

aWall: Agile Collaboration using Large Digital Multi-Touch Cardwalls

Despite the availability of many digital agile board tools, most co-located agile software teams still use physical cardboards for their daily standup meetings. This is due to the fact that existing digital agile boards lacks supporting a collaborative workspace, direct interaction for the whole team in meetings, or making project information directly visible. In this paper we present aWall, a digital agile cardwall designed for the highly collaborative agile work style using large multi-touch wall displays. The effectiveness of aWall was evaluated in a user study with eleven software practitioners. Our findings indicate that aWall enables and encourages team work due to the large size of the wall, accessibility and visibility of large amounts of information, and possibility of customization of the interface. Based on this work, we suggest that augmenting digital cardwalls with large interactive touch technology and new interaction concepts is a useful way to support effective collaborative agile software development processes.

C. Anslow, R. Burkhard, M. Kropp, M. Mateescu, D. Vischi, C. Zahn | martin.kropp@fhnw.ch

In agile software development, physical cardwalls continue to be an essential part of the agile processes despite the relative large number of available digital tools. Although digital cardwall tools like JIRA [3] and VersionOne [12] are commercially available and have been adopted by a large number of agile companies, some studies show [4, 8, 9]. Azizyan et al. conducted interviews with software practitioners and found that 31% of companies used both project management tools and physical cardwalls, where the usage of the cardwalls was not restricted to co-located teams [4]. Mateescu et al. found that 10 out of 11 teams still use physical cardwalls typically in combination with digital tools [9]. Despite their prevalence, physical cardwalls still have issues as content is not digitalized and not integrated with issue tracking systems. To address the issue with physical cardwalls, we aim to bridge the gap by creating a large digital cardwall that supports elements of the physical nature, integration with existing tracking systems, while also preserving the agile collaborative work style.

In this paper we present aWall, a digital agile cardwall designed for use by co-located and distributed teams (see Figure 1). aWall has the size of classical physical cardwalls by using large multi-touch high resolution displays and so provides enough space for the whole team to interactively collaborate. We first give an overview of related work, followed by the design and user interface of aWall. We then present a user study conducted with aWall and software practitioners to evaluate the usability and effectiveness of the design. The paper concludes with a final summary and future work.

Related Work

Physical artifacts like pin boards, sticky cards, flip charts or whiteboards are used as a means of communication and collaboration by agile teams

[15]. The physical nature of artifacts is important to the collaborative process. For example being able to manipulate the cards easily (writing and posting) and their permanent availability on the cardwall helps support effective communication at least in co-located teams. Some studies show that physical cardwalls are valued for their flexibility, light-weight and easy usage, providing a big picture, and permanent and instant availability of information [8, 9]. Information can be concurrently edited during meetings and team members can see who is changing what. Cardwalls help to foster awareness and transparency in teams by acting as information radiators [6]. Paredes et al. conducted a survey of existing literature on information visualization techniques used by agile software development teams and found that information radiators and cardwalls are most frequently used for agile teams in communication and progress tracking [13].

There are some disadvantages of physical artifacts such as cards may get lost and they cannot be searched or shared easily [15]. Physical cardwalls are not well suited for distributed environments and displaying large amounts of information is difficult [8]. A common practice is to put extra information around the core cardwall content [9]. Any attempt to overcome these disadvantages by digitalizing cards and cardwalls should retain the advantages of the physical form while also benefiting from translation to the digital medium [15].

Digital agile tools lack the support for social interaction and team cognitive activities compared with physical tools. Several commercial digital tools exist to support the collaborative process in agile teams, such as *JIRA Agile* and *VersionOne*. These tools have been reported to account for less than 10% of tools used to support agile processes, meanwhile physical walls, paper, and spreadsheets account for almost 50% [4].

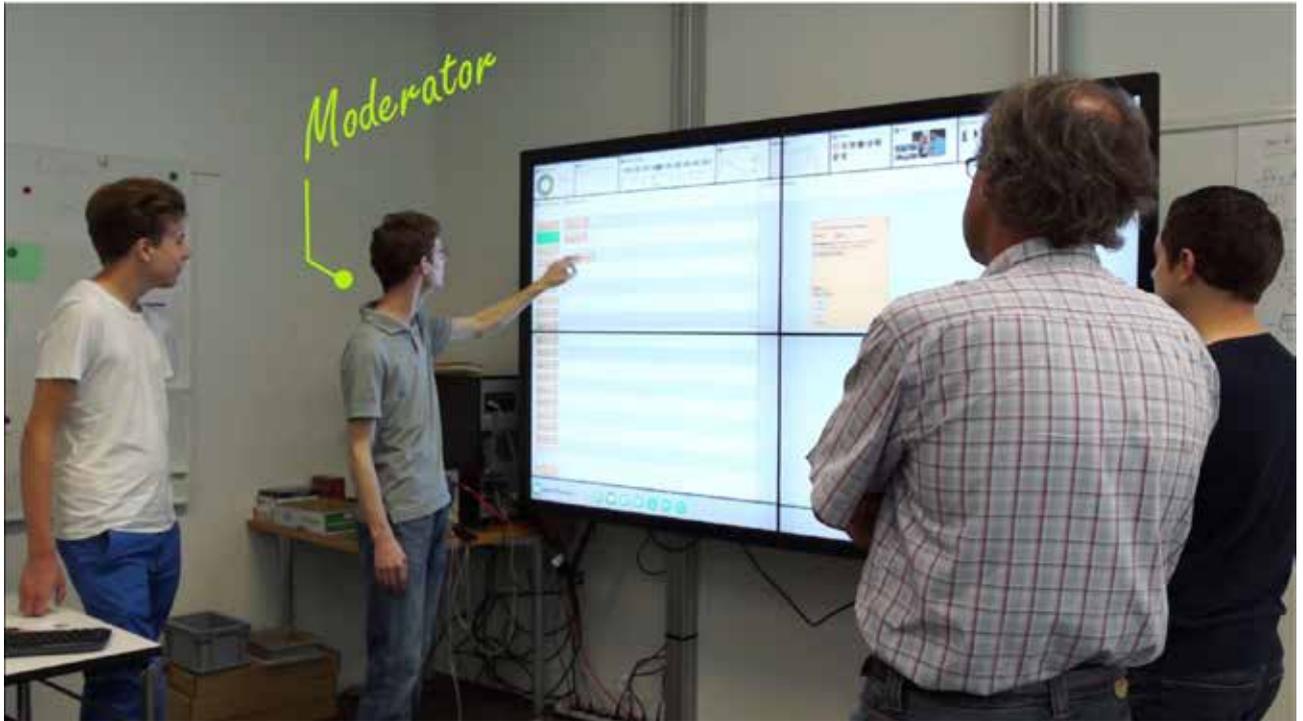


Figure 1: aWall – digital agile cardwall displayed on a large high resolution multi-touch wall (2x2 46" HDready displays) for planning and agile team meetings

A number of digital research tools have been developed for use on large interactive surfaces (e.g. horizontal and vertical). *DAP* [10] and subsequently *AgilePlanner* [16] were early prototypes developed to support agile planning on horizontal tabletops for co-located teams. *SmellTagger* supports collaborative code reviews for co-located teams using multi-touch tabletops [11]. *CodeSpace* uses shared touch screens, mobile touch devices, and *Kinect* sensors to share information during developer meetings but does not focus on any particular agile process [5]. Anslow et al. [2] evaluated large display walls for collaborative software visualization. *SourceVis* used large multi-touch tabletops to support code reviews using collaborative visualization techniques [1]. Rubart developed a basic prototype for multi-touch tabletops to support Scrum meetings [14]. *dBoard* is a Scrum board on a vertical touch screen with video capabilities for distributed development [7]. Based on our review we conclude that most digital agile tools only partially support collaborative agile processes and meetings.

Essentially, commercial or research digital tools do not sufficiently support the collaborative agile process effectively [8, 9]. Users value the traceability of information in digital tools, linking possibilities of artifacts, and the flexibility to adapt the tools to the users' needs. The main disadvantages of digital cardwall tools are that they are often too complicated to use, need to navigate to information and extra steps for opera-

tion, and no direct and concurrent interaction by all team members [8, 9]. The focus of most digital cardwalls has been centered on the daily standup meeting, and lack support for the whole agile process including other agile meetings and activities like sprint planning, retrospectives, and user story groomings [9]. Due to these shortcomings we have developed a digital cardwall tool to support collaborative agile meetings more effectively.

aWall – Digital Agile Cardwall

To understand how agile teams use cardwalls in practice, we conducted a field study and interviewed 44 participants from eleven companies [9]. When asked about the requirements for a digital agile cardwall, the interviewees stressed the importance of non-functional requirements. These included the need for a large size display, configurable views, instant availability of information, overview of information, at all time visible information, within easy reach context dependent information, increased readability of information, multi-user simultaneous touch interaction, direct interaction with data, and limited navigation. Our hypothesis is that existing digital tools do not adequately support the communication and collaborative aspects for agile team meetings effectively.

Based on our study and hypothesis we developed aWall to support agile teams (co-located or distributed) more effectively than existing physical and digital tools. aWall helps support agile team meetings (e.g. daily stand up, sprint plan-

ning, and retrospectives) by providing information dashboards, maintaining user stories and tasks, showing dependencies among user stories, customization of agile processes, and integration with issue tracking systems. aWall was developed by an interdisciplinary project team of computer scientists and psychologists (from the School of Engineering, and the School of Applied Psychology). We now outline the design and user interface of aWall, followed by a user study.

Design

Based on the requirements elicited during the interviews, we identified a number of design considerations.

- *Physical Size:* A digital cardwall needs to satisfy not only the needs for interacting with the digital content, but also provide enough physical space to display information to effectively support team collaboration. Therefore, the size of a digital cardwall needs to be at least comparable to that of physical cardwalls. aWall consists of four (2x2) 46" displays, for a wall size of 2.05 m width and 1.25 m height (see Figure 1).
- *High Resolution:* Each display in aWall is 3840x2160 pixels, for a total resolution of 15360x8640 pixels. The high resolution display wall provides enough real estate to display large amounts of information at once while still ensuring the readability of text elements, widgets, and views.
- *Multi-User and Multi-Touch:* The display wall consists of a 12 point multi-touch infrared optical overlay (PQ Labs frame¹) which is attached to the display wall. The multi-touch capabilities allow multiple users to work simultaneously with artifacts and provides an accurate and effective touch experience.
- *Integration with Issue Tracking Systems:* aWall is designed to run on top of existing third party issue tracking systems such as JIRA. Therefore, infrastructure functionality can be reused and already defined agile processes utilized.
- *Availability of Information:* aWall can replace physical cardwalls and act as the team's external memory of the project. For that, aWall should be installed in a team's open office area, always being switched on, and have a permanent view of the task board.
- *Web Technologies:* In order to have a ubiquitous and easily deployable design, aWall was developed as a web application based on HTML5 and JavaScript technology. For multi-touch support we used the *interact.js* framework².

User Interface

The aWall user interface contains a number of different views, widgets, and interaction techniques designed to support different types of agile meetings.

- *Action and Information View:* The results of the interviews showed that most interaction with the cardwall takes place during agile meetings. Each meeting has specific goals, operates on different data, and requires different supporting tools and information. To support these different types of information handling, we divide the display into an action view and an information view. Figure 2 shows the view for a daily standup meeting highlighting the separation into information view and action view. The action view is the main work area, which is dedicated to the core artifacts of a specific meeting. The main interactions during a meeting are performed by users on the action view. The information view provides supporting information and tools needed for the meeting. The information view represents the dynamic memory of the team and as any dynamic system they need to allow for change. For example, the information view for the daily standup meeting contains additional information, like a timer widget showing the meeting moderator and a countdown, a team widget showing the team members, a definition-of-done widget, an impediment list widget, and a burndown chart for an iteration. When necessary, new widgets can be added and removed from the information view.
- *Dedicated Views:* aWall provides dedicated views that are tailored to the specific needs of agile meetings. For the sprint planning meeting shown in Figure 3, the action view is divided into three columns. The left column shows the top priority user stories of the product backlog. The center column shows the so far selected user stories for the next iteration. The right column shows a detailed view of the currently selected user story. This column can be used by the product owner to discuss and clarify open issues during the meeting with the development team. Relevant documents can be easily attached and opened in the application. Figure 4 shows the retrospective meeting view after team members have sent their iteration feedback where the notes have been ordered on the right side. Users can navigate between the different meeting views by means of a navigation bar displayed at the bottom of the view.
- *Information Widgets:* The information view consists of a set of widgets (e.g. team widget, timer widget, fun widget, avatar widget (see Figures 2, 3, 4) and can be independently configured for each agile meeting. Each widgets is designed to support distinct aspects of the

1 <http://multitouch.com/>

2 <http://interactjs.io/>

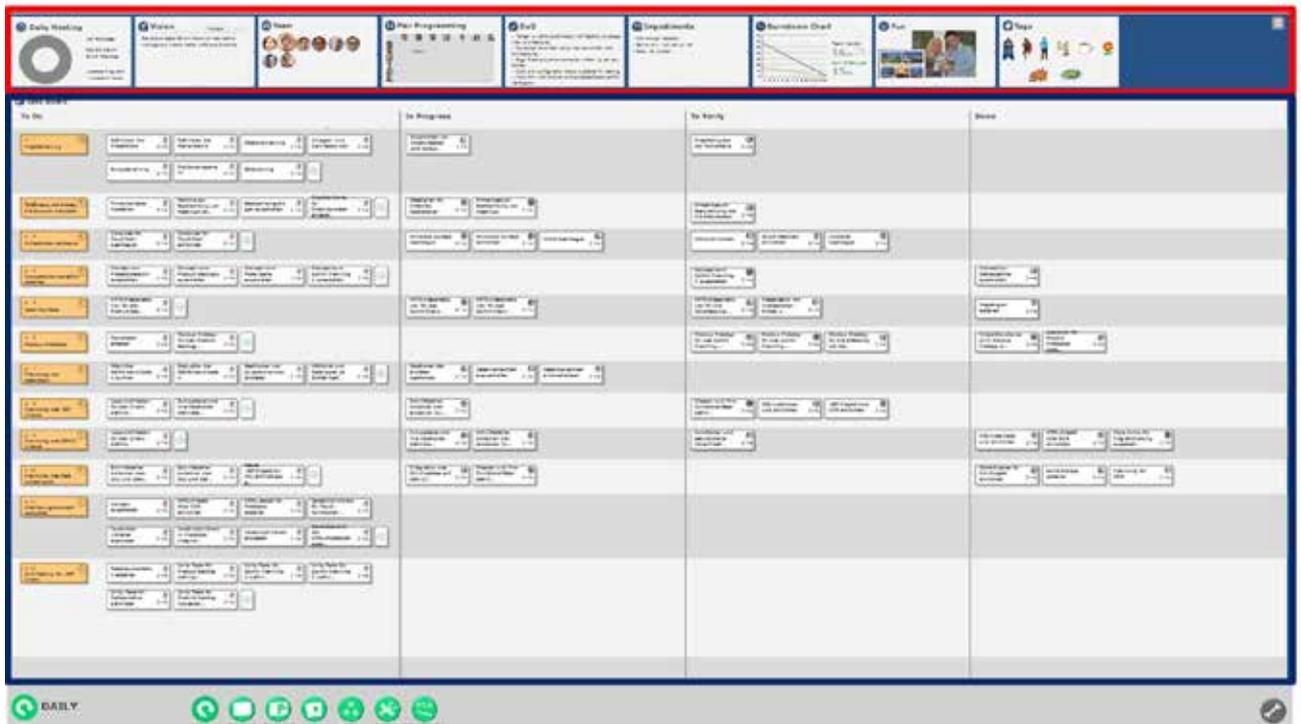


Figure 2: Daily standup with the following views: Information view (top section with red border) and action view (middle section with blue border)

collaborative agile process. The team widget shows the team members and can be used to assign people to tasks during a daily stand-up meeting. The timer widget supports time boxing during the meeting and furthermore, allows to choose a meeting moderator. The moderators' names are stored in the application and future moderators can be suggested based on previous selections. The fun widget allows users to post personal or fun images

to the information view to help bring emotion to the cardwall and foster team thinking. The avatar widget can be used to drag avatars to any position on the wall or attach it to tasks or user stories. Both the fun and avatar widgets are designed to help with the interpersonal process in agile teams (emotion management, team spirit). All widgets can be detached from the information view and moved around the cardwall to facilitate user interaction.

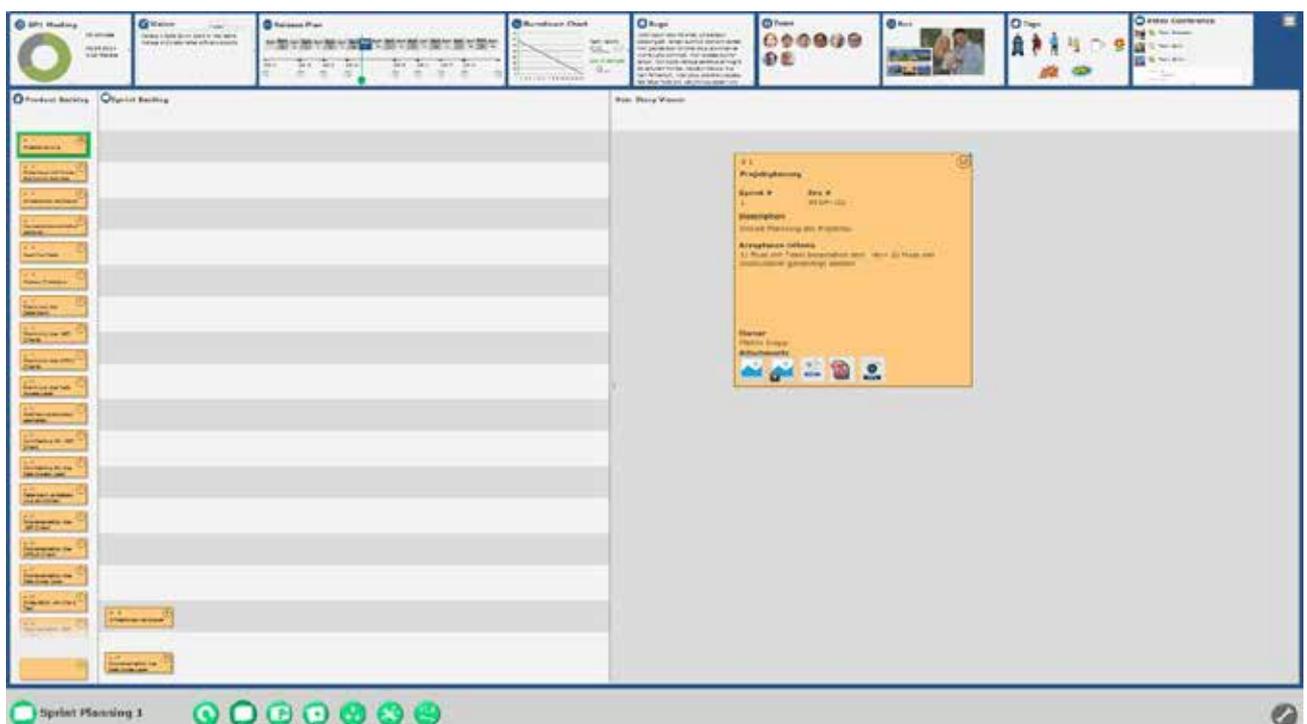


Figure 3: Sprint planning meeting with a user story detail view

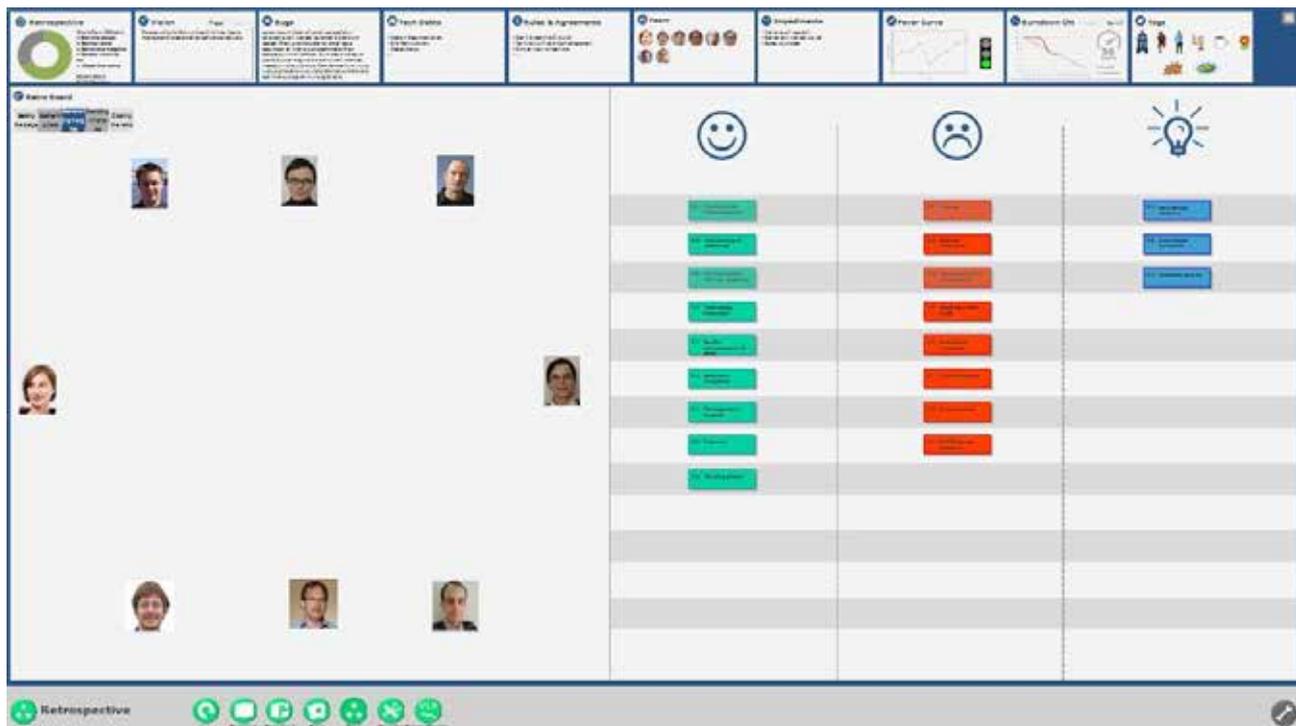


Figure 4: Retrospective meeting view

- **Availability of Information:** Any information needed for a meeting is visible and accessible; either on the action view or on the information view. If the team needs different supporting information, additional widgets can be switched on or off in the configuration button on the right side of the information view.
- **Interaction:** aWall supports multi-touch and multi-user interaction. Fluid interaction with widgets and cards is enabled by gestures like tap, double tap, drag-and-drop, and pinch-to-zoom supporting changing task and user story cards position, moving widgets around the cardwall, and changing the size of a widget. Data can be either entered on the cardwall with a virtual or physical keyboard or via the underlying issue tracker system and mobile devices such as tablets.
- **Scalability of Information:** By default, user stories and tasks cards show only a few details (e.g. title). By increasing card size with a pinch-and-zoom gesture more information is displayed. The text size increases concomitantly with the widening of the cards so that information can be more easily read depending on the distance from the cardwall. When all information is shown the widget automatically switches into edit mode, so that data can be added or modified.

User Study

To evaluate the design of aWall, we conducted a user study with professional agile practitioners. The main focus of the study was on the usability and discoverability of functionality, support of

agile workstyle, and applicability to real life situations in agile teams performing the daily stand up and sprint planning meetings. The user study was conducted with an early aWall prototype where participants had to complete various tasks with the aWall working in groups.

We recruited eleven employees (nine men and two women – see Table 1) from the same companies that participated in our interview study [9]. Most participants had many years of experience in IT, and several of them in agile development. They came from different fields and covered a wide spectrum of agile team roles. Among the participants were four Scrum Masters, two agile coaches, two senior developers, one agile grand-master, one UX consultant and one head of a software development department. Two of the companies were from the assurance domain, one manufacturing, two service providers, one engineering, and one enterprise software development company. Four companies sent two employees, and three companies sent one employee each. All companies had been applying agile processes for at least one year.

Procedure

We divided the eleven participants randomly into two groups. Both groups completed the same tasks with the aWall. Upon signing an informed consent statement, the participants were asked to act as a team during the workshop. Prior to the user study, the participants received a presentation on the interview study results, but did not receive any information about the aWall application. Each participant received three tasks to be

Gender	IT Exp	Agile Exp	Job Title	Company	Group
male	23	3	Head SW Dev	D	1
male	5	1.5	Senior Dev	E	1
male	13	2	Grandmaster	C	1
male	10	3	Agile Coach	F	1
male	19	4	Senior Dev	G	1
male	10	3	UX Consultant	B	1
female	8	3	Agile Coach	C	2
female	15	5	Scrum Master	A	2
male	15	3	Scrum Master	A	2
male	1	1	Scrum Master	E	2
male	6	2	Scrum Master	F	2

Table 1: Demographics of workshop participants: gender, IT experience, agile experience, job title, company (anonymized), and workshop group

solved together in groups using aWall. The tasks involved a daily standup meeting and a sprint planning meeting. After receiving the task, each participant read the task out aloud to the other participants and completed it with their help. The daily standup task was to start the daily standup meeting, choose a moderator for the meeting, and update the task board during the meeting. For example: *“In this team you play the role of team member M. Please find a way to carry out a daily standup. The application suggests a moderator. Please ask the team member suggested by the application to play the moderator. Please act as a team accordingly to the received instructions.”*

The sprint planning task was to show and discuss a user story during the meeting and move the story to the sprint backlog. The third task was to decide upon how to conduct the retrospective meeting. After completing the tasks for each type of meeting the participants discussed the benefits and disadvantages of aWall for that type of meeting together with the two moderators. The discussions were recorded and the results written down. Both workshops were conducted by two moderators and lasted one hour each.

Findings

The overall feedback for the prototype was very positive, with the participants considering aWall to be usable, capable to support agile processes in general and especially the collaborative working style in teams.

- **Size Aspects:** The participants especially valued the large size and high resolution of aWall. The large size supports real team collaboration capabilities, similar to physical cardwalls. Displaying a large amount of information at once

was deemed positive. One participant stated: *“With the large size you can display many user stories and tasks.”*

- **Readability of Information:** Most participants considered the displayed information to be legible, especially since the card titles are relatively large. Some participants considered the actual cards to be too small. Therefore, it is very important to be able to display the whole content of a card and enlarge the font size so that the whole team can read it from a distance. One participant stated: *“That’s really a nice feature that cards can be enlarged and font size increases to improve readability.”*
- **Availability of Information:** The participants especially valued the availability of additional information and functionality for the different meetings. The separation of the display into action view and information view was easily understood. Some participants mentioned that elements placed on the upper side of the display wall might be out of reach for smaller people. Another participant liked the extra features: *“I like the extra features around the main view and the additional information.”*
- **Discoverability of Functionality:** The participants discovered most functionality of aWall by themselves and could easily interact with the display wall. There were some issues with discoverability of those functions that were not a straight-forward transfer of the pin-boards into the digital world. For example, the timer widget has no corresponding artifact in the practice of agile teams. Whereas, direct implementations of the pin-boards functionality (e.g. the task-board shown in the daily standup meeting) were instantly understood and deemed as valuable by the participants. That was also the case for the widgets inspired from agile practices such as the team widget which is based on the observation that agile teams sometimes write the team members’ names on the cards or even hang their pictures on the pin-boards.
- **Third-Party System Integration:** The integration with third-party tools was positively rated. Tasks modified during the daily standup meeting, are immediately synchronized in the agile project management tool (JIRA). There is no extra effort to update the tasks manually from the physical cardwall after the meeting. One participant stated: *“The link to JIRA with automatic update of data is important.”*
- **Flexibility and Customization:** Increased flexibility with respect to both the manner of conducting the meetings and displaying information was considered important by the participants. For example, the timer widget solicited choosing a moderator at the beginning of a meeting. The flexibility provided by aWall

was also positively rated, especially with respect to conducting retrospective meetings that sometimes might prove strenuous. The participants considered that it is important to create a proper environment especially for this type of meeting as sometimes they tend to transmute into a drill. Most participants were in favour of a greater flexibility of the time boxing, with only optionally choosing a moderator and not showing the elapsed time, but the time of day during the daily meeting. The participants valued the team widget, but requested to have more information being displayed (e.g. absences, vacation days) and allow for more customization. Furthermore, the participants remarked that they should be able to add functionality to aWall on their own and not be dependent on standard functionality as often is the case with other agile tools.

- *Agile Collaborative Workspace*: Offering tags and avatars as well as the fun view was positively seen as bringing emotions onto the board. One participant mentioned the positive effect of avoiding of media disruption, by being able to do all interaction with only one medium: *“With such a board we could probably avoid media discontinuity.”*
- *Filtering and Representation of Information*: The participants requested especially to have filter functions, to highlight and show the desired information. As an example, participants requested to highlight all tasks of a team member, when touching that person in the team view. The usage of colors for different types of user stories was suggested to increase readability (e.g. to distinguish between technical tasks, bug reports, or user requirements).
- *Task Time Recording*: Some participants suggested automatically capturing the time spent on a task combined with computing of the work hours on the task would help provide further metric details of performance.
- *Provenance of Information*: Some participants suggested having automatic recordings of meetings with voice recognition and transcriptions of the discussions form the interactions in front of the display wall for later recollection and analysis of the meetings.

Conclusions and Acknowledgments

Current agile cardwalls don't fulfil today's requirements for effective software development. We aim to bridge that gap with aWall, a digital cardwall tool to support co-located and distributed agile teams. aWall provides a collaborative workspace using large multi-touch displays, information transparency, direct information interaction without the need for navigation, support for the whole agile process, and dedicated views for different types meetings. We conducted a user

study with eleven agile practitioners and found that they especially valued the large size of the wall due to the physical space affordances, the dedicated views with context specific information, and the always visible and direct information access. Our future work involves deploying aWall within companies.

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