalities to the needs of inhabitants might work for one person, yet be more difficult to assure for a household or it might end in automations that are experienced as too rigid.

One form of automation that several interviewees considered as too rigid and restrictive were series of automated actions meant to accompany and enhance daily routines. One example of such an automation can be found in Beat's house. In the morning at a set time, music starts playing and the lights in the homeowner's bedroom come on, a bit later music and lights come on on the main floor and then turn off around the time when Beat normally starts working and when the children usually go to school. Tom had two similar automations that were based on what he describes as his TV and bathroom routine, respectively and started whenever the TV was turned off or when someone entered the master bathroom. For the two of them, this seemed to work well, also when sometimes they did not follow the fixed routine and had to have light, when according to the automation rules they should already have left or gone to bed. The rest of the respondents considered this kind of automation not to be desirable. Lukas and Jan, for example, had not (yet) set up anything similar. They were thinking of useful automations that fit their routines, but they were not sure whether such automated processes would make them feel like the smart home imposed the same practices on them every day. Ursi equally expressed her reluctance for any technology that would impose a default procedure on her or trap her into fixed routines. Her family had experimented with a console that put the disposed groceries automatically on the families online-shopping list when their house was still used as a testbed for new smart home technology. With respect of the reordering console she argued: "But I don't want it to reorder a strawberry yoghurt when I've eaten a strawberry yoghurt or I would remain with the strawberry yoghurt for my entire life. That would be so boring"²⁴ (Uris and Daniel 2017). As the examples showed, several respondents imagined or experienced life with automation enhanced routines as being trapped in routines. Thus, while routines are an important, meaningful part of daily life, they are not as fixed and rule-based as automation. Therefore, such forms of automation might cause feelings of a loss of freedom and of self-determination.

²⁴ 'aber ich will doch nicht, dass wenn ein Erdbeerjoghurt gegessen ist, dass wieder ein Erdbeerjoghurt nachbestellt wird, sonst bleibe ich ja mein ganzes Leben immer beim Erdbeerjoghurt. Das ist ja so etwas von Langweilig.' (Ursi and Daniel 2017)

It seems that the preference for one or another option to operate the building systems differs between individuals and depends on what is to be controlled and achieved. Some opt always for the nearest control device whichever it might be, others prefer the simplest or, in their eyes, the most adapted control (often a switch or, for Beat, a central control panel). Processes that are automated are most of all things that should happen independent of whether there is someone at home or not (shading, monitoring room climate, watering the garden, fire alarm, etc.). Routines turned into automated processes, in contrast, are less frequent and discussed skeptically. What control device is used is also situational. Several participants stated to enjoy using the smartphone app for turning the light on or off when on the sofa or in bed, as it allowed them to do so without having to get up, but did not use it frequently in other situations.

6.2. Feeling in control: a question of reliability and agency

This subchapter asks in what situations people living in smart homes might feel controlled, patronized or observed. First, it summarizes some fears of people living in smart homes losing control over the smart home and, potentially, their life. Then it turns to the professionals' assessment of situations that could lead people living in smart homes to feel controlled by the technology. Finally, it examines the participants' answers to my question whether they had ever felt observed, controlled or patronized by or in their smart homes.

My discussion of automation for enhancing routines has shown that such kinds of automation might be perceived as fixing practices in a way that is seen as annoying or as limiting one's self-determination. As automating processes gives agency to the smart home system, letting it evaluate variables and react to determined situations and events, it seems not surprising that some "horror scenarios" of smart homes take this a step further to imagine smart homes controlling their inhabitants. For example, HAL 9000 in the movie "2001: A Space Odyssey" (Kubrick 1968) or as it was later parodied as Ultrahouse 3000 in the Simpsons (Cohen et al. 2001) took control over their inhabitants. Imagining a smart home, computer scientist and psychologist Donald Norman voiced also doubts about whether automation would always do what the inhabitants want it to do. He perceived a potential danger of "overautomation" in smart homes and asked whether reliance on automation would not lead to a loss of the inhabitants' ability to control (Norman 1990:197, 214). These fears seem to be linked to visions of "automated homes" (Strengers 2016:65) taking over tasks and responsibilities from humans. Besides automation, there is another technical source for perceived

danger: the possibility for third party (unauthorized) access²⁵ to the smart home system, if it is linked to the Internet or to external services (e.g. if it has remote control or if data is saved on a cloud, on an external server of a service provider). One might disagree on whether smart home technology is developed to take over control from inhabitants or to allow for constant monitoring by third parties or whether those are unpleasant side-effects of smart technology. Although some smart home visions might include these aspects, they are generally formulated in terms of care or empowerment.

The professionals emphasized different reasons for why someone might feel controlled by smart home technology or providers: programming; interdependent automations that interlock each other; smart devices that save data on clouds, that is, on providers' servers somewhere around the globe. The last point refers to the idea that someone, a company, utility or hacker, could analyze and make use of personal data or sabotage the system. The other two points mentioned relate to a feeling of loss of control to the system. According to the professionals Studer and Meyer this might happen, when the programming is poorly executed, when it is not adapted to the family's needs or when there is too much automations that interfere with each other disrupting smooth workings. Over all, they consider the problem as limited because inhabitants always have the possibility to intervene, to override automations or deactivate them.

On my question whether they had ever felt observed, controlled or patronized in their smart homes, all the participants stated they had not. While Beat was perplexed about my question and could not imagine that anyone would feel controlled, Gabriel and Lea said their parents sometimes did. Gabriel explained that his parents would prefer to decide themselves when the shutters should go down instead of having them automated. This is so, he suggests, because it might hinder them from going out on the terrace, if they don't remember how to override the automation. On the other hand, Lea's parents (and sometimes Lea herself) feel controlled – not by the technology but because of Lukas's energy monitoring practice. Lukas regularly checks the visualization of the household's energy consumption and might comment if that the energy consumption was higher than average and he might inquire who had let the windows open too long or who had chosen an energy-intensive washing program. On my question, why they did not feel controlled or patronized, the interviewees answered that they could always intervene and override automations, that they had the last say or, in

²⁵ This refers to both, utilities and governments monitoring activities and consumption patterns and hackers.

the case of DIYers, that they were themselves responsible for malfunctions. In what follows, I will argue that the feeling of being in control and of being controlled should be thought of as linked to various factors such as the implementation and reliability of smart home technology, the way the relation between humans and the smart home (technology) is imagined and the distribution of control within and beyond the household.

The ways in which smart home projects have been implemented, what technology has been chosen and how the automations have been programmed critically shape the smart home and how one can interact with it. Automations reflect desires, experience, sensory perceptions and situations are taken into account in the programming and might reflect single householders' perception. Therefore, professionals and DIYers made a point in avoiding the creation of automations that could be experienced as patronizing, as trapping or binding people to specific practices or rhythms of life by any of the householders. To find a balance between avoidance-strategies and the wish for some automation might be challenging and not result in a satisfactory situation.

Reliability refers to the question of whether the smart home system works as it should, as expected and as the inhabitants would want it to. This was evaluated rather positively by the respondents, although several households reported having (had) problems with motion controls randomly sending commands (H1, H3), with voice control reacting to kitchen appliances and opening the door (H4) or other things. These problems were generally perceived as problems in the programming, as "bugs". Clearly not all the household members had the same prerequisites, the skills, knowledge and tool to fix programming errors. For example, Lea and Gabriel's wife were frustrated with a motion control reacting only rarely to their presence and had been waiting for some time for their husbands to fix the problem – without any result. Sometimes, though less often, the DIYers would also get upset and frustrated, principally, when they could not detect any reason for the malfunction. Overall, however, DIYers saw problems of programming and reliability rather pragmatically: If the system did not do what they want it to do, they saw themselves as the ones to be blamed for and at the same time as the ones who could solve the problem. The answers of the interviewees to the question why they did not feel patronized or controlled by the smart home technology point in the same direction – that the householders position their control over that of the technology.

Strengers, referring to a Woodruff & colleagues' study of an Orthodox Jewish community living in smart homes (Woodruff, Augustin and Foucault 2007), points out that smart homes are not passive slaves, but that they have agency: '[home automation technologies] act back, taking on human-like characteristics and embodying agency by guiding, facilitating and even recommending actions' (Strengers 2016:70). The smart homes of my informants can be described to have similar forms of agency recommending when to air out the house or what washing program to choose (see chapter 5.2.), taking over monitoring or repetitive practices. My respondents seemed to recognize and appreciate this agency, however, they – especially the DIYers – attributed it to the programming. They insisted that the technology would just do as it had been told to, as it had been programmed to do. Therefore, they considered humans – professionals or themselves – to have more control, to be able to exercise control on a different, that is, higher level.

Chapter 4 had already pointed to different constellations of how responsibility and work related to the smart home technology might be distributed within and beyond a household. I have also pointed out that to control a smart home system and make changes, one needs special knowledge, skills and tools. This might lead for some households or individuals to situations of dependency, dependency on others to implement what oneself is not capable of doing. For none of the households living with professionally installed smart home systems this was directly experienced as a loss of control to people outside the home. Probably, they would also have relied on electricians or other technicians to solve technical problems, if they still had conventional building services. The dependency on external experts was generally not seen as problematic as long as there was a relation of mutual trust with the professional and as long as they had confidence in the professional's expertise. Of these three households only H9 (Peter) had at some point lost the confidence in his technician's expertise and professionalism, which gave rise to his wish to learn more about how he could better use the system and adapt the system and to find out whether some of the functionalities the technician was unable to implement were actually not possible or whether it would prove his assumption that his technician was just not able and unwilling to do more.

Furthermore, the responsibilities over and possibilities to control the system (but also the household) are unequally distributed. Kennedy & colleagues (2015) have pointed out that responsibilities and necessary expertise for managing home technology are gendered. My data reflect the same tendency, yet are too scarce to draw any meaningful conclusion. I should stress again, that the views I was able to analyze and represent here were mostly those

of the family members in charge of the households' smart home technology – in my study this were all men. Nevertheless, my data suggests that not all household members feel the same and have equal possibilities to control the system or making changes to the programming. For example, I have mentioned that Lea and Gabriel's wife regularly complaining to their husbands about motion sensors, depending on them to fix the problem. Lea's teasing her husband to be a control freak also points to another way who control is experienced and practiced within the household: the controlling of other members of the household. Bell, Blythe and Sengers describe it as the "Little Brother" in dependence on [Orwell's] "Big Brother" (Bell, Blythe, and Sengers 2005:12). In the case of Lukas and Lea... not centrally about controlling the other, but just about monitoring consumption practices. Only Ursi expressed an interest in smart home technology – principally video cameras – to check whether things were calm at home when on holiday or to see where the rest of the family was and whether they were occupied before calling on them for dinner. Her family was also the only one who had video cameras in various parts of the house. As Ursi explained, the aim was not so much controlling others, rather she saw video images as visual communication.

My analysis of how the participants' view the danger to lose control to the technology or to be controlled suggests most of them do not perceive it as a danger in their own smart homes. It emphasizes the implementation of and reliance on smart homes as well as the individual's perception of how agency is distributed between themselves, (other householders or experts) and the technology as central factors influencing individual's feeling of control. Especially the implementation but also the perception of agency can be influenced to raise their feeling of being in control – the first through configurations and deactivation of overpowering automations and the second by encouraging and assisting persons to learn to make themselves changes to the home system. One might also imagine that people are glad to leave this work to experts or other household members, however, for the DIYers and otherwise technically interested participants in this study this was an important element to their feeling in control.

7. Smart Home Security & Data Security

In the theoretical and methodological chapter, I introduced the notion of home as a place of security and control. The aim of this chapter is to examine different perceptions of potential and security holes of smart homes. The aim is not to deduct implications for the design of such technology but to gain a better understanding of the different kinds of threats that

(smart) home inhabitants recognize, what they do about it, and the meanings and social effects associated with security mechanisms.

Security is a central argument in the smart home discourse. The first part of this chapter presents the stories and promises about security in/of smart homes as they are told by producers and vendors. I then compare the perception of security issues, relative strategies and effects as described by participants living in smart homes and working in the smart home industry. As elaborated in chapter 4.2., for some households' perceptions about security limited their smart home projects to what in their eyes could be done in a safe way. The security issues that led to restricting and protective actions are mainly those related to the topic of data security (7.2.2.), whereas other more traditional domestic security issues led several households to include more smart home technology or to use these technologies for multiple purposes (7.2.1.). This analysis includes data drawn from forum-discussions, journals, vendors webpages and adds additionally to the interviews.

7.1. Selling the smart home as place of safety and security

Whereas some critics point out the vulnerability of smart home systems to hacking, security is often used as one of three main arguments for promoting home automation in the local smart home market. In his analysis of the smart home discourse from the 1990s, architect and sociologist Amphoux found that the discourse focused on the security of people and possessions considering multiple roles smart home technology could accomplish: social, economic, preventive, assistant (for elderly or disabled people or children), and pedagogic roles (Amphoux 1990:68). Not all of these continue to be central in the current smart home discourse. For example, the pedagogic role tends to disappear, at least in the context of my study. Amphoux argued that the discourse tended to mystify what smart home technology could actually do for securing the domestic space by imagining absolute security (*ibid.*:70). In what follows, I present what kinds of security issues smart homes are considered to be able to counter and how. I build on presentations of the issue in two specialized Swiss journals (Swiss KNX association's "busnews" and the yearbooks "Intelligentes Wohnen" (smart living)), on producers and vendors webpages (websites of the smart home technologies used by my participants and some other Swiss vendors) and in my interviews with professionals.

In the *busnews* and the yearbooks of the professional group *Intelligentes Wohnen*²⁶, security was as a marginal topic compared to presentations of smart home projects and new smart home devices or questions of energy management. Smart homes were generally depicted as offering protection against burglary when discussed as source of security. The focus there was on prevention (e.g. notifying people about open windows when they leave the house, simulating presence with lights, shutters, music etc.), determent (e.g. lights and an alarm come on when an intrusion has been detected), and/or alarming (internal or external) (e.g. Simeon Lutz 2016b:83). While vendors of professional home security systems point out that their systems can be integrated into smart homes and, for example, be automatically turned off when the finger print reader at the door recognizes that a household member came home, producers and vendors of smart sensors and actors rather point to the fact that their products can be double-used to ensure convenience and to secure the house (e.g. Simeon Lutz 2016b, 2017). For example, when the status of the home system has been changed to absent, indoor and outdoor motion sensors usually used to control the light can additionally be used to detect unwelcome guests. A detected motion could trigger the following scenario: lights come on in the entire house, music starts playing loud to distract the potential burglar and the shutters go down to hamper a break-in (e.g. ABB NN; Simeon Lutz 2016b:83; Somfy NN). Also, the system might send a message to the homeowners to alert them.

The anti-burglary protection was equally a central argument on the producers and vendors websites. There, alarm systems were discussed more often with regard to the safety of the inhabitants and the house, for example, in the case of fire or flooding. Similar as for the protection against burglary, already existing sensors can be used to alert inhabitants if certain values of heat or humidity are exceeded, from which one might conclude that there is fire or water in the house. A predefined alarm scene similar to the one described above would then be put into effect, with the little difference that now the shutters should open to free an escape route (e.g. eQ-3 NN b; Loxone NN b; Somfy NN). Furthermore, an entirely different aspect presented under the heading of “security”, was that of conservation of value. They considered the investment in a smart home to offer security for an unknown future because such technology can be easily adapted to changing desires, needs and circumstance.

²⁶ The professional group *Intelligentes Wohnen* is a subgroup of the *Gebäude Netzwerk Initiative*, the leading national professional association for building technology. It promotes the construction and development of smart homes and publishes information material for builder-owners besides the yearbook.

Similarly, all professional interviewees mentioned the security an alarm system or video cameras (also just a video intercom) could offer as an advantage of smart homes technology. Another element most of them mentioned was the feeling of security that something like an ‘all-out’ switch might offer – the security that all lights and predefined electric appliances are turned off without inhabitants having to check and double-check. This, then, goes in the direction of what Mr. Tanner called ‘information security’, a feeling of security which results from being informed about what is happening in the house and from knowing that they can rely on the technology. Another aspect pointed out by Mr. Vogel is the use of smart home technology for the safety of elderly people (e.g. emergency buttons, detecting any falls) a field also referred to as ambient assisted living (AAL).

As presented in this short passage, producers’ and vendors’ ideas of security cover the protection of house, household members, valuables and value. Potential risks for houses and how to protect the house and people against these risks are presented as rather straightforward and unproblematic. They do not seem to consider competing interests and how individuals might assess risks differently.

7.2. The smart home as a place of safety and security

My participants who live in smart homes were mostly middle-class, well-educated homeowners. They showed ‘confidence in the house as providing shelter and security’ (Rainwater 1966:24), yet they tried to further improve the security of the house, those who live in it, and their possessions. My analysis of their perception and dealing with potential risks is divided into two parts according to different sets of risks: (physical) threats to the inhabitants and their possessions through break-ins, natural hazards and the like and digital threats that derive from smart home technology, mainly hacking. The interviewees’ assessment of potential threats varied considerably with some emphasizing burglary and others mainly concerned with digital threats.

7.2.1. Security as side effect?

From the point of view of my interview partners living in smart homes, the points in which smart home technology can help them secure their house, valuables and household members reflect the arguments of the smart home industry: protection against burglary (households H1, H3, H4, H6, H8, H9), fire alarm (H3, H6), protection against damage by water (for the electronics and servers (H4, H6)), functionalities such as an ‘all-out’ switch or automatically closing windows for reassurance, comfort and convenience (H4, H6, H8). Of these, anti-

burglary protection was a topic also intensely discussed on the home and living forum where I had recruited three participants – and not just with respect to smart homes. The discussion on the forum tended to emphasize physical barriers like quality locks and windows. The following table offers an overview of the various materials and technologies used to secure the house(hold)s including security features that are currently active (also if not used on regular basis), under planning or that have been dropped.

	Working security features	Planned security features	Security features stopped
H1	Presence simulation Alarm system <i>Window sensors</i> Motor lock (door) Fingerprint Switched electrical outlets	Video cams (door, terrace)	
H2	Fingerprint <i>Video camera (intercom)</i> <i>Humidity sensor (wine cellar)</i>		
H3	Fire alarm	Window sensors <i>Video camera (intercom)</i>	
H4	Alarm system Time controlled light (when on holiday) Video cameras Motor lock (door) Fingerprint Window sensors No remote control of stove, chimney stove and water inlet		Presence simulation
H5	No remote control Security glass (door) Quality lock (door)		
H6	Presence simulation Video cameras <i>Window sensors</i> Smoke & water alarm		
H7			Video cameras
H8	Outdoor lights	Presence simulation	
H9	Alarm system	Presence simulation	

Table 3 Security features in the participants homes

Some of the security features from the list have multiple purposes such as the window sensors. These were mostly considered to prevent shutters from closing when the door to the terrace was open and someone might be outside and to alert inhabitants when it started to rain and less in as elements linked to alarm systems. Security products pointed out only in some cases are doors and door locks. These appear in the list only when explicitly pointed

out as elements for securing the house as I consider taken-for-granted security goods²⁷. One feature, that is not mentioned in the list were shutters which are programmed to automatically raise when there is high wind or hail in order to protect the shutters. Not all the interviewees mentioned this but it seems to have become somewhat of a standard in connected homes (and also in houses that have just central shutter control) as my professional interlocutors assured me²⁸. Other elements that are not visible in the list but which I consider highly interesting are functionalities described as offering a feeling of security that is not so much related to protecting, but rather to the idea of ‘keeping an eye on’ (‘all-out’ switch, automatically closing windows) or for caring (irrigation system and mowing machine).

The table gives an idea of what objects and functions different households considered as connected to the security of the household, home and possessions and against what sorts of threats households are equipped or see an interest in doing so. However, it does not say anything about whether and in what situations security goods and features are used or activated or for what purpose these were acquired or installed. For example, household H1 appears to have implemented multiple security features, but Gabriel stated that several of these elements were not implemented for security reasons but appeared rather as “side effects” of smart home technology in general.

Loader & colleagues, who have examined consumption of security goods, conceptualize security consumption as ‘grudge spending’ (Loader, Goold, and Thumala 2015). Three elements make up their idea of grudge spending: (1) it is a ‘non-conspicuous consumption’ that is not driven by desires or a wish to affirm social status but rather as ‘insurance driven’ (*ibid.*:862); (2) there is some reluctance to pay for security goods; (3) consumption is not informed by advertising but by informal recommendations (*ibid.*:863). Domestic security consumption, they argue is under challenge with respect to questions of costs and benefits and with respect to not making the home feel less like a home (*ibid.*:868f). Gabriel’s description of security features as side effects takes up the idea of non-conspicuous consumption

²⁷ I take doors, locks or windows for granted, although Ursi and Daniel stated that in their old house they did not use to lock the door because it was so isolated. It is notable that there is a panoply of doors and locks of different quality and prices and that these might become more and more fused with digital technology, e.g. finger print readers or vein authentication systems replacing keys or motor locks that allow for remote control.

²⁸ I wondered where this tendency to protect the shutters came from. Was it the building management or the shutter industry? Living for over 20 years in the same semi-detached house, my family had to replace only two shutters and none due to storm loss. In a discussion on the forum I can take others share my doubts. But apparently Gabriel had made other experiences which led him to program such a shutter protecting feature for his house.

and of the reluctance to pay much for security, insinuating that in smart homes this goes even further, that with smart home technology security can be created with already present technologies and devices. The technologies considered to provide protection and offer a feeling of security are mainly based on devices that are present in many connected homes and not necessarily or principally used for the purpose of security. For example, sensors are used for monitoring the room climate or to detect fire or water, motion sensors that are primarily used for light control are also a key element of anti-burglary alarm systems, etc. Furthermore, motion sensors, automated shutters or ‘all-out’ switches are primarily valued for the comfort and convenience they offer.

I asked my interview partners more specifically about three types of security technologies: Presence simulation, burglar alarm systems, and video cameras. Of these three, presence simulation was the technology that virtually all interviewees imagined to be useful and to have the potential to keep burglars from even considering their houses as potential targets. Nevertheless, many of them thought that their own houses were not interesting for burglars either because they thought ‘there is nothing to get’ (surprisingly also the owner of the villa took this position) or because of the houses position. For example, contiguity with/to (other) villas was considered to attract attention of burglars to the wealthier neighbors or houses on a slope were considered as more difficult to access and thus less interesting. Only Nick considered the position of his house as potentially interesting for burglars because it was a little isolated. Still, all interviewees living in smart homes considered presence simulation as ‘nice to have’ rather than an essential in order for them to feel their house and valuables were safe when they were not at home.

Automated presence simulation can be considered as replacing other, simpler forms of faking presence through time controlled lights. For example, Gabriel stated that, before having had smart home technology, he did not use to simulate presence with a clock timer for the light when on holiday as some people do, because to him it seemed too much effort and the implementation too obvious and inauthentic. While Gabriel and Tom saw in presence simulation thanks to smart home technology a good alternative to conventional time switches for lights as more authentic, Ursi and Daniel decided, when recently updating their smart home, that they did not want their old presence simulation anymore. In their eyes, the way presence simulation was realized in their house through a restaging of the previous days was a waste of energy – ‘why should the light burn as much as though a family of four were there [when

actually no one is]?’ (Ursi and Daniel, 2017)²⁹. Therefore, they switched to time switches that are integrated in the home system for controlling just a few lights. Instead of or besides presence simulation, part of the householders (H3, H5, H6, H8) stated they generally informed family members or neighbors when leaving for a few days and counted on them to keep an eye on the house, maybe also taking in the mail or watering plants.

While presence simulation was not considered necessary by several informants, alarm systems and video cameras were seen as more problematic at least by some individuals. It might be interesting to point out that none of the households had experienced any break-ins and besides Peter none had had alarm systems before living with smart home technology. On the contrary, Ursi and Daniel stated that in the old house where they lived before, they were not even used to locking the house’s door as the house was so isolated. For the households H1, H4 and H9, the burglar alarm system works both as deterrent for burglars and as reassurance for them and their family. In all three households, it appears to be principally the women who appreciate the security of the alarm system the most or who have wished for an alarm system. In the houses of Gabriel and Peter, the alarm system starts and ends automatically when leaving the house as the last person or coming home first. Ursi and Daniel indicated that they used their alarm system only seldom because they feared it would interfere with the different rhythms of life of the household members and might provoke unnecessary false alarms.

It is interesting to see that while some valued their burglar alarm system (or other alarms) for the reassurance it gives them, others imagined it would stress them enormously. Alarm systems were imagined to be troublesome and stressful by some because of false alarms and the uncertainty over what was happening when not present. For example, it might be stressful and make someone feel powerless, if they were on holiday and got noticed that probably there was someone breaking-in in their house but could not verify whether it was just a false alarm or not. Jan and Nick, for example, thought they would prefer to come home and then see that there had a burglary taken place, then the uncertainty of not knowing whether it was just a false alarm or whether there was actually something happening. For several interviewees, the chance of false alarms was the main reason why they rejected anti-burglar alarms – besides the fact that they did not see any need for it.

²⁹ ‘wieso sollte das Licht so viel brennen, als wäre hier eine 4-köpfige Familie [wenn niemand da ist]?’ (Ursi and Daniel 2017)

In contrast to the technologies and devices integrated in presence simulations or alarm systems, surveillance cameras are principally seen as security and surveillance devices. Several interviewees' assessment of cameras, especially in the living areas of the house, was in stark contrast with the idea of home as a place where to feel secure and free from external control. They considered cameras, especially in the living areas of the house, as highly problematic, as threat to the privacy of the home (if hacked). Yet, some respondents appreciated cameras in what appear to be less problematic and intrusive contexts like in relation to the intercom or outdoor surveillance cameras. Tom, for instance, was rather critical about cameras in living areas of the house, but as smart home hobbyist he was curious to try to integrate video cameras into his smart home system and find out how test how they interact. He had recently reoriented one of the cameras to capture his cat carrying its toy to the basement. The only family who had cameras in several areas of the house, household H4, emphasized other uses of the cameras over the surveillance aspect. They emphasized how it would keep them in contact and supporting communication. For example, Ursi explained, that she would check where everyone was about the house and whether they were occupied before calling for dinner. These examples suggest that technologies that some consider to be intrusive and threatening, might be seen as supporting both a feeling of homeliness and security by others. Through the process of domestication security devices might be used for other, more rewarding and valued functions.

Generally, the smart home functionalities my respondents discussed with respect to domestic security reflect the arguments put to the fore by the smart home industry. Yet, most households have only one or two security functions activated, as the risks and their vulnerability were perceived to be limited or because they relied on other things or mechanisms to offer sufficient protection or deterrent (e.g. dogs, neighbors, and other taken-for-granted security goods such as doors, windows, locks, etc.). I have already mentioned some of the arguments why the homeowners were reluctant to adopt security features and security goods. An additional point, that moreover leads me back to Loader & colleagues' 'grudge spending', is how risk prevention was discussed linked to questions of costs. For example, professionally managed burglar alarm or firewall were by some considered to be too expensive, considering that it entails a certain risk for false alarms and that the chance for being target of a break-in was taken to be rather small.

Security was not something that my respondents were enjoying to spend their money on, yet they were not completely unwilling to do so. Security features that could be achieved without

special security goods, just with what the smart home offers and would therefore moreover not introduce any security technology into the houses which could put the feeling of hominess under pressure. In this regard, my analysis of smart home owners' relation to security consumption echoes elements of 'grudge spending' as described by Loader & colleagues (2015). However, in smart homes, securing the home might not necessarily require the purchase of specific security goods and technologies. What is special about smart homes, is that they seem to advertise such a form of security consumption. Security features like alerts for open windows when it starts raining, automatically closing windows or 'all-out' switches are valued for reassurance as well as for comfort and convenience. Such functionalities are appreciated in various ways. Similarly, most technologies and devices participating in securing smart homes have multiple purposes and security might be perceived as a welcome supplementary function and not the main function of smart home technology. Yet Loader & colleagues concept of grudge spending focuses on the purchase and less on later forms of consumption. As the discussion of alarm system and risk of false alarms suggests security features might be dropped or only partially or unregularly used and it emphasizes that what some experience as reassuring might be considered stressful by others.

7.2.2. Dealing with the threat of an unsecure smart home

With increasing digitalization of our houses, these are reported to be increasing vulnerable. Media sometimes imagines a future where we don't have to bother about the heating, ventilation or whether we have turned everything off before leaving, but show also concern for the question security and vulnerability of smart home technology. For example, in 2015 the German online newspaper Spiegel investigated the risks of smart home technology and published two articles on the topic: (1) about the constant production of data by such smart home devices and that this data is non-stop communicated to the provider in the case of smart home technologies that use the providers' cloud for storing and evaluating data (Hochert and Stöcker 2015); and (2) about the vulnerability of smart homes to hacker attacks (Schröder 2015). Earlier this year, the Swiss economic journal Bilanz published an article on the vulnerability of smart homes to hacking, giving an example of a hacked and blocked smart TV to be released only upon payment of a ransom demand. The author of the article blamed the producers for not caring enough about security standards and just trying to make the race against competitive companies (Heuzeroth 2017).

Asked about potential risks related to this topic, my research participants mentioned a variety of risks mainly related to the hackability of smart homes. The risks they identified are mainly

of two sorts: (1) that of hackers being able to (remotely) control the home system either for sabotage, to provoke dangerous situations (turning on the water or the stove) or for break-ins; and (2) the potential for being constantly surveyed and the houses data being analyzed by individuals, state or private institutions. Other risks mentioned by professionals were also related to hacking. Hacked devices might be interesting not in themselves, Mr. Studer argued, but for how they can be misused for bigger hacking attacks. And Mr. Meyer saw the biggest risk in the theft of personal data. These potential risks seemed, however, to be only of limited concern for most households apart from Tom and Markus. Most households seemed to be more concerned with making their homes comfortable, reliable and secure (in the sense that they do not have to care about tasks being executed), than with the security and management of their private data. In contrast, Daniel and the professionals expected data security to gain increasingly in importance as ever more smart technologies push into the market and producers' efforts to secure them seem to be limited.

As respects the growing number of smart devices, also the Federal Reporting and Analysis Center for Information Assurance (MELANI) makes a point in protecting devices from misuse by hackers on its website. The center does not explicitly make mention of smart homes – keep in mind that home networks must not necessarily be connected to the Internet – but refers more generally to the growing number of devices that are connected to the internet. MELANI considers devices that are not regularly updated (that do not use software that up to date with respect to security holes) and that can be accessed with standard passwords as particularly vulnerable. They propose a series of preventive measures and measures after a hacking attack. These measures include gathering information about security precautions for the devices and providing and ensuring a secure internet access. This presumes some previous knowledge about networks and configuration of electronic devices (MELANI 2016).

It is important to keep in mind that compared to single smart devices that are connected to the Internet a connected home is generally based on an in-house bus-system, like in the case of the participants in this study. This leaves a limited target open to hacker attacks, most interviewees thought. Having the data on a home server and not on a cloud, thus significantly reduces their perception of risk for their own home. This was also the reason why Tom chose not to follow the producer's proposal to use their cloud-service but instead set up an in-house storage/server solution. While several considered cloud-based solutions as dangerous, Jan, who has professionally to do with cloud services, emphasized that clouds are not bad, that it is more a question of where and for what a local or a cloud solution make more sense. Like

Mr. Meyer he pointed out that big providers' clouds might be more interesting targets for hackers, but the providers have better means than most households for protecting their data.

The idea that single households are not an interesting target, was an important element in reducing the households' perception of risk and a central argument for why some households do not consider it necessary to protect their home system beyond the standard protection (e.g. no standard password, firewall). 'We have nothing to hide' or 'there is nothing to get from us' were typical statements of this perception (Beat, Lukas, Jan, Daniel and Ursi). In an article on individuals' understanding of the internet and perception of risks, Kang & colleagues, computer scientists, also found that the statement 'I have nothing to hide' was a recurrent argument for why individuals might not take action against potential risks even though they know about the risks (Kang et al. 2015:47).

Kang & colleagues further argue that individuals' perception of risk is a better indicator for whether they take action to protect the Internet access and their data than the individuals' level of technical education (Kang et al. 2015:47f). As most of the participants interviewed were more or less technically interested, it is difficult for me to say what role their technical education plays in their decision about against what risks and how to protect their smart home (data). I do, however, see a link between the perception of the risk of one's own smart home and the measures taken to protect it. Mr. Meyer, Tom and Markus, who described themselves as rather cautious in respect to data security or told me stories seen on TV about how easily smart devices like a smart TV can be hacked or about a case of data theft, were the ones who seemed put most effort on securing their (or, in the case of Mr. Meyer, his customers) house. Admittedly the three of them are professionals in IT and/or home automation, but so were most interviewees.

The strategies taken or recommended are mainly concerned with limiting and securing remote control on the one hand and avoiding that data considered sensitive is saved and logged by their home system. Another space to protect from attacks are outdoor gateways such as for IP cameras. (One has to be physically present to be able to use such a gateway for entering a network through exposed devices.) Markus took the most restrictive position in respect to remote control by completely rejecting remote control. Few others limited the functionalities remotely controllable (Gabriel) and encrypted the communication for remote control (Tom), however, besides Markus no other participants considered giving up remote control an op-

tion as for them it is an essential element of a smart home. Alternatively, householders restricted the implementation of potentially dangerous functionalities and the logging of data considered to deserve protection. This seems to be perceived as less incisive measures than renouncing remote control.

Overall, it has become clear that all interviewees did recognize risks to data security in smart homes and the fact that there can be no 100% protection against these. What kinds of protective measures are taken, seems to be influenced both by the technical understanding and sensitization about the possibilities and interest in hacking smart homes and by the individual perception of (imminent) danger. Another potentially influencing element that had not been discussed with my participants was the know-how needed to implement and manage protective measures. Personally, I can imagine this to be an obstacle for some. Personally speaking, I guess, I would need some assistance for implementing, for example, the recommendations made by MELANI.

In this chapter, I have tried to give an overview over the householders' strategies for protecting the household, the home and possessions and their data. I have attempted to carve out the tensions surrounding the homeowners' attempts and effort to secure their house and creating a safe place for the household. It is a balancing act between making use of the options smart home technologies offer as best as possible and limiting the system's surface for potential hacking attacks. I have argued that whether any measures against potential risks to the home as a place of security depends on the households' perception of the risk of their home, on their perception of costs and benefits and other commitments that security is weighed against. As risks and security features are perceived in different ways, there are many different strategies and ways for achieving a feeling of security.

8. Conclusion

This Master's thesis represents one of the first qualitative studies with people who had (mostly) been living in smart homes for a few years focusing on how they made their smart homes into homes, into places where they can feel secure and in control. The term "smart home" echoes ideas of home, yet what it refers to more precisely is the *technology* behind it. The main purpose of this study was to examine the domestication of smart home technology and to explore connected smart homes as places of security and control.

I started with presenting smart home technology with a focus on automation. As one of the core elements of smart homes, which was also emphasized by the study participants, I pointed to the reliance on the simplification and specification of daily life for programmable rules and constraints as well as monitoring of domestic (and external) space as input data. The programming of such automations reflects necessarily ideas and individual theories about domestic life and desirable technological support for everyday practices.

I then have turned to how the householders' desires of and concerns about control and security, along with other concerns (some emphasizing security or openness of the system or wishing for specific control and monitoring options), had an influence on the form their smart home systems took. I have retraced how the participants had adopted and adapted (to) smart home technologies to fit their life and value system, conceptualizing this process of practical and technical learning about technologies and sense making of these as crucial to the domestication of smart home technology as it creates new ways for personalizing the home. My analysis of how smart home technology is being domesticated builds on previous research about the domestication of smart home technology and broadband networking with an emphasis on skills, knowledge and the learning involved in the process by anthropologists, sociologists and environmental social scientists (Hargreaves, Wilson, and Hauxwell-Baldwin 2017; Kennedy et al. 2015; Nyborg 2015; Tolmie et al. 2007; Tolmie et al. 2010). Domestication, at least of such a comprehensive technology as a smart home system, requires more than planning and the practical/technical work of placing, installing, setting up and configuring, learning how to use the system and make sense of it. Smart home technology might demand additional adaptation of the inhabitants' practices, social and human-technology relations and, as Hargreaves & colleagues have argued, the re-domestication of elements that made up the home before it was augmented with smart technologies.

Tolmie & colleagues (Tolmie et al. 2007) introduced the term “digital housekeeping”, which righteously points to the new work that a home network requires. Smart home technology requires mainly programming, managing and regulatory work. Yet, in respect to smart homes, not all households do their “digital housekeeping” by themselves, instead they might, depending on their aims and means, have professionals taking that practical/technical work of domestication over (respectively, do it together with professionals). Instead of speaking of the work done by householders in terms of “housekeeping”, I have described the householders, who do so, as Do-it-yourselfers as my discussion of work was centered around the introduction, installation and attempts to make it work ‘properly’ more than on continuous management and regulation of the data or room climate. I have followed Bernheim Brush & colleagues in comparing households with DIY and professionally installed and managed systems, respectively. Bernheim Brush & colleagues note that professionally installed systems tend to reach faster a state of relative stability (where no more configurations and changes are made to the system), whereas DIYers more regularly make changes to the system (Bernheim Brush et al. 2011:2118). The DIYers thereby seem to practice a more continuous integration and domestication of smart home technology. Broadly speaking, my findings correspond to this, though I would add that whether DIYers keep working on it and adapting it is, for some, also a question of time as changes might be rather work and time intensive. I have also suggested that smart home technology adds an additional layer to personalizing the house, to make the house a home. DIY smart home projects might thus be evaluated negatively, as things do not get done and dragged along, or positively as it allows for more flexibility and individuality. Research on DIY and home improvement discusses DIY home maintenance as ‘an important arena for the negotiation of identities, particularly masculinities and relationships, as well as being a way to gain a home that better conforms to the household’s needs and desires’ (Cox 2016:70).

I should stress that I did not accompany the families for a longer period of time and had to rely on their descriptions of the changes that had taken place since their smart home project had first taken form. My research was restricted to a small number of participants in the German speaking part of Switzerland almost all of whom considered themselves to be technically interested, several of them working either in the building technology industry or in IT. The interviewees were mostly men, which makes it impossible for me to thoroughly discuss gendered uses and views of smart technology, yet generally my data seem to point

in the direction of Kennedy & colleagues' argument about digital housework reflecting traditional forms of gendered housekeeping. What I was able to analyze and present was rather their longer-time experience based on their retrospective account.

In all that, it was my aim to do so with respect to the idea of the home as a place where one can feel secure and in control. The domestication concept has supported the analysis of smart home technology for control and security insofar as the new control options that smart homes offer might require some learning of how to use it and, as I have elaborated in chapter 6.2., the implementation and iterative configuration. The beforementioned process of learning makes up an important part of the domestication of smart home technology and plays an important role in creating a smart home that is perceived as giving control to the people in it and not as having a lot of control and influence over the inhabitants.

In respect to the issue of control, I attempted to follow it across various levels looking at technological aspects, its role in the planning and domestication process, and finally, as link to questions of reliability and agency. The question of control runs through the domestication process, often from the first considerations (remote or automatic control), and daily life with the smart home. Admittedly, my discussion of control remains currently at a purely descriptive stage. An attempt of theorization would be interesting, especially with respect to the paradox of designing for automation as well as control, that is, for control being taken over as well as for allowing smart home owners more control. A discussion of "feeling in control" (of one's life, environment, etc.) within the home should take into account both practices of social control and control in the sense of controlling and interacting with the environment.

Distinguishing between households that had their smart homes installed and configured by professionals and households where one person (as DIYer) was responsible for the home system revealed different constellations of control and responsibilities and different possibilities for interacting with the smart home, making it into a home. My study suggests that how the relation between householders, smart home (technology) and external factors is imagined and experienced might be an important factor for whether people feel in control and secure in their homes. Therefore, I suggest that offering all the household members the possibility to make some adaptations to the system might, on the one hand, make inhabitants feel more in control and secure and, on the other hand, also offer them new ways to make their smart homes into their homes.

As regards the discussion of domestic security, the concept of ‘grudge spending’ proposed by Loader, Goold and Thumala (2015) seemed to be a valid starting point for my analysis of contrasting needs and desires with respect to the security of people and (smart) home. Yet, it is limited to the motivation and reluctance of spending money that decide over the purchase of security goods and how such goods are valued is under pressure. With respect to my own research on the domestication of smart home technology for security (and control), but also for the broader field of security consumption, it might be interesting to ask what forms of consumption, use or non-use the “grudge” attitude can be associated with.

Researching smart homes in respect to social science or traditional concepts of home is a rewarding endeavor to concentrate more on the lived realities and transformation of visions of homes and domestic values and practices. This study focused on (smart) homes as places of security and control and was only marginally able to scratch the surface of other dimensions centrally associated with home. There is more to research on smart homes reflecting moral ideals and identities, on the impact of disruptive technology for existing practices, existing technical environments and responsive practices, on the reorganization of responsibilities and the capacity to control within and beyond households. Another avenue for further study would be research into how agency is perceived to be split or shared between smart (home) technology, individuals and households (and external professionals, depending on the case) is experienced and negotiated by different members of a household.

My representation of the small number of households interviewed and their respective homes, their preferences for controlling or monitoring functions and their ideas about risks and security has clearly shown that depictions of smart homes as either dreamlike or as technical nightmares equally miss the diversity of human-smart home interactions and relations, of home visions and of lived realities of households living in smart homes.

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LEA and LUKAS, 08.02.2017

MARKUS, 06.03.2017 (telephone interview)

NICK, 16.03.2017 (telephone interview)

TOM, 01.03.2017

URSI and DANIEL, 28.02.2017

Professionals:

Mr. MEYER, 14.03.2017

Mr. SCHMID, 06.12.2016

Mr. STUDER, 10.03.2017 (end-user seminar), 21.06.2017 (follow-up interview)

Mr. TANNER, 13.11.2015 (for qualitative methods seminar), 18.11.2016

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