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Impacts of new technologies on media usage and social behaviour in domestic environments

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Technological infrastructure at home is changing continuously and is becoming increasingly interconnected. Media devices, including the TV set, provide access to the Internet and offer manifold opportunities to consume media on demand. Additionally, personal devices, such as smartphones, also enable flexible consumption and sharing of media. Questions about how these technologies change the user's media usage and how these changes affect the social structure of a household, however, remain largely unanswered. In order to gain insight into the adoption of new technologies into daily routines, we explored these changes in respect of people's media usage in a qualitative long-term Living Lab study. We will present findings regarding personal routines, flexible integration of new devices into existing practices, influences on households as social systems and related issues in device access and collective use. We will highlight potentials and conflicts regarding device shifts and roles; restrictions in device access; social influences in the living room; and individual changes in media consumption.

Keywords: Living Lab; diary study; television; living room; media usage; long-term study

1. Introduction

New media technologies provide manifold options to handle and consume media in different contexts and to easily share them with others. There are several web-enabled devices (e.g. smartphones, game consoles, Media Centre systems, Smart TVs or tablet computers), video platforms (e.g. YouTube) and social networks (e.g. Facebook) available for individual media consumption. This media landscape continuously changes and influences the way people consume and interact with each other.

Television as a traditional mass medium is also influenced by new technological developments. Even if the role of television as an important source of information, relaxation and entertainment has remained the same, technological developments have changed the way it is used (Bernhaupt *et al.* 2008; Obrist *et al.* 2008). New transmission standards and bi-directional technologies mean that television usage can be decoupled from the traditional broadcast schedule. TV content can be accessed on different screens (O'Hara *et al.* 2007; Barkhuus 2009) and is complemented by on-demand services on the Internet, e.g. in order to get additional information on a TV show. Users have several options of what they want to watch and when (Barkhuus and Brown 2009; Irani *et al.* 2010).

A special focus of interest (Cesar *et al.* 2009) has become the second screen (e.g. smartphones; tablets). These devices can be used to retrieve personalised content and to interact with others, e.g. in order to catch up on the TV programme or to communicate with others via instant messenger. But at the same time, these new options also correlate with basic single use of devices versus shared use of devices, raising questions concerning ownership and privacy. Aspects of personalisation, security and privacy in interactive television (iTV) environments are related to each other and need to be handled carefully (Bernhaupt *et al.* 2010).

This suggests that a profound understanding on how users appropriate new technologies and how they integrate them into their daily routine helps to design useful systems. Previous studies have explored patterns of technique usage (O'Brien *et al.* 1999) and the nature of communication among household members (Crabtree and Rodden 2004). Other studies, e.g. by Brown and Barkhuus (2006), have focused on users' practices in relation to video-on-demand technologies. Devices and services are used in parallel; either in reference to each other or without coherence. Users 'jump' between content from different sources and between different services on different devices (Hess *et al.* 2011).

To answer questions about the effect of new media technology and use, we conducted a two-stage qualitative empirical study under real-life conditions based on media usage behaviour of 16 households before and after introducing new devices (a smartphone and a Media Centre system). The empirical data we present give an insight into how users adapt new technologies and how their functionalities influence the personal media usage behaviour and social

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practices within households. We also provide insights into users' individual perception of the changes that the findings are presented in the form of usage patterns and are then discussed in order to gain new design-related insights.

2. Technology studies at home

One of the early studies on traditional television viewing was done by Lull (1991) in the 1980s, and explored already established social practices of behaviour in families when watching television in the living room. As shown in the study, television can nurture interpersonal relationships, e.g. by having a common topic to talk about. Nowadays, new technologies have changed the once simple act of watching broadcast television in several respects. Television is embedded in a process that Barkhuus and Brown (2009) described as the video media lifecycle. Watching television today means much more than the just the simple consumption of planned programmes; it facilitates a number of possible functionalities related to searching, obtaining, sharing, collecting, and discussing the viewed content. New technologies such as personal hard-disk video recorders and download/streaming portals on the Internet support these processes and have changed the way in which users watch television (Brown and Barkhuus 2006). Smith and Krugman (2010) investigated these practices with regards to established consumption patterns and how users perceive changes in their media usage. They found that personal hard-disk video recorders lead to a more flexible and controllable TV consumption, which makes the user's viewing behaviour more convenient. In this context, Irani *et al.* (2010) dealt with the concept of rhythms and plasticity in order to analyse new temporalities of media consumption. Both rhythm and plasticity co-exist and effect watching experiences. The plasticity of time describes the way users interrupt or reduce the time they spend watching content by using, for instance, time-shifting or skipping functions, rhythm refers to the organisation of when and with whom content should be watched, which is related to daily routines. In this regard, Wonneberger *et al.* (2009) developed a process model of sequential-viewing patterns that allows investigating the dynamics of the entire viewing process from when users start watching TV until they turn off the device. Therefore, a typology of influential factors has been deduced from the existing models of watching television. The factors that influence and change viewing habits fall into four categories: individual characteristics, programme structure, social environment and context. Applying these factors when investigating existing phenomena can help clarify television watching behaviour. Bernhaupt *et al.* (2008), based on two ethnographical studies explored seven aspects of domestic media use that became important in the context of iTV. Apart from the importance of privacy, security, personalisation and communication, watching television is still characterised as a communal activity that is relevant to the user's social life. Obrist *et al.* (2008) identified similar user requirements and derived recommendations for an iTV concept that should offer, for instance, content-related information, recommendations and communication services. In relation to this, Tsekleves *et al.* (2009) have investigated the role of television in the living room. In their findings, they emphasised the importance of the television set as a shared device – not only for watching television together, but also to make sharing information on the Internet possible or to share data stored on the computer via the TV screen. Bernhaupt *et al.* (2011) then specifically investigated the changes an interactive TV system will bring to the living room behaviours in terms of security and privacy. The results indicated that new forms of user interaction were required, which should enable personalised access to the content on the television and the new forms of connectivity for all devices used in the living room. In later work, they conducted a media study focusing on how people currently use their Internet Protocol Television (IPTV) systems and associated devices in their homes (Bernhaupt *et al.* 2012). This study generated design recommendations for mobile applications that enable users to control IPTV-systems including all connected devices. Such recommendations include not only how users would like to interact with the IPTV system (e.g. a limited set of touch-enabled buttons to control and navigate, or pointing at a device for direct control), but also showing additional information on the mobile device to the TV channel currently being watched.

Turkle (2011) examines how the phenomenon of mobile devices, as an additional source of media content, changes our social life with respect to our communication behaviour, stressing the 'alone together' aspects. Turkle argues that users prefer text messages instead of physical appointments or, if they meet, interaction is mediated by mobile device and face-to-face conversations are reduced. In addition, Barkhuus (2009) explored the phenomenon of watching television on a computer and how the Internet influences user behaviour. She showed that tech-savvy users combine original characteristics of the computer as a working instrument, with leisure activities and entertainment aspects of television. The Internet as an additional channel for video content offers users the chance to break away from the programme schedules of broadcasters and enables a more specific and time-independent access to content. Nevertheless, programme schedules still exert a huge influence onto users' viewing habits. Embedded in social practices, television series for instance are shared among friends or recorded content is watched the same day it is broadcast live (Barkhuus and Brown 2009). Given this social significance, research has often focused on concepts that allowed shared experiences on TV remotely via exchange and communication functionalities (Harboe *et al.* 2008; Nathan *et al.* 2008; Huang *et al.* 2009).

Besides computers, portable web-enabled devices such as smartphones or tablet PCs have also become increasingly important for accessing video content, because content is

readily customisable and can be shared on the go (Cesar *et al.* 2009). In their study, O'Hara *et al.* (2007) also focused on video consumption on mobile devices. They noted that mobile video consumption is more than just a personal pastime. Mobile video is seen as an important feature in bringing video content into social situations and places, which is not possible with a fixed TV set. They also stated that people have an additional opportunity to effectively coordinate their various viewing interests without losing their proximity to the family. This cross-platform consumption of multimedia content requires that the desired content is accessible from the selected device. However, content is often distributed on various devices and not necessarily stored on the device where the user wants to consume it. Protocols like Airplay (Apple Inc. 2010) or DLNA (Sony Corp. 2003) address this issue by allowing the streaming of multimedia content from one device to another and provide easy access to distributed content without the need of copying it between the devices.

In the context of simultaneous use of mobile devices, mobile multi-media devices are often referred to as 'second devices' or 'second screens' used to retrieve additional information or for associated social activities (Tsekleves *et al.* 2007, 2009; Cesar *et al.* 2009). This has become a significant research area: D'heer *et al.* (2012) explored the use of multiple screen technology and found that in most cases the use of a second screen was not related to TV content. Courtois and D'heer (2012) similarly investigated how tablet use was related to the TV experience. They identified three patterns: only focusing on TV, usage of TV in combination with other screen media and the usage of TV with media in general including print. Regarding the application level, Courtois and D'heer identified a modest interest in using second screens for sharing options. Basapur *et al.* (2011, 2012) developed a secondary device concept that enhances watching television by providing auxiliary information and media. The additional content is semantically related and synchronised to the ongoing TV content. A three-week field test with 11 households allowed participants to better connect with their TV shows by using social features as well as the time-shifting functionality. On the other hand, participants also mentioned concerns including distraction from the TV show. Murray *et al.* (2012) created parallel narratives on the iPad, synchronised with the TV, in order to provide additional information and to support navigation of story threads.

In our present study, we want to contribute to the altered consumption process of audio-visual content by using new technologies and devices in the living room. Moreover, we will fill the gap of how media usage behaviour is influenced by new technologies over a long period of time and how these technologies change social structures in multi-person households. While previous studies mostly investigated changing habits in the use of single devices, as for instance the aspect of computer or mobile use to watch broadcast or video content, emphasise a holistic approach to technical and social factors in order to understand the interplay of different multi-media devices in the living room. Therefore, our aim is to explore established media usage behaviour and accumulated social interactions before technical interventions have happened and after they were appropriated as new functions in everyday life.

3. Method

Our study aims to explore daily media usage behaviour in domestic environments on a long-term basis, which will influence the design of new entertainment concepts. As an empirical frame for these investigations, we used the Living Lab approach (Almirall 2008; Følstad 2008). The approach offers a setting where several stakeholders, e.g. academia, industry, public facilities, and users, come together in an innovative and open development process that takes real usage contexts into account (Niitamo *et al.* 2006). Users are involved actively in the process from the earliest research stages. The synergies resulting from utilising real-world settings and conducting long-term inquiries, workshops and interviews, contribute to a co-creation process with a potential output in acceptable and usable applications and services. These characteristics lead up to the unique value of the concept. Our Living Lab (Hess and Ogonowski 2010; Hess *et al.* 2011) consists of stakeholders from academia, media companies and of participants of a local user sample. The Living Lab provides usage contexts for comparison of established media usage behaviour and appropriation of new media constitute one of the core aspects of our design paradigm. Thus, research and design cycles iterate closely.

In the context of our two-stage empirical study, we first wanted to gain an in-depth understanding of current media and device usage of households in relation to the routine consumption of audio-visual content. After the first study, we provided Living Lab households with current marketable technologies. Each household was equipped with a Media Centre system with Windows Media Center, which was connected to the TV set, a wireless keyboard with trackball and a remote control to navigate the system as well as an Android OS smartphone. Both devices (Media Centre and Smartphone) could only be used independently of each other, which means that no remote control software or similar was preinstalled. Households with a tube television were additionally equipped with a high definition television. We chose this system based on the fact that the Windows Media Center offers a stable performance software solution for TV consumption. In addition, it basically helps reach a common experience within households regarding the Media Centre's technical functionalities. Again, Android OS was chosen because of its openness for application development, as well as because of its strong acceptance within the user market. Budget constraints meant we were only able to equip each household with one smartphone, so that only one person at a time was able to use the device unless they shared it with other household members, which was

Figure 1. Documentation box.

Figure 2. Structure of diary page.

rarely the case. By implementing the market technologies in peoples' home, we gave a brief introduction to the systems and their functionalities, but did not demonstrate how to do specific tasks or attempt to force new usages. In most households, marketable technologies are replacing existing TV systems. One of the two households, who already had a Media Centre system, even replaced the existing solution with the new one. The reason for that was the easier handling of the new system. The other household used their Media Centre system until our framework was running, because their own system was perfectly integrated into their own network. The participants spent a couple of months using and learning the new functionalities on their own and integrating the technologies into their daily routines. In the second stage, we investigated how the new technologies were appropriated and how the media usage behaviour had changed over time.

Over an interval of nine months, we conducted two self-documenting diary studies (February and December 2010) with our Living Lab households. The first study consisted of a three-week documentation period, while the second study was designed for a two-week period. Therefore, we designed a cultural probe (Gaver *et al.* 1999; Bernhaupt *et al.* 2008) that helped participants with self-reflection and stimulated them in an open and creative manner, to give researchers an insight into their private space. Our probe contained one media diary (see Carter and Mankoff 2005) for each participant in the household, a digital camera, a privacy policy, a stand-up display to remind participants of the documentation and some sweets for motivation (see Figure 1). This provided us with structured and *in situ* feedback.

The diary represents the most important part of the study. As Figure 2 illustrates, it contains semi-structured pages, on which the participants are asked to document every single audio-visual media usage with the following information:

- Date and time of usage.
- Number of persons involved.
- Kind of media (TV, video, Internet, cinema, or other) and synchronous usage with other media.
- Content of media.
- Motivation for media usage.
- Communication with others about the content.

Apart from the camera, which was used to get more visual insights into the consumption settings, the diary of the first study also included special creative pages with different tasks, which helped us to understand the households better in regards to their social structure, life style, experiences and individual opinions without invading the household's privacy. One task, for example, involved asking participants to sketch the layout of their homes and their technical equipment within each room. Beyond that, they were asked to mark their favourite spot, helping us gain some understanding of where household members feel most comfortable and relaxed, and of the relationship between their comfort and the organisation of technical equipment in the household. These tasks were also used to make the documentation period less monotonous and to keep the participants motivated.

After each study, we collected the probes from the households and conducted additional semi-structured feedback interviews with each participant from the household to reflect on their own media usage behaviour, the relevance of devices, changes in consumption behaviour, and the diary study itself. In our study, we involved 27 participants (14 m, 13 f) from 16 households (5 couples with children, 5 couples without children, 2 single households with children and 4 single households without children) (see Table 1). They were between 13 and 51 years old and resided in the urban region of Siegen-Wittgenstein, Germany. The sample was divided into two groups to give a heterogeneous sample with various types of users. In doing so, we did not aim to create a representative profile, but one, which afforded some perspicuous insights into mainstream media users. One group (11 participants) consisted of users with existing experiences in using smartphones and/or Media Centre

Table 1. Characterisation of living lab participants.

Households	Characteristics of participants (sex, age, tech. experience [high +, low −])
Couples with children	F1_1 (*m51*−), F1_2 (*f41*−), F1_3 (*f13*−) F2_1 (*m38*+), F2_2 (*f34*+) F3_1 (*m43*−), F3_2 (*f44*−), F3_3 (*f18*−) F4_1 (*m38*+) F5_1 (*m37*+)
Couples without children	C1_1 (*m32*+), C1_2 (*f36*−) C2_1 (*m29*−), C2_2 (*f24*−) C3_1 (*m37*+) C4_1 (*m38*+), C4_2 (*f34*+) C5_1 (*m34*+), C5_2 (*f24*−)
Single households with children	E1_1 (*f43*−), E1_2 (*f15*−), E1_3 (*m16*−) E2 (*f38*−)
Single households without children	S1 (*m44*−) S2 (*f46*−) S3 (*m35*+) S4 (*m28*+)

systems. The other group (16 participants) only possessed minor technical experience within these fields and applications, but they all had a high daily TV and Internet usage in common. The participants were recruited via a call for participation in local newspapers and radio stations. The following selection process was based on semi-structured telephone interviews and predefined characteristics (e.g. socio-demographic factors, broadband connection, technical skills, average daily media usage, personal motivation for participation, social skills) and is also described in detail in Hess and Ogonowski (2010).

From the first diary study, we received an overall of 26 duly completed diaries (14 m, 12 f), with a number of 669 entries in total (average 25 entries per person). One female participant was absent during the study and was not able take part. From the second study, we received 20 diaries (11 m, 9 f) with a number of 296 entries in total (average 15 entries per person). Seven participants did not complete the diary due to their limited time during the stressful pre-Christmas period. Two participants explained in the additional interview that they did not see any sense in documenting their media usage again, because they believed it had remained the same.

The collected data, the entries in media diaries and interviews, were digitised and transcribed. By using inductively and deductively derived categories, the data were coded, analysed and triangulated afterwards, with regard to media usage patterns, changes in media usage behaviour due to the intervention of the described technologies, social phenomena, and individual perception of change.

4. Results

Our results showed how people use current multimedia devices in their domestic environment, how they appropriate recent technologies into their daily routines and how technologies affect and change those routines. We have looked at the changing role of devices within consumption processes and their flexible usage opportunities, the corresponding social phenomena and at the users' individual perception of change through the intervention of new technologies.

4.1. Device and media usage behaviours

From a technological perspective, current media usage behaviour is permanently influenced by both new functions and possibilities on existing platforms and on new devices. Thus, the use of a single device changes will be mediated by the functionality of other devices or even substituted by others. One of the interesting phenomena identified in our long-term study was the changing media usage behaviour assigned to available devices and the special kind of expedient device usage.

4.1.1. Integration of new devices

The Media Centre system became an important part of daily routines and changed the role of PC/laptop usage significantly. A good example is given by F2_2, who was using a laptop intensively for email, social networks and news before the introduction of the market technology. Her laptop had a fixed place in the kitchen, so that the usage of the television and the Internet were spatially divided. As the results of our second study revealed, her usage behaviour changed by using the Media Centre system and its wireless keyboard with integrated trackball that offered additional opportunities for accessing online content. TV and Internet usage became flexible and more integrated in the living room as F2_2 explained in the interview: *I turn the computer [Media Centre system] on and then watch breakfast television to relax [. . .] switch to the Internet, check Facebook for new messages, check web.de, surf a bit on bild.de, switch to the TV program again, [. . .] it is much faster than using my laptop in the kitchen, until it is booted [. . .] that is much easier with the computer [Media Centre system]* (F2_2).

Due to the introduction of the Media Centre system and the wireless keyboard as input device, additional opportunities for accessing online content emerged. This did not eliminate laptop usage, but offered a situationally flexible media usage within the households (see Figures 3 and 4). Apart from retrieving information and entertainment content, communication and social exchange via social networks also became important in this context. One participant (F2_2), for example, supplemented her previously used communication channels, e.g. SMS or instant messaging on PC/laptop, with a direct exchange with friends on the TV set. She uses the Facebook chat for short conversations with her friends – without leaving the living room or changing the device. F2_2 described her communication behaviour and its changes as follows: *During commercials,*

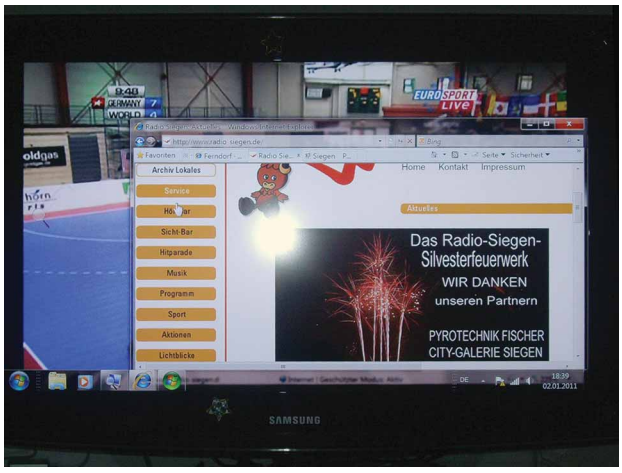

Figure 3. Integrated Internet usage on TV with TV signal in the background.

Figure 4. Separated Internet and TV usage in the living room.

I logged on to Facebook [via web browser on TV] in order to have a quick chat with a beloved friend of mine. I knew that she was online so I did not have to text her via phone. [. . .] it is much easier. I usually choose Skype or something like that, but you need much more time for that, because I will not just end the conversation. During a chat I can write 'I have to leave!'—if it is true or not—I log out on Facebook chat, I'm still there but no one can see me. I did this a lot of times (F2_2).

Other participants, who already used the laptop simultaneously with the television set in the living room, as we knew from our first study, also switched to the Media Centre system instead: F5_1 described a simultaneous usage of the laptop in order to check e-mails, Facebook, Amazon or eBay. In the second study, he reflected that the Media Centre system partly substituted these functions previously done on the laptop. He also explained that more active tasks, such as printing or writing mails, were still done on the PC. *Actually, it [the laptop] is replaced [by the Media Centre system]. We own a laptop, it is also here [under the coffee table], but it is being used very rarely. From this point of view things will be done mostly with the Media Centre system. With the exception of checking email and printing, which is done on the stationary PC* (F5_1).

For a more spontaneous usage of the Internet, such as searching or retrieving situationally relevant information while sitting on the couch, one participant (C3_1) enhanced this usage directly via the TV. In the meantime, in such situations he did not use the smartphone or netbook anymore. The described experiences of another participant (E2) can be seen as a contrary example in this context. Searching the Internet on the TV was rated less positively regarding personal benefits and the operability of the application. She was more critical of the new functionalities of the Media Centre system. *After we got the new technologies, we have used the Media Centre system to surf the net. Nevertheless, we found it difficult to search the Internet [. . .] You have to sit very close to the TV screen in order to read the texts. Insofar, we tried it at the beginning, to test how it works, but afterwards we haven't used this functionality very often. We only use it in emergency situations when no other Internet access [. . .] is available* (E2).

We could also identify another interesting usage behaviour with regards to the Media Centre system: its full list of features makes it a perfect media hub for parties. C5_1 reflected on his party experience and pointed out that because of the all-round features, he really appreciated the Media Centre system as a party media hub: *When my friends were here, we used mainly the Media Centre system to listen to music and watch YouTube videos. That's also what I valued especially. With the Media Centre system, one is able to do everything: to surf the net, to watch a film, or listen to music* (C5_1).

In addition to that, we also perceived shifts from PC/laptop towards the smartphone. Several participants used the smartphone instead of the laptop to regularly check their email. In the case of S1, this change became clearly visible insofar as his early morning media use increased considerably with the introduction of the smartphone. A similar behaviour could be identified by S2. She described it as prioritising follow-up activities based on her business email: *After I get up in the morning I check my email. [. . .] Maybe that is just curiosity, is there something important, is it necessary to react immediately? Or will I have time to handle other things?* (S2). For another participant (P2_2), the smartphone also became very important. We knew from our first study that her cell phone was only used to make phone calls and to send text messages, her usage behaviour increased after the technical intervention with respect to email, Facebook and video on demand usage. Moreover, she revealed an additional change with respect to her communication channels. Instead of sending text messages, she is now sending emails to friends whom she knows are using smartphones. She stated that financial savings faster replies of inquiries sent by email were the main drivers of this change.

Besides the observable behaviour in the morning, we identified additional changes, especially in cases when the PC or laptop had a fixed position and was spatially divided in the household. F2_1 reflected on his PC and Internet usage which before mostly happened in the cellar, but has now changed to a strong Internet usage on the smartphone without any spatial separation from his family. *I often use the smartphone to surf the Internet, if I have to emphasize something. There are several websites which I regularly visit and apps I use. Before I boot my PC in the cellar and when my wife is using the laptop in the kitchen, I use the smartphone* (F2_1).

The introduction of the smartphone thus established fundamental practices of flexible media usage. S4 described this practice as a 'just-in-time' behaviour. Through the permanent availability of the smartphone and the option to go online, media usage is flexibly distributed throughout the day and is not limited to the evening anymore. S4 explained this kind of improved flexibility as follows: *Information and exchange have turned into a 'just-in-time' behaviour. If you want to look up something or you're bored, you can directly check what's new, scroll down a bit and then exit again. I'd say that's pretty flexible* (S4). In case of F2_1, the gain reveals itself in the use of social networks. Before he used a smartphone he was not very active within social networks and could only use them in the evening. Photo uploads and postings were perceived as inconvenient because of having to boot the PC and load pictures. With the smartphone his social network usage increased and he preferred using them. *Due to the smartphone I became a real fan of Facebook. Just posting something or uploading a photo if I am on the way is much more easier than if I do this on the PC. In this case I have to load my photos to the PC before I can upload them on Facebook. Doing this with the smartphone is just one push of a button* (F2_1).

4.1.2. Flexible device usage

Besides the integration of new devices into users' daily routines, an interesting behaviour regarding the choice of devices for simple and short-term online activities, e.g. looking for brief information or checking email, could be identified when watching television (see Figure 5). As almost all of the available devices (laptop, Media Centre system or smartphone) were appropriate for these activities, participants described choosing a device based on a 'least-effort' consideration. C4_1 for example stated: *in case the laptop is not in my grasp, I'll use the iPad as it is ready immediately. And if the iPad is not in my grasp [. . .] I would use the smartphone. However, if the laptop is next to me, I will of course use the laptop*.

For more complex online activities that involve entering large amounts of text or complex graphical output, participants chose their device more carefully. For this purpose S1 described situations where TV content made him gather brief information using his smartphone. However, *in case I wanted more in-depth information, I would boot up the laptop, as it has a larger screen* (S1).

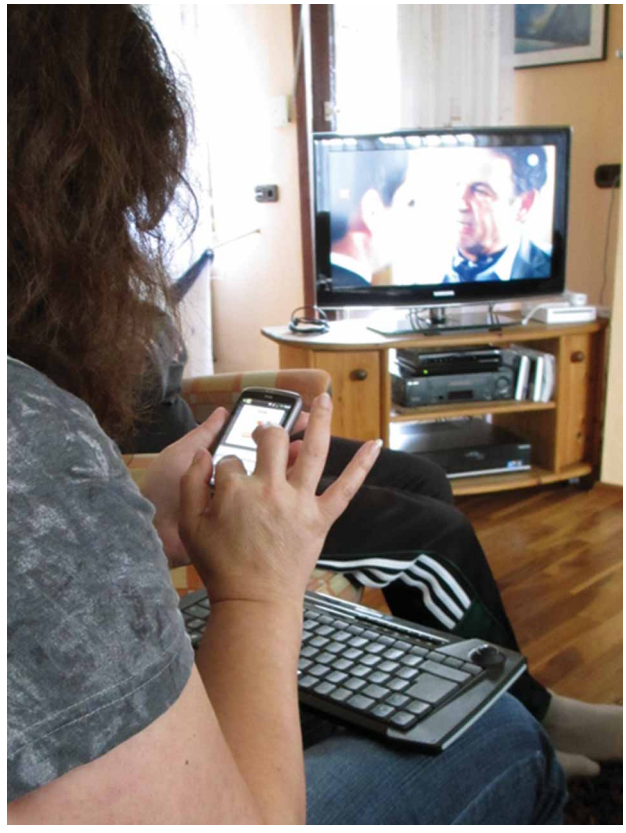

Figure 5. Checking emails while watching TV together with other family members.

Moreover, the presence of other household members is taken into consideration when choosing a device: *The PC must run parallel to watching TV together with other family members and then it's difficult to watch TV and check email simultaneously on the TV* (F3_1). He also stated that it was no problem if no other family member was sitting next to him in front of the TV. *Then I use this function during commercials* (F3_1). In addition to this, when watching TV alone, the simultaneous usage of a smartphone can be beneficial, as the watched content will not be interrupted. For this purpose E1_2 explains that *when I sit in front of the PC or TV [watching video content in both cases], I normally use the smartphone for surfing and texting with other people or checking if someone emailed me. The advantage is that you don't need to interrupt the video to do something else*.

Besides those short-term role assignments, we also recognised long-term assignments, where devices were given fixed roles for significant periods of time. This was especially obvious by the fact that participants separated leisure activities from working activities in the living room, if they worked at home (for their business, studying for school or university).

Concerning this phenomenon S2 realised that after appropriating new technologies, she now uses the

smartphone and the Media Centre system to surf the Internet on weekends. She no longer turned on her PC when she was not working, despite the fact that TV/Media Centre system and computer were not spatially divided in the living room. In a similar way, C5_1 said that for him the laptop *has a well-defined scope. Of course I'm working on it. Furthermore I use it for surfing, occasionally for gambling, while the Media Centre system is primarily used for movies and music*. Also a clear task specific and physical separation could be found in other households. C2_2 explained that after the introduction of the marketable technologies, her laptop *now remains in the room where she studies or works. In the past, it was also used in the living room since it was the only device with internet-capability [. . .]. I have established a total separation between university [work] [. . .] and private affairs – for the fun of it*. Another participant (E1_3) used her computer to do homework in the afternoon. After she had finished her tasks, she went to the living room to chat online with friends and play online games on the Media Centre system. Particularly, in both of the latter cases, the introduction of the Media Centre system clarified the assignment of fixed roles for the devices and their physical configuration within the households.

We found that the choice of device also depended on collateral activities and the fact that not every device is usable in every situation. For example, participant P2_2 mentioned that she watches podcasts when exercising. For this purpose, she placed her exercise bike in front of the computer where she can watch her podcasts on the large computer screen. The introduction of smartphone and Media Centre did not change this behaviour, as the use of the smartphone is not easy during exercise, and the Media Centre is located in the living room while the exercise bike is in the guest room. However, the new devices offer new options for use in other contexts. In this case, the participant now also watches podcasts after her afternoon nap in bed on her smartphone.

4.2. Social phenomena

The introduction of the Media Centre system and the smartphone changed the landscape of electronic appliances in the households, as we have argued above. Nevertheless, social structures within the households also adapted to the change. We identified some subtle yet interesting changes that happened during our entire study.

4.2.1. Conflicts in device sharing

Sharing devices in households is sometimes tricky, as some household members may dominate and monopolise some devices for a certain period of time. Almost every household has an established hierarchy of access for each device, e.g. children occupy the TV during animation time. Device domination used to be a problem before the new hardware was introduced. After the hardware introduction – although this domination continues to exist – this problem has become less severe by the decoupling of content and device. There is now a wider range of possible devices from which to access the same content. Thus, the device no longer plays a decisive role in this situation.

In one household, the mother (F1_2) had very little chance to use the computer before our hardware introduction, because her husband and her daughter were always occupying it. *I've noticed that I seldom use our computer. Looks like I don't need it and my husband spends quite a lot of time sitting in front of it, playing, my child also. To be honest, I think I have neither the time nor the chance to use it* (F1_2). After we introduce the hardware, she started to use the Media Centre system to surf the Internet when the computer was not available. Interestingly, she claimed her Internet usage in the second study to be 'relatively high', given that she didn't even realise that she needed the Internet during the first study.

In another household, the situation was similar. C1_2 had very little access to the computer throughout our study. But with the introduction of the new devices she had the possibility to fall back on the smartphone or the Media Centre system to surf the Internet: *I could barely use it [PC] earlier (laugh). But now, I don't actually need it. Because most of the time I use the smartphone to surf the Internet, or the TV [Media Centre system]* (C1_2). The PC is not always the first device for browsing the web. In another case the participant (F2_2) first tried to use the Media Centre system to surf the Internet, but turned to the laptop when that proved impossible: *When the children don't let me use the TV, for example. They want to keep watching their program, but I want to check something on the Internet. . .They don't let me. Then I'll turn to the laptop, it's in standby mode all day long* (F2_2).

These conflicts in device sharing usually occur in connection with shared devices like TV sets or a family's computer. For private devices like cell phones we usually have well-defined property situations so that there is little conflict potential. However, due to budget limitations, as mentioned, we could only give one smartphone to each family, and thus artificially dissolved these family member claims to use the device exclusively. This circumstance led to different behaviours and decisions within the families concerning the allocation of the new devices. As we expected, in most of the families the smartphone was used by only one person so that we could not observe any direct changes regarding the cell phone usage for the other family members: *It's really stupid to share such a cell phone* (F2_2). However, within one year of providing the smartphone to our participants, in almost all cases the families bought at least one additional device for other family members. One of the few exceptions is a family that has still only one smartphone, where the device is mainly used by the mother (F1_2), but also by the 12 years old daughter (F1_3) for gaming and texting. The father (F1_1) however did not deal with the smartphone, which he reasoned as follows: *That's because both of them [wife and daughter]*

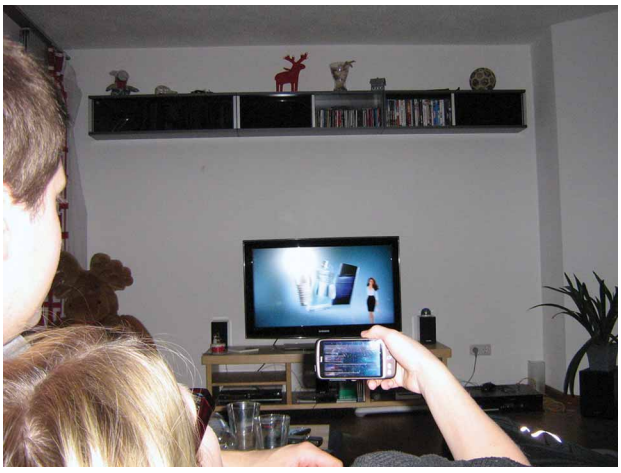

Figure 6. Co-watching in the living room.

are always using it. Of course, they use it intensively. [. . .] I know that you can do a lot with it [smartphone]. I guess if I would deal with it, it would be a comfortable thing. [. . .].

4.2.2. Family obligation

We noted a tendency towards physical proximity amongst family members, whereby even when expressing boredom about a TV programme, members would often stay in the same room but engage in different activities. We refer to this as, 'co-watching but with different interests'.

For example, in one household, one participant (C2_2) was interested in a TV series but her boyfriend (C2_1) was not. He then used the smartphone to browse the Internet in the meantime. In another household, the smartphone was also regularly used when co-watching (see Figure 6). C1_2 described her usage as follows: *I use the smartphone when C1_1 is watching something on TV but I'm not interested. I'll still sit beside him and just watch with 'one eye open', most of the time though I'll be playing or surfing the Internet on the smartphone.*

We could identify the same phenomenon in households with children. In one case, the child (F1_3) now has the opportunity to do more things while sitting next to its parents. *When my parents are watching the television and I'm bored with what they're watching, I use the smartphone [to play and text with friends]* (F1_3). However, this also led to conflicts within the family, as the father is often annoyed by his daughter's and his wife's intense parallel smartphone usage: *[. . .] they use it intensively. [. . .] So much, that I've already said: 'That's enough!'. This is somehow annoying* (F1_1).

4.2.3. Plasticity of time

8.15 p.m. used to be considered as 'prime time' for watching television and social life had to be aligned to schedules. But now, with the help of recording and time-shift, users are able to uncouple their personal timeline from the programme schedule of broadcasters.

One household reported that with the function of recording and time-shift provided by the Media Centre system, they felt quite relaxed at dinner. As they normally cooked around 8 p.m., they used to hurry so that they could catch up with TV programmes by 8.30 p.m. But after the hardware introduction, they let the Media Centre system record the programme. In this way, they could have dinner without being under pressure and enjoy the show later, and were then also able to manually skip the commercials: *Now we often start watching TV at 8.30 or 8.45 p.m.. We let it record first, then we watch and then we can skip the commercials. We actually do this quite often* (C2_2).

Another quite surprising way of use we identified was that the electronic programme guide was used for baby-sitting. One participant (E2) reflected that she was arranging the children's day according to the TV schedule. E2 stated that *EPG (Electronic Program Guide) helps me a lot when I have to be away and leave the children alone. Then I'll say: 'now this program is broadcasted, then this, then this and I'll be back by this program'. In this sense I often structure the children's day according to the TV program.*

4.3. Perception of change

As shown above, the implementation of technologies in households has led to changes in the daily routine of media consumption and social behaviours within a household. Even if the severity of these changes differs between various participants, they were always obvious to us. This was sometimes less true of participants themselves.

Some of the participants described their altered usage behaviour in a detailed and self-aware manner. C2_2, for example, mentioned that the TV consumption remained constant or even decreased, because of the opportunity to surf the Internet on the television set as an alternative to watch low-quality TV content. Furthermore, the boot time of the Media Centre system often led to the decision to leave the device off and thus to a more conscious television consumption. In contrast, the same participant described that the cell phone usage increased strongly and was kind of like an addiction. In the past she often left her phone at home but now she thinks to herself: *Oh my god, you left your smartphone at home! (laughs) It is as if I were addicted, it is totally crazy. I'm looking at it [the smartphone] every morning and think 'Yay! Its flashing!' [a signal for incoming messages]. It's like a Tamagotchi* (P2_2). F2_2 reported no changes concerning her consumption behaviour or time, but argued that the usage became more convenient due to the new integrated internet-capability of the television. *You just remain seated on the couch and you have your keyboard. Otherwise, during commercials I would go to [the laptop in] the kitchen and log on to Facebook or elsewhere. [Now] I can just remain under my blanket and do it on the TV. That's great!* (F2_2). Similarly, C5_1 found that the ability to watch high definition content was an improvement.

Other participants did not recognise any significant changes. Some within a household recognised changes, but others did not. C2_2, for example, who described variances in her TV consumption and cell phone usage behaviour, said that a simultaneous usage of various media did not take place in her household. Her boyfriend (C2_1), however, said that when watching TV together, he sometimes used the smartphone to surf the Internet when he was bored with the TV content his girlfriend was watching. This variable awareness regarding the changes becomes even clearer in the following statement of E1_1: *I always do the same. Because until now the Media Centre system doesn't offer much new.* Although she is aware of the new devices, for her, there is no change happening when using same functions (e.g. browser games, Internet, instant messaging) on different devices (PC at the desk or TV screen). Her daughter (E1_2), however, affirms that her mothers' usage behaviour has changed insofar that she now uses the Media Centre system excessively: *When I come home from school I use the Media Centre system to watch animes on the Internet until 8 p.m., when my mother chucks me out* (E1_2).

Another good example is the following excerpt from the feedback interview after the second diary study with F3_2:

> *Interviewer (I):* 'What changes did you recognize that are associated with the new devices?'
> *F3_2:* '[. . .] regarding the box [Media Centre system]?'
> *I*: 'Exactly!'
> *F3_2:* 'Ehm. . . No. Well, I record more now. I like recording, yes. But actually no changes.'
> *I*: 'Did your daily routine change?'
> *F3_2:* 'No, not at all!'
> *I*: 'Everything remained the same?'
> *F3_2:* 'Yes!'
> *I*: 'Did the TV's role change?
> *F3_2:* 'No, no!'
> *I*: 'You use it the same way as before?'
> *F3_2:* 'Yes!'
> *I*: 'The same intensity, the same content?'
> *F3_2:* 'Yes, right. Nothing's changed.'
> *I*: 'How do you organize your TV consumption? How do you plan watching TV? Has something changed?'
> *F3_2:* 'I don't plan watching TV. I always watch the same things, I don't have to plan.'
> *I*: 'Regarding the Media Centre system: Which functions do you use exactly?'
> *F3_2:* 'The recording function.'

This example illustrates clearly that the participant, despite the fact that she is using the new recording function of the Media Centre system now, does not recognise its significance. The statement also shows that when she says, she does not plan her TV consumption, this statement is contradicted by the fact that recording, in general, requires planning (e.g. programming the timer). In the interview with F1_2, we had a similar experience. She also mentioned that her usage of the TV set did not change, but in her answer to the question about what functions she used on the Media Centre system, she mentioned several services she could not use before (e.g. watching shared movies from the PC via Wi-Fi, recordings, Internet).

An additional result concerns the fact that the participants' reflection upon changes in individual media usage was often induced by the diary study. Some participants assumed that they were aware of their usage behaviour and the accompanied changes, but only by keeping the diary did they come to see significant differences between their assumed and real usage behaviour. S1 describes this experience as follows: *This is interesting. After the first diary I had no idea what could happen and I never thought that I would change. But this already started with the second diary, realizing that a lot has changed*. S3 stated something similar and challenged his self-perception. *I am appalled at how much media I consume and also by how standardized it actually is. Once I regarded myself as an individualist, but in actually I am a normal person. Through the project I became more aware of my media usage* (S3).

5. Discussion

The introduction of the new devices in our Living Lab households led to several changes in behaviour. Many of our general findings about the meaning of television and the flexibility of TV consumption conform with earlier research results, such as the study of Obrist *et al.* (2008) about TV usage and the television's role in daily life, the findings of Barkhuus (2009) about convergent media usage with the focus on PC, and the study of Brown and Barkhuus (2006) about how the introduction of a PVR influenced TV watching behaviour. Moreover, we identified interesting phenomena in regards to how changes were induced by new devices and how they affected daily routines and social structure within the households.

Device-Shifting: The trend of converging functions gives users more flexibility in choosing the device, as the same function is now available on more devices. We identified that both the Media Centre system and the smartphone took over various tasks of the PC and laptop in both single- and multi-person households. However, this substitution occurs only in specific situations. In case of the Media Centre system, the usage primarily took place simultaneously with watching broadcast television (e.g. using the Internet during commercials or retrieving additional content) or as a new alternative to habitual TV consumption (e.g. watching on demand content from the Internet or hard disk). It is interesting to note that although the new functions brought by the Media Centre system were frequently used, it did not result in an increased TV consumption overall.

However, the situation is different with the smartphone. Its permanent presence led to a more frequent usage within new usage context and an altered usage behaviour of the service itself. Email or social networks, for instance, were no longer used at specific time or in specific places. Instead, their usage was sporadically distributed throughout the day. This characteristic also led to changes in the synchronous device usage while watching TV. While the laptop was previously the device that mainly used for this purpose, it was substituted in many cases by the smartphone after the introduction of the new devices. This could be observed with participants with lower technical experience. Participants that already had experience with smartphones had shown this usage behaviour before.

This raises an interesting question concerning the 'second devices' or 'second screens' and their integration into situations where media are consumed (Tsekleves *et al.* 2007, 2009; Cesar *et al.* 2009; Basapur *et al.* 2011). Our study did not confirm the implicit order in which the television is the 'first device', and the computer/laptop/smartphone/tablet PC is the 'second device'. Instead, the order changed according to the user's attention, according to his/her main activity and purpose. In this regard, further investigations also could focus on the technical handling of several mobile devices in the living room. How should the architecture of applications be designed when they are used on second screens in addition to watched TV and video content and with the option to navigate on the TV-system?

Expedient choice of devices: Despite the fact that many services and functions (e.g. Internet, email) can now be accessed and used platform-independently, the choice of the device is not arbitrary. The users made unconscious decisions based on (a) *what effort* they would be willing to make to satisfy their information or communication needs and (b) *which device* to use. This obviously (a) depends on the level of desire and importance while (b) depends on a set of different influences. The following list of factors encountered in our study was derived from the classification of factors for TV viewing of Wonneberger *et al.* (2009):

- *Individual influences*: tiredness, comfort, joy of use, individual role assignment of devices, etc.
- *Physical influences*: location of the device, mobility of the device, boot time, usability aspects, interdependency with synchronous activities, etc.
- *Social influences*: device is occupied, consideration for others, privacy concerns, ownership situations, etc.

Particularly in multi-person households, our evidence indicates that social factors are the most significant. In these cases, users sometimes had to choose an alternative device, because the preferred one was occupied by another family member. Otherwise, the more devices exist in households, the more opportunities emerge, which allow diverse access to media content. The phenomenon of expedient choice of devices hence confirmed the assumption that the convergence of media does not lead to a substitution of existing devices, but to a more flexible and complementary device usage. While this on the one hand enhanced the user experience, on the other hand it also created a challenge for the right design. The same function is now used on different devices, which requires function sets to be defined to adapt to the characteristics and capabilities of each device. The user now has access to a wider range of devices, and 'jumping' between devices becomes more frequent. Therefore, it can be argued an awareness function is needed, to accurately locate the user so that corresponding services could be provided. The increased number of devices has also increased the complexity of personal configurations. In this sense, a cloud setting capability to centrally and dynamically arrange the configurations on all devices should be promising.

Role assignment: A surprising result is that after the introduction of the new devices, some of the participants assigned specific roles to their devices. The laptop or PC was previously the sole web-enabled device in most of the Living Lab households and used for any internet-based activities. Now, with the new devices, it was assigned the role of a work computer, while the Media Centre system and the smartphone were used for leisure time activities. Another example is that the Media Centre system was only used for multimedia (TV, YouTube, music, etc.), while communication applications were used on the laptop or smartphone. Both phenomena could be found in all household structures, as well as in both types of experienced users. This raises the questions of whether this behaviour is based on traditional device roles (PC/laptop as a working tool), which are still embedded in the users' cognitive pattern, and what this means for the future design of new devices and interfaces. To answer these questions, more investigation into this behaviour is necessary.

Restricted device access: Because the devices were previously limited in number (mainly the PC), the members of many multi-person households had to share. This led to the situation that some household members gave others priority when it came to device access. This was often the case in households with mixed technical experience and ability. Participants with less experience tended to cede devices to other household members with more experience. However, the first diary study showed that this restricted access to devices, notably the Internet, did not correlate with user satisfaction or dissatisfaction since users did not anticipate future possibilities. The introduction of the Media Centre system and the smartphone made two new devices available, which solved the problem of restricted access and, interestingly, led to a heavily increased use by those participants with less technical experience. That is, despite the fact that such users had not expressed any dissatisfaction with their prior access to devices, when new devices afforded more access they radically increased their usage.

Access possibilities seemed to generate usage even where there was no perceived need. This did not dissolve existing 'rights' over technology but created alternative and parallel possibilities.

The living rooms' social situation: Our study confirms earlier findings associated with, e.g. Bernhaupt *et al.* (2008), that watching TV in multi-person households is an important social activity and an unspoken family obligation, and where family members come together in the living room and spend the evening together. However, it is not invariably the case that the programme choice is to everyone's liking, so compromises have to be made. Parallel device use comes into its own in such circumstances. The smartphone as a new ultra-mobile device affords the possibility of following individual interests without breaking up the physical proximity. Nevertheless, we see no evidence of enhanced interaction. This 'being alone together' behaviour, which was critically discussed by Turkle (2011), helps on the one hand to ease conflicts regarding the programme choice, but on the other hand cannot be said to enhance existing social cohesion within households. Family members are present in the room but do not necessarily orient to common activities. Moreover, due to the personal characteristics of smartphones and their small screens, the users' individual activities are hidden to other family members so that everyone can sit in his own corner without knowing what the others are doing. Therefore, the design of new concepts for tabletop systems can be seen as a challenge in order to recreate social cohesion in the living room. In our further work we will explore the use of shared second screens as a hub for new social activities in the living room. In addition to the TV set and the users' smartphones as personal second screens, we will introduce an interactive couch table based on a multi-touch surface display that allows multi-user interactions. Our challenge is to find out if the visibility of users' activities – regardless of whether they are TV content related or not – leads to more social interaction between family members in the living room and if so, to support this with suitable tools.

Loose coupling to elaborated program schedules: One of the frequently used functions of the Media Centre system was the recording feature. The study showed that many households, regardless of their household structure and technical experience, used the EPG to plan recordings for the entire week and watched the content on the weekend. However, we should not assume that the result is total flexibility. Programme schedules relate to assumptions about patterns of family life and, contrary to the findings of Brown and Barkhuus (2006), daily routines are such that old patterns of TV watching sometimes persist. In our study, we identified an interesting behaviour that deals with this circumstance and extends earlier findings of Irani *et al.* (2010). Participants, we found, were often still guided by the given schedule but in order to finish previous activities (e.g. cooking and dining), they used the time shift feature to record the TV show and then watch after they had finished dinner. This allowed for a more relaxed evening schedule on behalf of social activities within the household. The time-shift in question, however, was quite small.

Methodological challenges: The results of our study showed that the participants' perception of their changed usage behaviour differs substantially from individual to individual. While some of the participants did not notice any changes, others reflected on their changed usage in a very detailed manner. One clear pattern was that the smartphone was perceived to have enabled a changed usage to a greater extent than the Media Centre system itself. This brings up the question of whether new devices or functionalities that are embedded in existing usage scenarios (TV set in the living room) are less noticed than devices that evolve new habits of usage (smartphone). In addition to that, a more general question is how pronounced the changes have to be such that users notice and pay attention to them. Hence, the participants' reflective faculties pose a major challenge for such a long-term field study. Because of this, selected methods have to aim at a continuous stimulation of users' reflective capacity. One example is the interview excerpt in Section 4.3, where the interviewee helped the participant by asking specific and precise questions to reflect and describe her unconscious usage behaviour.

Furthermore, we consciously used self-documenting methods in order to keep the living room a private space and to build up trust for further interviews and long-term investigations within the field. Even if our data base is not complete, for our exploratory procedure, it was important to get an insight into the real life, understanding of usage behaviour and changes that occur over time. It could be seen as a limitation of the qualitative study that we did not use a tracking system that gathers more quantified data about the devices, used functionalities, timeframes and consumed content. Even so, whether to use a tracking system in personal contexts without destroying natural TV consumption behaviour as well as risking trusted relationships has to be considered very carefully. For further investigations, it could be helpful to track timespans and the functionalities typically used, but not detailed content information.

Another study limitation is related to the limited budget, such that we could only equip each household with one smartphone. For more extensive results, especially within multi-person households it would be helpful to equip households with more than one device, reflecting its characteristic as a personal device. Within our study, only two households shared the smartphone with the other household members, while most of the others saw one person use it as a personal device. As a positive feedback from the field, we noticed that three of the households purchased another device, which gave us a better understanding of the smartphones' integration into daily routines.

6. Conclusion

In this work, we explored current practices of adopting and using media technologies in domestic environments. For this purpose, we conducted a qualitative long-term study with 27 participants in 16 households of our Living Lab. In the first step of the two-stage empirical study, we gained an in-depth understanding of the current media and device usage. After the first stage, we introduced market devices – each household had an Android OS-equipped smartphone and a Microsoft Media Centre system. In the second step, nine months later, we figured out how the new devices had changed media usage behaviour and how these changes impact on social structures within the households.

We identified several social and usage phenomena concerning device shifts, expediency of devices, roles of devices, restricted access to devices within families, the social situation in the living room, and the degree of binding to programme schedules. Furthermore, we identified a strongly divergent reflective faculty regarding the individual perception of changes among the participants. Our results showed that new devices and services were adapted rapidly within the households and resulted in a better, more flexible and more comfortable media usage. But our results also indicate that current concepts bring forth several issues that need to be investigated in future research. On the one hand, even if proposed as a 'convergence' of current solutions, it is not supported at an optimal level, e.g. when switching between television and Internet on the Media Centre system. On the other hand, further solutions need to address the expediency, e.g. using related services on a secondary device that is in a reachable distance or the separation of shared and personal use, e.g. by additional personalised content on mobile devices in a better way.

The results of our study provide insights that may affect the design of new cross-platform concepts in current home-IT infrastructures. Such environments are characterised by a diversification of devices, services and content offers. Content is accessible on different devices and can be enriched with functionalities that support personalisation and social exchange as well. However, as an important issue we should address ramifications surrounding social cohesion within households. We observed different patterns including conflicts in device sharing, role assignment and expedient choice related to personal interests. Further design-oriented work may consider these insights, e.g. by service switch on different devices with access to current state and history, and by providing interfaces with an adequate functional range. However, our results also underline the more critical aspect already mentioned by Turkle (2011), to the extent that her observations about the effects of social media can be seen even in the living room. Domestic life, in other words, does not seem to be entirely exempt from the phenomenon of being 'alone together'. Whether or not this has important consequences is not part of our remit here. Even so, further work may address this issue by developing approaches and concepts that support shared activities within and between households, e.g. by using an interactive secondary shared display. The interconnection of devices within the home and the multiplicity of services available there, require new interaction concepts that overcome boundaries by resolving issues identified in that work.

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