

# Ambient Surfaces: Interactive Displays in the Informative Workspace of Co-located Scrum Teams

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## ABSTRACT

This paper contributes long-term findings on a custom ambient display solution (*Ambient Surfaces*) in the informative workspace of co-located agile (*Scrum*) software development teams. The study is based on the premise that displaying relevant information in a team's informative workspace is beneficial, as it readily provides information of common interest. However, existing research shows a lack of experience with software visualization tools in commercial settings. To our current knowledge, there is no study which examines ambient displays in Scrum teams with a longitudinal approach in order to address challenges in awareness and informal communication. A mixed-methods field study, which began in February 2014, is currently being conducted in cooperation with a medium-sized software company near Hamburg, Germany. Our current findings, which the following addresses, support the value of the Ambient Surfaces as a beneficial tool for Scrum teams.

## Author Keywords

Informal Communication; Awareness; Ambient Displays; Scrum; Informative Workspaces; Visualization.

## ACM Classification Keywords

H.5.2 User Interfaces: Graphical user interfaces (GUI);  
H.5.3 Group and Organization Interfaces: Computer-supported cooperative work.

## INTRODUCTION

A defining characteristic of *Agile Software Development Methods* (ASDM) such as *Scrum* is the increase in awareness and team interaction due to a shortened and highly iterative software development cycle [2]. However, sharing information about artifacts, remaining mindful of a pro-

ject's big picture and focusing on specific goals for a particular timeframe are common challenges for agile teams [10]. Thus, *informative workspaces*, which encourage communication and aid information sharing [10], play a central role for agile teams [3].

Informative workspaces help teams to keep track of a project's current state by conveying information in a non-disruptive manner [12]. The most important goal is to provide accessible and easy-to-read project tracking [3]. Continuously displaying relevant content in informative workspaces is beneficial because it provides basic information of common interest [3]. Moreover, software developers use their workspaces to communicate with teammates [10]. This implies a mutual understanding of status and context [3]. Informal communication is a major factor in this regard, as it is crucial for information exchange in software development teams [7].

Within agile teams' informative workspaces, various techniques and tools for software visualization, e.g., sketches, information radiators, dashboards and ambient displays, are commonly applied [10]. Software visualization is highly relevant for agile teams; it improves software quality by raising awareness about software artifacts [10]. In this respect, we introduce *Ambient Surfaces* as a means of addressing awareness and informal communication challenges faced by Scrum teams by outfitting their existing informative workspace with two large and interactive displays (see Figure 1). Literature indicates that screens such as these are known to enhance both informal communication and information awareness [6, 9]. Following the principle of a dashboard [10], the Ambient Surfaces display relevant actual project information from various data sources on the company's intranet as a custom visualization.

In a comprehensive systematic mapping study on information visualization in agile software development teams, Paredes et al. [10] analyzed 50 papers and sorted them into four categories with respect to their focus: *Design, Development, Communication* and *Progress Tracking*. They argue that agile teams use different visualization techniques and tools throughout the software development process in order to foster awareness and communication. For example,

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Biehl et al. [2] and Jakobsen et al. [5] present solutions which increase teamwork awareness via large wall projections in team offices. *FASTDash* [2] enables the identification of conflict situations (e.g., editing the same source file) during the actual software development process and shows which files are currently being accessed and by whom. *WIPDash* [5] focuses more on a project as a whole by providing abstract information from a work-item repository. A different approach, called *CodePad*, is utilized by Parnin et al. [11]. It focuses on maintaining artifact awareness by reducing disruptions caused by the overwhelming quantity and scope of information. In their study, they employ interactive displays directly in the workspace which are designed to help with tasks such as code refactoring. Other contributions like *SourceVis* [1] address the lack of collaboration tools for software maintenance. This system utilizes a multi-touch table to display the structure and evolution of a software system via metric visualizations. Lastly, other studies utilize physical artifacts to foster ambient awareness. Downs et al. [4] provide such a system to help teams understand build statuses and causes of build failures.

## STUDY DESIGN

The following introduces our study's setting and contribution as well as the research questions and methodology.

### Approach, System Description and Setting

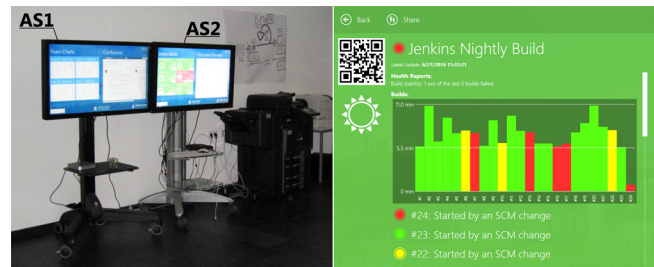
This study utilizes a custom ambient display solution in a co-located Scrum team setting. In contrast to the related work, our display solution is not designed to benefit only one specific group within agile teams (e.g., software developers), but rather the entire Scrum team, including *Scrum Masters* and *Product Owners*. Displayed information was also intended to be relevant for management personnel who are not direct members of a Scrum team.

Furthermore, our study's system displays content in a common informative workspace as opposed to, e.g., a single team's workspace. Finally, our research contributes long-term findings on the use of a software visualization tool in a commercial development environment. By investigating information awareness and informal communication questions in particular, we address other agile practitioners who are interested in rethinking their informative workspaces as a means to overcoming awareness and/or communication challenges faced by their agile teams.

The Ambient Surfaces solution consists of two main components, the first of which is two large interactive displays, each  $\geq 46$  inches and Full HD, that can detect multiple touch inputs simultaneously (2 and 10, respectively). The second component is the custom software installed on small form factor computers that selects and aggregates relevant content and provides it to the displays.

The first interactive display system was installed in February 2014, and the second in August 2015. In their current configuration, the two systems provide four interactive sections in total, with two on each system:

1. A collection of team charts from *Atlassian JIRA* (issue tracking software) to show the overall progress on work packages in the current Sprint (AS1).
2. An *Atlassian Confluence* (wiki platform) website with announcements from the software architects (AS1).
3. Build information, e.g., summaries and reports, from the Jenkins (continuous integration tool) server (AS2).
4. A custom Confluence website summarizing build-failure errors (AS2).



**Figure 1. Left: The installation setup of both Ambient Surfaces in a common room on the ground floor; printers, whiteboards and the stairway to the upper level are in this area as well. Right: A custom visualization showing a build summary for a specific Jenkins job.**

In sections 2 and 4, employees are able to browse the websites, e.g., to read articles entirely in Confluence or to investigate errors in JIRA. Sections 1 and 3 offer detail-views that provide more specific information. Section 1 displays JIRA team chart overviews. Section 3 presents a custom visualization of data from Jenkins (see Figure 1). All content is selected automatically and updated every ten minutes.

Our project partner is a medium-sized software company specializing in custom software solutions for the pharma and biotech industries. The company employs roughly 400 people spread across different departments and offices worldwide. Approximately 76 employees work in the 2-story building in which the Ambient Surfaces are located. Offices surround the common room on the ground floor where the systems are installed. The building contains offices for Scrum Masters, Product Owners, software developers and management personnel, as well as additional workspace for administrators and consultants.

Scrum has been utilized for several years in the software development department, and all Scrum teams are continuously engaged in developing the company's proprietary software products. Despite their experience, however, there are persistent challenges with information visibility and team coordination.

### Research Questions and Methodology

Existing research on the effects of visualization tools in the software industry is limited [10]. Research on the effects of ambient displays is also rare, as one of the biggest challenges is identifying practical day-to-day uses for such systems within organizations [6].

We are unaware of any existing long-term study that has used ambient displays to address awareness and informal communication challenges in a commercial agile setting. The following research questions have been the foremost focus of our study:

Q1: Are the Ambient Surfaces, by displaying process-related information, motivating informal communication?

Q2: Is information awareness benefiting from this kind of ambient displays as well?

In our study, a mixed-methods design (combining quantitative and qualitative data) is conducted. In particular, *Grounded Theory Method* [8] is applied following the coding guidance for materials such as group interviews and observation protocols.

As this method utilizes a constant comparative method, each analysis was used to determine subsequent data collection measures. As a result, various types of research were utilized over the years, which include observations (March 2015), a group interview and a group survey (January 2016). Furthermore, ad hoc feedback and interaction logs were continuously collected.

## RESULTS

This section discusses the study's results based on data collected between February 2014 and January 2016.

### Maintaining Practical Value

We faced several challenges throughout the study resulting from changes in the development department (e.g., team reorganization) and technical issues (e.g., network problems). However, the greatest challenge was a crucial requirement for continued research: continuously evaluating the displays' content to better meet the needs of employees. For example, a custom visualization of JIRA activity feeds was removed due to the overwhelming amount of data (April 2015), and other user interfaces were added (e.g., a failed-builds summary in March 2015). Existing user interfaces were updated as well (e.g., the Jenkins visualization in July 2015). It is likely that the Ambient Surfaces would no longer be used if we had not collected and addressed user feedback, i.e., the results with respect to awareness and informal communication would be less profound.

### Usage Statistics

In 2014, there were 18,353 *touch down* events in total (2015: 12,905). On account of the system's initial novelty in early 2014, the logs show very high usage (9,949 events) in the first calendar weeks (8–13) of the deployment. As a result, the mean weekly events for that year is very high (2014: 408 compared to 2015: 243). This average also varies week-to-week throughout the study for reasons such as holiday seasons, trainings and illnesses.

Varying workloads impacted usage behavior as well; e.g., weekly interaction averages in the end weeks of a *Sprint* (in calendar weeks 20–49 of 2015) were higher (276.70 com-

pared to 227.95). However, no statistically significant difference between both sets was found ( $p > .10$ ). In this regard, nearly half of the survey's participants (46.4%) state that a high workload does not influence their Ambient Surfaces usage frequency.

The interaction logs also show that the systems are most likely to be used during informal events, e.g., during lunch breaks, while fetching beverages, while waiting for meetings to start or when leaving work. In this context, observations also reveal that employees regularly use both systems in a passive manner, e.g., standing before and observing the screens while drinking coffee.

The majority of interactions in 2015 (4,002) occurred between 11:15 a.m. and 1:15 p.m. One explanation is that some daily meetings (e.g., *Daily Scrum*) start at 11:30 a.m. in front of the Ambient Surfaces and are intended to end at 12:00 p.m., as this minimizes work interruptions for the software developers. Moreover, observations showed that employees tend to congregate around the systems when they are returning from lunch circa 1:00 p.m. Finally, out of 28 survey participants, 13 reported daily system use, 14 reported weekly use, and 1 participant reported a usage rate of less than once per week.

### Q1: Results with Respect to Informal Communication

Our findings underline the importance of informal communication in agile software development teams. 11 of 28 participants in the survey indicate that they spend at least 21% of their time engaging in informal discussions. Thus, the demand for communication is very high. This is also supported by the observation study. It was found that over 1,100 crossings occurred in front of the first system, manually counted throughout 14 total hours over 2 work days. Scrum Masters require mobility the most in their workplace environment on account of their team coordination duties. Informal situations in front of the systems were mostly spontaneous in nature, e.g., before, during or after a lunch break or when fetching a beverage. 2–3 people partake in these discussions on average, and observed communication notably included conversations between management personnel and software developers.

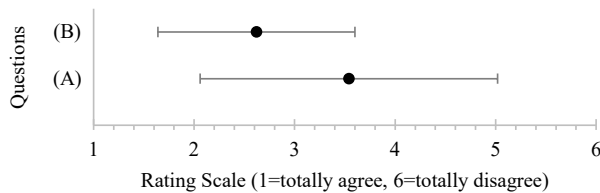
The results also show that employees actively involve colleagues in discussions in front of the systems. One participant strongly emphasized a personal observation: whenever a single colleague stands in front of the Ambient Surfaces, others will usually join out of sheer curiosity. Almost two-thirds of participants in the survey reported confronting teammates because of content displayed on the screens; in the same respect, roughly half reported confronting members of other teams.

Finally, nearly 90% of survey participants state that they regularly engage in discussions in front of the systems. These findings show that the Ambient Surfaces not only enriched, but also directly initiated, discussions that were both formal and informal in nature.

## Q2: Results with Respect to Information Awareness

Information awareness benefits from these systems as well. 76.9% of the survey's participants confirm that the Ambient Surfaces have increased information visibility. 20 of 28 participants state that the systems ease access to information. The three most popular reasons to use them are: (1) Gaining an initial situational overview, (2) catching up on project news and (3) staying informed of colleagues' activities. The systems' foremost advantages are the fostering of information transparency, the ability to see what is happening within the department and the initiation of discussions. In addition, employees find the presentation of information in this form appropriate for their teams' workspace.

Figure 2 shows that the systems are more likely to foster awareness among the Scrum teams (mean=2.62, SD=.98) than within the actual teams themselves (mean=3.54, SD=1.48). Employees note that they are normally aware of their teammates' activities as a result of their Daily Scrum meetings. They also reported being presented information which, in the absence of the Ambient Surfaces, they likely would have missed.



**Figure 2.** Result plot of two survey questions enquiring the increase in intra-team (A) and inter-team (B) awareness resulting from the Ambient Surfaces (n=26).

Finally, the findings show that there are role-dependent expectations regarding the content displayed on the screens. While the management personnel are more often interested in abstract information (e.g., team charts), software developers focus more on specific details (e.g., Jenkins build summaries and reports).

## CONCLUSION AND FUTURE WORK

Our study contributes long-term findings on the use of ambient displays in a commercial agile software development environment. The results indicate that the Ambient Surfaces are a beneficial tool, as many employees use them on a daily basis for both informal and formal purposes in both active and passive manners. Our future work will focus on passive use. The findings support a case for further research into group collaboration in front of the systems. In such work, group sizes and behaviors will be analyzed in order to gain a deeper understanding of the systems' organizational effects. The feasibility of optical observation via technology such as *Microsoft Kinect* cameras is currently being evaluated as a means to achieving this.

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