Exploring Interactive Information Radiators – A Longitudinal Real-World Case Study

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ABSTRACT

We present a longitudinal case study of implementing interactive information radiators in a semi-public corporate context. Our insights include the importance of individually relevant and easily recognizable content with an aesthetic design suitable to be consumed peripherally and to entice multi-user interaction. The semi-public space poses special challenges for design and clearly shows the need for doing research through (longitudinal) deployment-based studies in the wild. On the other hand, the study outlines some challenges of doing longitudinal case studies of semi-public installations – particularly field access and the availability of quantitative data.

KEYWORDS

Information radiator; ambient display; awareness; serendipity; CommunityMirror; case study; multi-touch; multi-user; relevance

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1 Introduction

Our daily work in the information age is increasingly based on creating, searching and combining digital information objects. While in the past the time and space independent access to these information objects was the main challenge [1], the general availability of information is no longer an issue. Pieces of information are available in different data stores in organizations and from people that can easily be reached via electronic media. Particularly because of the growing information pool a new challenge of the information society is to find individually relevant content in the flood of information.

Especially in corporate contexts, one frequently overlooked possibility to help people in finding relevant content is to use large screens as proactive information radiators. Large displays are already available widely in semi-public spaces throughout organizations (see Fig. 1), and have been a subject to research in HCI from different perspectives, e.g. as ambient or pervasive displays ([2]–[5]). Since contemporary technology offers different new interaction opportunities like touch or gesture based direct interaction with the displayed information objects, we see a new class of applications appear: interactive information radiators. These devices do not only support peripheral passive consumption of information, but also allow active (inter)action and even collaborative multi-user scenarios.

Figure 1: Social information spaces with non-interactive and interactive information radiators [1]

Compared to the design and implementation of traditional single user (desktop) interfaces in private space there are a lot of new and unknown challenges that developers are facing with multi-user information radiators in semi-public spaces. Due to the uncontrolled nature and complex dynamics of the interaction in public, the HCI-typical controlled laboratory experiments are not suitable alone for deriving design recommendations.

This paper documents a longitudinal case study of interactive information radiators covering more than five years of

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development and usage. The goal of the evaluation was to learn more about reasons for success or failure of such systems and to derive some lessons for design. Contributions to research are a set of observations and different design recommendations derived from these observations. Better understanding the special design space requirements of semi-public multi-user environments can help academia to validate hypotheses about information radiators and provide best practices for implementing and rolling out information radiators successfully in real-life settings. In addition to these particular findings, we provide some experiences of doing longitudinal evaluations in semi-public environments in general.

2 Information Radiators – Definition and related work

The term "information radiator" has first been coined by Alistair Cockburn for frequently updated posters showing the current state in software development processes in a high traffic hallway [6]. The radiators provide pieces of information or in other words visual representations of information objects stored in the underlying data sources in a way that makes them consumable peripherally. In contrast to most other IT systems which only show information after a certain user interaction (e.g. a search) information radiators proactively distribute their "info particles" independently from any user in order to generate appreciation for the contributors and thereby motivate them for further participation and sharing [7].

Large semi-public and public displays have been a topic in the HCI and CSCW communities for a long time (e.g. [8]). There have been numerous studies of interactive installations in museums (e.g. [9]), which amongst other things analyze in detail how visitors interact with these devices. In contrast to these applications the "interactability" (as the visibility of the interactive potential) of information radiators is not so apparent. Because they also allow passive information consumption their influence on the information supply is harder to measure and to analyze.

2.1 Non-Interactive Information Displays

Information radiators are meanwhile rather present in public urban spaces. Most of them are non-interactive information displays showing advertising and non-commercial information like news headlines, weather forecasts or sport results. Davies et al. [4] present a good overview of this kind of digital signage solutions. They also discuss different observations relevant for the design of these solutions including the so-called "honey pot effect" or the "landing effect".

Additional examples of non-interactive information displays can be found in HCI and CSCW research – e.g. in the large body of work on ambient displays [10]. One particular example of an ambient display that acts as information radiator is the Aware Community Portal [11]. The setup consisted of a projected display with an associated camera and server used to display items of relevance to researchers within a laboratory. The display showed live news and weather feeds, an hourly cartoon strip and a periodic clock update as well as a feed from a camera.

2.2 Interactive Information Displays

Interactive solutions are less common than passive non-interactive large screens for advertisement, digital signage or awareness. One of the key challenges for those systems is making users "aware" of the offered interaction possibilities in order to entice for interaction. Vogel and Balakrishnan presented an early overview and thoughts about interaction with public ambient displays [12].

Some examples of research prototypes exploring the design space of interactive information radiators over the past ten years are CommunityWall [13], Plasma Poster Network [14], Ambient Surfaces [15], [16], XioScreen [17] and CommunityMirrors [7], [18]–[20]. An example of a public deployment with long term evaluation can be found in the UBI-Hotspots project [21].

The different systems show both the potential of the underlying concept as well as the added value of interactivity. In evaluations of the CommunityWall users considered at least 50% of articles interesting enough to interact with [13]. The evaluations also showed that people were willing to contribute to such a system by submitting content. One problem with the evaluations was that the evaluation mainly took place in or near the groups that built the systems, and that the evaluation covered the usage of only some weeks. Rare exceptions like [22] briefly report about the usage outside the research setting over more than one year. In most cases, some years after the studies have taken place most of the systems were no longer in operation.

Some meta studies and discussions of particular (methodological) problems in longitudinal evaluations confirm these observations [5], [23], [24].

Figure 1. CommunityMirror in use [7].

3 Case Study Context and Methodology

Between 2009 and 2016 we had the opportunity to observe the implementation and operation of an information radiator based on interactive and non-interactive large screens in the company headquarters of a large US company.

The goal of the evaluation was to learn more about reasons for success and failure of such systems in a real long-term evaluation. This should contribute to existing research discourses by identifying reasons for failure that only manifest after a longer period of operation.

During the first two years (2010-2012, Phase 1) one researcher from our group was part of the project team and thereby was directly involved in the requirements analysis, the design and the early evaluation of the system. We did permanent participatory observation in the design and development process for 12 months and conducted several informal interviews and observations at the site where the system was installed for one week in 2012.

The following five years (2012-2016, Phase 2) members of the project team continued to work on site and were interviewed by the authors of this paper two times for several hours. In these interviews we collected several first-hand observations about what happened with the system and why it happened. Most of our information from Phase 2 is based on the ongoing work of the project team on site and derived from several workshops, walkthroughs and prototype tests with groups of actual users. Detailed information about the number of these workshops and about who exactly was involved have not been available to the authors.

The fact, that we only had the opportunity to be involved in the project at the beginning and to indirectly interview people from time to time how the project continued is biggest limitation of the present study. Unfortunately, there was no direct access for the researchers to the end-users nor to (non-existing) usage log files. The only reports available to us have been from interaction during the design and setup phase and from speaking with people from the external company that designed and implemented the system and monitored its operations.

In the following presentation of the case study we first briefly discuss the project background and on the overall goal of the project. Then we describe the system how it was initially designed and summarize the findings from the first observations of the system in the field (Phase 1). Afterwards, we report on how the project continued in Phase 2.

4 Project Background and Implementation

In 2010 the company started remodeling the semi-public areas of their headquarters' campus to better present the company's spirit of innovation. The goal of the project was the architectural and technological transformation of the existing buildings into a space where innovation and collaboration can take place beyond the constraints of classical desktop workplaces. The core of this solution was designed to be an ubiquitous media installation with several "Collaboration Hubs" in a semi-public ring passage that connects the different buildings of the campus (see Fig. 3). The system was designed and implemented by an external company that had long experience in implementing media installations.

Inspired by the CommunityMirrors project [7], one important part of these Collaboration Hubs were information radiators – to bring information to the people and to motivate people to interact with the information they found, and to start interaction with other people around this information. Our group was involved in the project because of our long experience with implementing and deploying information radiators.

Due to customer requirements, the design and implementation had to be done using a waterfall approach – from requirements analysis to design and rollout. So, the first step in the project in 2010 were some focus group interviews supplemented by a first on-site visit of the design team. The insights and ideas of the team then were written down in a specification book. The specification book was finished in 2011, the full version of the system was completed in 2012.

5 The Interactive Collaboration System (ICS)

The basic concept of the developed Interactive Collaboration System (ICS) was based on the idea of semi-public large screens serving as windows into existing information and collaboration systems.

All existing information sources were aggregated into a person-centric activity stream [25] and made visible and "experienceable" on large touch screens in the semi-public passage of the headquarter. The overall aim of these information radiators was to achieve a better proactive information supply, more awareness and better identification of the employees with the company.

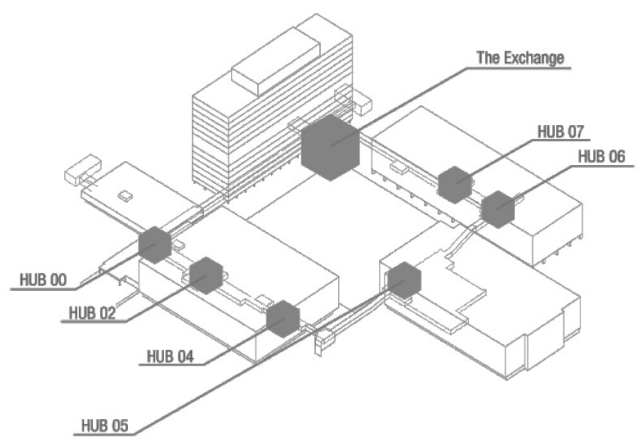

Figure 2. Floorplan of the headquarter building showing the semi-public ring passage with the envisioned locations of the Collaboration Hubs.

The ICS combined stationary semi-public large screens for the ubiquitous access to information objects with a powerful backend. Additional personalized access was planned to be offered via mobile devices.

Backend – Data aggregation and reasoning

The backend combined functionalities for data aggregation and reasoning. A data integration component collected selected types of information objects from all existing sources, extracted the required pieces of information, applied transformations and filters and integrated all data into a person-centric activity stream. Special substreams were configurable for specific places or events. The reasoning engine furthermore added links to other information objects like product data or matching videos.

Information sources included in the system in Phase 1 were the public website of the company, the company wide intranet, product databases, product video libraries and different internal enterprise social networking services (ESNs).

Information particles

The data from the backend was displayed in the frontend as touch screen adequate visual representations – so called "info particles". The visual representations differed by data source and data type so users could easily distinguish e.g. a blog post from a user profile or a product video. Using the possibility to display particles not only by themselves but also in the context of directly linked or thematically connected other pieces of information provided a possibility to interactively dive into the corporate information space.

Figure 4. Collaboration Hub consisting of soffits (top) and interactive table / wall combination plus a room for spontaneous talks in the back.

Collaboration Hubs

Several collaboration islands were seamlessly integrated into the building's architecture. These so called "Collaboration Hubs" can be seen as user interfaces for the ICS. Passing the Hubs, the users could gather information, start to explore the information space and interact with other people (around the information they found). To achieve these goals the Hubs included the following components (see Fig. 4 and Fig. 5):

Soffits: Large multi-display screens as eye catcher on the ceiling that show the flow of info particles large enough to be readable already from further away in order to support awareness and peripheral information supply while passing by or approaching.

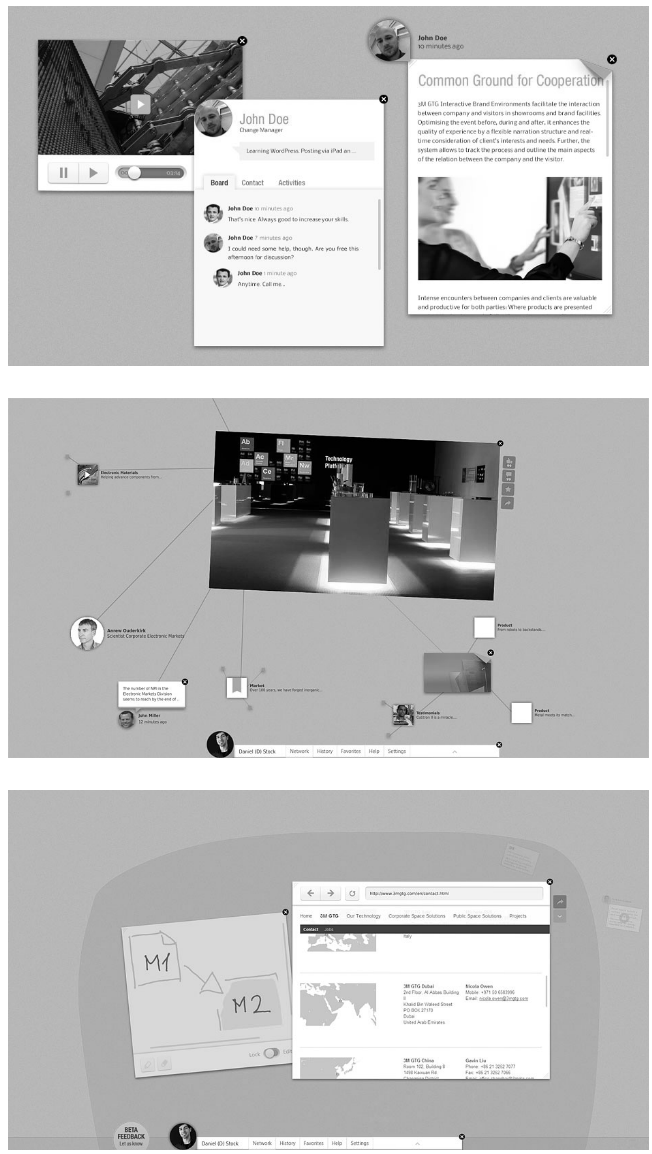

Figure 5. Screen shots of tables and wall (from top: info particles, semantic tree/graph, user space)

Tables: Interactive tables for independent browsing of the information space by several users at once. Information displayed on the soffits is available on the tables so users can immediately continue browsing after the soffits helped to catch their attention and enticed them for interaction.

Walls: Interactive wall screens for collaborative browsing in the information flow in order to encourage inter-human communication and interaction around the displayed info particles.

When going to the cafeteria or the parking lot every employee had to pass one of the Hubs. Put in a nutshell, the Hubs were meant to be the link between the digital-virtual world of the information spaces and the real-physical world of the headquarter building in which the employees work on a daily basis.

6 Initial observations in Phase 1

After the system was implemented and put into use, we had a chance to do different informal interviews and observations on site. In the following we summarize our findings our findings.

6.1 Advantage of proactive peripheral information supply

Users provided feedback that the proactive display of information while passing by offered an important added value. Different than in Web-based Enterprise Social Networks (ESNs) where additional interaction was needed, news could be seen already while entering the building and walking to the workplace, during meetings or on the way to the cafeteria. The users mentioned the following particular advantages:

Aggregation and filtering: Instead of having to access different systems for daily information and news, all information could be found in one activity stream. The targeted localization and scheduling of the flows (e.g. special emphasis on corporate news and videos in the entrance area) supported an initial overview about important events in the morning.

Time saving by proactive information supply: Often the headlines of information particles were enough to improve one's awareness (and allow implicit coordination). These could be consumed quickly while passing by and without additional effort.

Opportunities for conversation: In contrast to accessing ESNs from the own desktop or from personal mobile devices the informal semi-public atmosphere in the Hubs allowed an easier entrance to conversations with others. This subtle ice-breaking especially supported networking with colleagues or even potential customers (visitors) that were not known.

6.2 Higher data quality by semi-public presence

Shortly after the announced go-live of the installation a huge raise in profile image updates and completions of existing user profiles in the ESNs could be seen. Even through the audience did not change, users found their profiles not suitable for the presence in the semi-public space.

6.3 Increased motivation to use by visibility

Several users reported in first interviews that the semi-public visibility of their content motivated them to contribute to the underlying systems (particularly the ESNs). Additionally, employees who did not actively know about the ESNs were made aware of the possibility to interact with these systems. We for example got the reply: "Where do all these (nice) contents come from?" or "How can I post something myself?".

6.4 Lucid drive and serendipity

Especially on the tables it was often observed that users individually or in small groups threw particles over the different screens – similar to air hockey. While not having a direct informational added value it often happened that one of the users stopped to further focus on a particular (randomly noticed) information particle. These "accidental" information discoveries provide an additional contribution to supporting serendipity.

6.5 Honeypot effect

On the walls and tables a kind of honeypot effect [26] could be observed – i.e. the attention of other (potential) users was not only drawn by the displayed information (user attraction of content) but also by the interaction of other users (user attraction of interaction). Especially with the interactive walls the user interaction could be seen from some distance and therefore raised attention completely detached from the displayed information.

6.6 Summary

Altogether, these observations match what we thought would happen from reviewing studies on other research prototypes. The users agreed that the system was beneficial. They used the system repeatedly, and only reported different minor problems.

7 Usage and Further development over time (Phase 2)

In the following section we describe how the components of the ICS have been used in the long run, and how they changed over time. We especially emphasize the reasons for these changes.

7.1 Collaboration Hubs

Observation of long-term usage showed that the Collaboration Hubs have not been used for "real work" or exchange between people, but only to "kill" waiting time. The interaction possibilities were used from time to time, but there never was a deeper digging into the content and further exploration of the information. Most of the employees never stayed in the Hubs for a longer time.

As one reason for not using the Hubs as originally intended, the users told that the spaces were too unattractive. From an architectural perspective the Hubs were compared to a waiting space in an airport or train station. The nice and modern design was positively mentioned; however, the employees did not feel comfortable in the Hubs.

In addition to this "unattractiveness to stay", several respondents found it inappropriate to sit down and browse the information space during work time without explicit order from their bosses.

Another shortcoming mentioned by the users was, that it was nearly impossible to take along the discovered content– neither to their personal workstation nor to a personal mobile device (since the planned mobile app never was put into productive use due to budget restrictions).

7.2 Soffits

The soffits were not really noticed by the users at first. So, the idea to attract users by the soffits, and then invite them to continue on the tables and walls did not work. The main reason for that was the unattractive presentation of the content on the soffits. This was partly due to the content being directly taken from backend systems. Although there were display templates to format the content, the texts were unreadably truncated, and images were not always available.

Because of these observations, in 2014 the participants of a redesign workshop developed and implemented several improvements in the form of different layout examples and animation effects like e.g. a thumb-through effect comparable to a flip chart. Additionally, the font size was increased, and truncated texts were replaced by non-truncated versions. Most of the adjustments went into the direction of digital signage and hence needed special editing of the content.

After the redesign was rolled out, more people stopped in front of the soffits. This observation continued over time, so a potential novelty effect [23] could be eliminated as a reason.

Finally, more and more curated information was displayed on the soffits, e.g. stock exchange prices, weather forecasts, traffic information. These changes further improved the attractiveness of the soffits.

7.3 Tables

The interactive tables showed major problems related to the touchscreen hardware in regular usage:

1. The multiple displays integrated in the tables developed quite some heat what made them uncomfortable to touch.
2. The rough surface of the screens was uncomfortable for longer usage.
3. The displays became dirty very quickly, and there was no frequent cleaning cycle foreseen for the Hubs.
4. The hardware produced frequent ghost touches and pixel failures – which did not show in tests but only in continuous operation.
5. The high parallax (parallel shift between image display and expected touch interaction point) only allowed very imprecise interaction.
6. Practical usage of the multiple screens as one large interactive table, as originally planned, was not possible due to the large bezels of the individual screens.

All in all, the devices were not usable for real work on the table. But not even browsing in content took place. Because of these problems, the touch tables were removed quite early (Spring 2014) and were replaced by regular tables.

7.4 Walls

The walls were planned to give the users the possibility to actively consume content and to collaborate around content on the interactive large screens. Also here, the intended usage did not occur due to the same hardware based reasons mentioned above.

As with the soffits, the information source for the walls was changed step by step from a mashup of different existing corporate sources to a typical digital signage feed of curated content. During that process the interactivity of the walls was switched off, so they only displayed non-interactive content and videos.

8 Summary

The first year of regular usage showed, that the intended collaboration around information did not happen as expected. Furthermore, not even the information radiator functionality based on social content worked well. The main reason for this seemed to be that, especially in the beginning, there was too little focus on the aesthetic aspects and the visual look and feel of the information radiators. The project team primary focused on innovative collaboration possibilities and neglected to ensure continuously updated interesting content combined with a visual design and presentation of the information objects attractive enough to entice interaction.

Collecting the content from different (social) sources was one of the main features of the solution but did also not work out well. Social services were not used enough in the company to generate sufficiently interesting content, even though the semi-public visibility encouraged the usage of the underlying systems. So, more and more curated content like stock exchange prices, weather forecasts or traffic information was included in the information flow. Especially real-time traffic information was well received, although this kind of information was also easily available on smartphones and desktop systems.

In addition to importing external content the project team also tried to motivate the users to explicitly publish or enrich content for the information radiators – e.g. by adding short titles and images. Such content included information about work anniversaries and about clubs in the company. The possibilities to create or enrich content for the system as well as involving users in this process as a kind of crowdsourcing showed great potential in interviews and tests. But these ideas were never really brought to productive use during the project due to resource restrictions.

At the time of this paper, the system is reduced to a non-interactive digital signage solution using only the soffits and the walls. Some crowdsourcing is available for content collection, but only in the form of sending emails to the editors of the system.

9 Conclusion

The evaluation of the Collaboration Hubs in a complex corporate setting confirmed that interactive information radiators indeed have the potential to improve the peripheral information supply in semi-public spaces. This finding is mainly based on the observations and feedback in the first phase of the project.

However, the long-term evaluation also pointed out important challenges that may lead to the failure of such a deployment – as it did in the presented case.

The challenges in the project were both of cultural nature, like dealing with employees not feeling comfortable using Hubs in "company time" as well as of technical nature, like addressing the desire to take information away from the radiators.

In addition to these general cultural and technical issues the core challenge of the installation turned out to be the simultaneous addressing of design principles of non-interactive information radiators as well as the special requirements of multi-user interaction design for semi-public spaces. As lessons learned we can summarize the following guiding design principles:

1. Present useful and relevant information for the users (first identify what the users want to see). In order to find what kind of information is useful, do not only ask the users, but observe them.
2. Do the presentation in an attractive way. Pay much attention to the design of the information representation. (seems to be self-evident but is often neglected both in research projects and in real-world projects like this one.)
3. Design the interface with all different (semi-)public interaction zones you want to support in mind (cf. [7], [12], [27]), e.g. provide information in different font sizes so that users in different distances can be equally attracted to allow social multi-user interaction in front of the screens.
4. Design for attention competition. Semi-public spaces have much higher attractiveness demands than other environments, because semi-public applications have to compete with other devices (e.g. personal smartphones).

In addition to these learnings there was one very important finding regarding automatic content collection and co-creation or crowdsourcing: Users are willing to contribute and enhance existing information or create new one. This motivation should be used to make the concept work.

Based on input from this and other field studies we are currently compiling a list of design guidelines for (interactive) information radiators. Based on [28] this list currently includes the following sections: data sources and enrichment, information selection (filtering, personalization), information presentation (in the small and in the large), interaction (including multi-device interaction), walk-up-and-use and joy-of-use. An important addition to the list in [28] is the focus on data sources and enrichment – which we found to be a core success factor. Data has to be available without special effort, but there also has to be an easy to use possibility to add or enrich data if users are willing to.

The presented case study also shows once again that limited trials, simple technology tests or laboratory experiments are not able to identify all problems a real-world installation might encounter. Case studies like this one are therefore valuable contributions in addition to other research. Also see [5], [23], [24] for more information on this issue.

Furthermore, the study emphasizes two typical challenges of longitudinal case studies in general, that are especially valid for semi-public installations in the wild: field access and the availability of quantitative data. In our case we did not have direct field access. We were only able to build on indirect reports from the people that designed and maintained the installation. Also log files were not available due to privacy issues.

As methodological restrictions we need to mention that the whole case study has an inherent lack of scientific validity as it does now follow any particular research design but tries to document what was done and what happened (as far it could be seen from the informal observations). Doing a more structured case study [29] or even design case study [30], [31] was not possible due to missing direct access to the field.

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REFERENCES

[1] L. J. Bannon and K. Schmidt, "CSCW: Four Characters in Search of a Context," in *Proceedings of the 1st European Conference on Computer Supported Cooperative Work (ECSCW'89)*, 1989, pp. 358–372.

[2] T. Prante, C. Röcker, N. Streitz, and R. Stenzel, "Hello.Wall – Beyond Ambient Displays," in *Adjunct Proceedings of the 5th International Conference on Ubiquitous Computing (UBICOMP'03)*, 2003, pp. 277–278.

[3] W. R. Hazlewood, E. Stolterman, and K. Connelly, “Issues in evaluating ambient displays in the wild: two case studies,” in *CHI ’11 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 2011, pp. 877–886.

[4] N. Davies, S. Clinch, and F. Alt, *Pervasive Displays – Understanding the Future of Digital Signage*. Morgan & Claypool, 2014.

[5] F. Alt, S. Schneegaß, A. Schmidt, J. Müller, and N. Memarovic, “How to evaluate public displays,” in *Proceedings of the 2012 International Symposium on Pervasive Displays (PerDis 2012)*, 2012, pp. 1–6.

[6] A. Cockburn, “Information Radiator,” 2008. [Online]. Available: http://alistair.cockburn.us/Information+radiator.

[7] F. Ott and M. Koch, “Social Software Beyond the Desktop — Ambient Awareness and Ubiquitous Activity Streaming,” *it - Inf. Technol.*, vol. 54, no. 5, pp. 243–252, 2012.

[8] K. O’Hara, M. Perry, E. F. Churchill, and D. M. Russel, *Public and Situated Displays - Social and Interactional Aspects of Shared Display Technologies*, vol. 2. Dordrecht, 2003.

[9] S. Reeves, *Designing Interfaces in Public Settings: Understanding the Role of the Spectator in Human-Computer Interaction*. Springer, 2011.

[10] T. Matthews, T. Rattenbury, and S. Carter, “Defining, Designing, and Evaluating Peripheral Displays: An Analysis Using Activity Theory,” *J. Human-Computer Interact.*, vol. 22, pp. 221–261, 2007.

[11] N. Sawhney, S. Wheeler, and C. Schmandt, “Aware Community Portals: Shared Information Appliances for Transitional Spaces,” *Pers. Ubiquitous Comput.*, vol. 5, no. 1, pp. 66–70, 2001.

[12] D. Vogel and R. Balakrishnan, “Interactive Public Ambient Displays: Transitioning from Implicit to Explicit, Public to Personal, Interaction with Multiple Users,” in *Proceedings of the 17th annual ACM symposium on User iIterface Software and Technology (UIST’04)*, 2004, vol. 6, no. 2, pp. 137–146.

[13] D. Snowdon and A. Grasso, “Diffusing Information In Organizational Settings - Learning From Experience,” in *Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI’02)*, 2002, pp. 331–338.

[14] E. F. Churchill, L. Nelson, L. Denoue, P. Murphy, and J. Helfman, “The Plasma Poster Network,” in *Public and Situated Displays - Social and Interactional Aspects of Shared Display Technologies*, K. O’Hara, E. Perry, E. F. Churchill, and D. M. Russel, Eds. 2003, pp. 233–260.

[15] J. Schwarzer, L. Barnkow, and K. Von Luck, “Förderung der Anerkennung in agilen Softwareentwicklungsprozessen,” in *Proc. Gemeinschaften in Neuen Medien (GeNeMe2013)*, 2013, pp. 185–188.

[16] J. Schwarzer, S. Draheim, and K. von Luck, “Förderung von informellen Kontexten und Awareness in Scrum-Teams,” in *Proc. Mensch und Computer 2015*, 2015, pp. 13–22.

[17] L. John and T. Rist, “xioScreen: Experiences Gained from Building a Series of Prototypes of Interactive Public Displays,” in *Ubiquitous Display Environments*, A. Krüger and T. Kuflik, Eds. Berlin: Springer, 2012, pp. 125–142.

[18] M. Koch, F. Ott, and A. Richter, “Socio-technically Integrated Access to Virtual Communities with CommunityMirrors,” in *Virtual Communities*, J. M. Leimeister and B. Rajagopolan, Eds. Armonk, NY: M. E. Sharpe, 2014, pp. 145–161.

[19] F. Ott, M. Koch, and A. Richter, “CommunityMirrors™ - Using Public Shared Displays to Move Information ‘Out of the Box,’” in *Competence Management for Open Innovation: Tools and IT Support to Unlock the Innovation Potential Beyond Company Boundaries*, J. Hafkesbrink, U. H. Hoppe, and J. Schlichter, Eds. Lohmar, Köln: EUL Verlag, 2010, pp. 141–169.

[20] F. Ott and M. Koch, “CommunityMirrors – Large Interactive Screens as Natural User Interfaces for Cooperation Systems,” in *Workshop Proceedings of the ACM International Conference on Human Factors in Computing Systems (CHI’10): Natural User Interfaces - The Prospect and Challenge of Touch and Gestural Computing*, 2010.

[21] T. Ojala *et al.*, “UBI-hotspots : Sustainable Ecosystem Infrastructure for Real World Urban Computing Research and Business,” in *Proceedings of the International Conference on Management of Emergent Digital EcoSystems (MEDES ’10)*, 2010, pp. 196–202.

[22] J. Schwarzer, S. Draheim, K. von Luck, Q. Wang, P. Casaseca, and C. Grecos, “Ambient Surfaces: Interactive Displays in the Informative Workspace of Co-located Scrum Teams,” in *Proceedings of the 9th Nordic Conference on Human-Computer Interaction*, 2016.

[23] M. Koch, K. von Luck, J. Schwarzer, and S. Draheim, “The Novelty Effect in Large Display Deployments – Experiences and Lessons-Learned for Evaluating Prototypes,” in *Proc. 16th European Conference on Computer-Supported Cooperative Work*, 2018.

[24] J. Schwarzer, K. von Luck, S. Draheim, and M. Koch, “Towards Methodological Guidance for Longitudinal Ambient Display In Situ Research,” in *Proc. Europ. Conf. on Computer-Supported Cooperative Work*, 2019.

[25] P. Lachenmaier, F. Ott, and M. Koch, “Model-driven development of a person-centric mashup for social software,” *Soc. Netw. Anal. Min.*, vol. 3, no. 2, pp. 193–207, 2013.

[26] H. Brignull and Y. Rogers, “Enticing People to Interact with Large Public Displays in Public Spaces,” in *Proc. IFIP TC13 International Conference on Human-Computer Interaction (INTERACT)*, 2003, pp. 17–24.

[27] F. Ott, A. Nutsi, and P. Lachenmaier, “Information Ergonomics Guidelines for Multi-User Readability on Semi-Public Large Interactive Screens,” in *Proc. of the Workshop on Information Ergonomics, iKnow’14*, 2014.

[28] M. Ames and A. Dey, “Description of design dimensions and evaluation for Ambient Displays,” 2002.

[29] P. Schubert and R. Wölfle, “The eXperience Methodology for Writing IS Case Studies,” in *Proceedings of the Thirteenth Americas Conference on Information Systems (AMCIS)*, 2007.

[30] V. Wulf and M. Rohde, “Engaging with Practices: Design Case Studies as a Research Framework in CSCW,” in *Proc. ACM Conf. on Computer-supported Cooperative Work*, 2011, pp. 505–512.

[31] V. Wulf, C. Müller, V. Pipek, D. Randall, M. Rohde, and G. Stevens, “Practice-Based Computing: Empirically Grounded Conceptualizations Derived from Design Case Studies,” in *Designing Socially Embedded Technologies in the Real-World*, 2015, pp. 111–150.