Using a Large Whiteboard Wall to Support Software Development Teams

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Abstract

This paper reports on some salient characteristics of how a large (21-foot wide) whiteboard wall mediates and facilitates the work of a software development team. While most research on whiteboards report on their use in design conversations, our data show this large whiteboard wall fulfilling 59 different uses over a 17 month period. This paper describes this whiteboard wall, categorizes the uses, and illustrates a few ways in which it is intimately involved in how this software development team works. We conjecture that three aspects of this whiteboard wall make it into a particularly useful tool for self-organizing teams: its size, its surface material, and its location near the nexus of work.

1. Introduction

Software developers are continually seeking more effective ways to increase their ability to handle higher levels of complexity and higher rates of change. This has led to agile processes that embrace change, and to the use of self-organizing teams that can react quickly to the emerging particulars of their work. Therefore it is important to understand how self-organizing groups, such as software developers, do complex work.

This paper focuses on one particular question related to the nature of self-organizing work: What support structures and systems can help a self-organizing group be effective? Better understanding the answer to that question will help identify tools that could make such groups more effective, as well as propagate behavioral design patterns that other groups could adopt or modify.

It is well known that complex work is highly situated in that the materials of the environment in which work is situated have a profound impact on mediating joint activity [6,12]. Two very common materials that help mediate such work in software development organizations are whiteboards used for inscriptional purposes such as enabling design discussions or presenting ideas to others [2], and walls as surfaces to hold team artifacts such as story cards, kanban boards, storyboards, and mockups [9,11]. What about walls with a large expanse of whiteboard surface? What might happen if a team of software developers spent several years working next to a *large whiteboard wall* that was theirs to use as they wish? How might that team utilize that space? What practices might emerge? What might these practices tell us about the nature of self-organizing teams?

This paper explores those questions through a case study of such a situation in which the team of software developers in a 50-person software development organization evolved, and continues to evolve, their use of a 21-foot wide whiteboard wall over a nine-year period of time. We analyze the full spectrum of materials that this organization placed on this wall, and attempt to present the salient particulars of their practices so that others can better understand the nature of the work and adapt it to their circumstances.

This next section describes the organizational and work context from which are data were collected. Section 3 describes how we analyzed the data, with the results largely presented in Section 4. Section 5 draws some conclusions from these results, and proposes some hypotheses about how this whiteboard wall enables and mediates the work of this self-organizing team.

2. Organization and Work Context

The data for this paper was collected at a 9 year-old software development company in the Seattle area The company employs approximately 50 people who all work in a single office with an open floor plan (see Figure 1 and Figure 2). In 2011, the company was acquired by a non-US parent organization which has continued to let the company operate largely independently.

The company's product is a software system that helps friends and family share information. It has over 13 million users, includes a significant backend Software-as-a-Service (SaaS) component, and has both a web-based version and client versions for Macintosh, Windows, iPhone, and iPad.

The founders of this company came from a technical background and designed the company's processes and practices based upon a small set of

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values and principles intended to address the question of: "How to operate a small software team and make it its best?" Their goal was to optimize for a self-organizing team of 5-14 people, instead of trying to create practices that scale to larger groups.

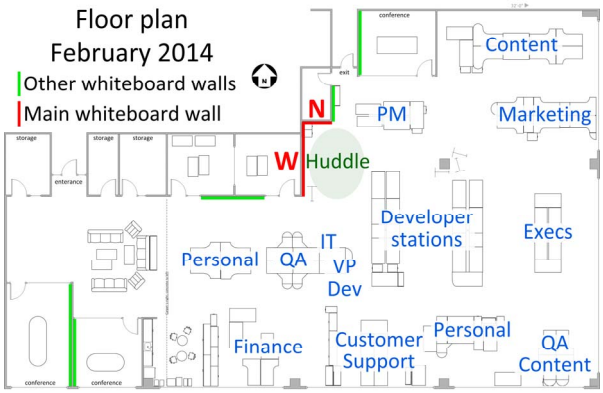

Figure 1: Office floor plan showing the locations of the whiteboard walls, huddle area, developer stations, and other stakeholders.

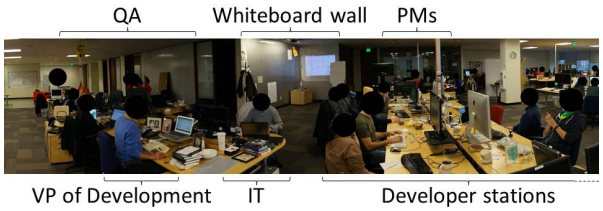

Figure 2: A portion of the company's office space showing the open layout. This paper focuses on the whiteboard wall in the back middle of the photo.

Figure 3: A frame from a video of the developer huddle in front of the whiteboard wall described in this paper.

Since the founding, the software developers in this organization have used a mix of extreme programming [1] and Scrum [8] practices, which they continually experiment with and adapt.

Whiteboards have played a key role in these practices since the company's founding. In their first location, they often used 2-4 whiteboards to cover a wall. When they moved to their current location, over which they had more control, they painted seven entire walls with whiteboard paint (see Figure 1) and purchased a number of small (3'x4') easily movable whiteboards on wheels.

These floor-to-ceiling whiteboard walls and the smaller mobile whiteboards have become increasingly intertwined with the company's development practices, and now are used for a wide variety of purposes beyond those we have found described in the literature.

This paper focuses on the primary whiteboard wall used by the developers. This whiteboard wall consists of two adjoining walls (labeled W and N in Figure 1) that form a corner directly adjacent to the huddle area. These whiteboard walls are also visible at the backs of Figure 2 and Figure 3.

The huddle area (see Figure 1) between the whiteboard walls and the developer stations is sufficiently large to allow the developers and other product stakeholders to meet in a circle for their thrice-daily standup meetings (which they call huddles, see Figure 3). They have a huddle before each 2-hour-long pair programming session. This huddle space was intentionally located directly between the whiteboard wall and the developer stations in order to facilitate the interplay between the material on the whiteboard wall, the activity in the huddles, and the activity at the developer stations.

The developers in this organization work in a very collaborative manner. The developer stations are collocated, as shown in Figure 1 and Figure 2. Each developer station consists of a workstation configured to support pair programming. Working in pairs and having the developer stations close to each other allows the developers to interact in an organic and ad hoc manner in order to benefit from "radical collocation" [14].

3. Methods

This study of the whiteboard wall began on October 17, 2012 when the first author initially visited this company to begin a case study of how software developers collaborate on their actual work in their actual place of work ("in the wild").

As part of this larger investigation we visited the organization on several days, taking field notes, photographs, and videos of the developers collaborating on their work.

Part way through this data collection activity, we realized that while the numerous whiteboards in this organization were infrequently used by the software

developers to sketch or diagram, there was a centrally located and prominent whiteboard wall that was *continuously* and *intensively* used by these developers in other ways. An initial analysis of the photograph of this whiteboard wall from the first day on-site indicated 16 different types of information on this whiteboard wall supporting a diverse set of ways to mediate the organization's work. The literature did not have descriptions of such a variety.

We hypothesized that this whiteboard wall was an instrumental aspect of how this software development team did its work, and that a study of how physical sections of this whiteboard wall mediated this work might help generate hypotheses to help other teams. Therefore we began to more systematically collect images of that wall during the rest of the study, following the grounded theory canons and procedures [4] to iteratively and collaboratively analyze and classify this data. Rather than working strictly with text or speech, we largely worked with the participants' own visual representation of their work: the material on the whiteboard wall. By continued viewing of the images of their work over time we began to partition, or categorize, physical sections of the space of the wall, where each section appeared to have a single primary role.

We also put aside any presuppositions about what was useful or related to work, and instead analyzed *all* of the inscriptions and materials that appeared on this whiteboard wall. On some visits we collected videos of interactions near or on the whiteboard wall. In February 2014, we conducted an intensive data collection exercise that included using 6-9 GoPro cameras mounted on tripods near developer stations or from the ceiling to collect 11-days of collaborative activity in this organization. To date we have collected over 400 hours of video from the developer stations, 17 huddles, and other meetings; time-lapse images of the entire room over the11 day period in February 2014; screen recordings from some of the developer workstations during that same period; field notes from 24 hours of ethnographic observations; and hundreds of photographs. Some of the videos capture developers using the whiteboard walls during huddles, design discussions, and other activities, which allows us to explore the fine-grained interactions at the whiteboard wall. The photographs include images of the whiteboard wall on 21 different days over the 17 month period from October 17, 2012 through March 18, 2014.

This provided us a rich data set to maximize the chances of discovering insights about how this wall mediated the work in this organization. Rather than focusing on a subset of the artifacts on this wall, as done for the Wall in studies by Sharp, et al. [9,10], our goal was to investigate the full range of materials produced by the developers regardless of their intended or actual purpose.

We also interviewed two of the developers with a long history of using the whiteboard wall about how and why different sections came into existence, how sections were used, how sections evolved, why sections were removed, how sections mediated the work in this organization, and how sections related to other aspects of the work in this organization. One of these interviewees is a senior developer who has been with the organization for several years. The other was the VP of Engineering who had been with this company since shortly after its founding, and is a co-author on this paper.

4. The Whiteboard Wall

In order to make sense of the material on the wall, we conceptually divided it into physical "sections", where each section appears to contain a single type of information fulfilling a particular role. Figure 4 shows three of the initial photographs of the main (W) portion of this whiteboard wall. These three images span a 14-week period from October 17, 2012 to January 24, 2013. Overlaid on these photographs are numbered boxes, each of which uniquely identifies a different section containing material that the team has put on this area of the wall for a specific purpose. Section 1, for instance, lists this company's organizational values (this section spans the top of the W and N walls). Section 9 lists rules to follow when the developers meet in their thrice-daily huddles. Section 12 is a "parking lot" in which people list items they wish to discuss in the last portion of a huddle. Section 22 is a piñata shaped like a tequila bottle. Developers also opportunistically use blank portions of the whiteboard for notes and sketches during brief design discussions. Typically, these inscriptions are erased by the end of the design discussion, and thus did not persist long enough to be captured as a section in a photograph.

Sections are color-coded in Figure 4 according to whether the section is new since the prior photograph (red), contains changed content of the same type as in the prior photograph (yellow), has been removed since the prior photograph (white with dashed lines), or has not changed since the prior photograph (black). All of the sections in the October 17, 2012 photograph are black since that was the first photograph we took of this wall; so we had no information about when these sections last changed. Section 25 and 26 on January 1, 2013 are shown in black because those sections had existed earlier in a different area of the wall. We have such photos of the W and N wall for eacsh of 21 days.

Figure 4 shows a wide variety of sections with different types of information. Over the entire 17 month period, we identified 59 different sections on the whiteboard wall, which we categorized according to their primary purpose (see Table 1):

Table 1. Primary purpose for a section.

Primary purpose	Number of sections
Working agreements	8
Bookkeeping	11
Scheduling	8
Commitments	4
Continuous improvement	5
Technical design	6
Information from other teams	4
FYI	1
Teambuilding	3
Art	19

- **Working agreements**. Eight sections displaying agreements about how developers do their work. These sections included the values listed along the top of the whiteboard wall; a section listed four rules for how to behave during huddles; and some "simple rules" the developers had agreed to follow.
- **Bookkeeping**. Eleven sections that help track work to be done. These sections included an area where the Mingle task management system was projected onto the wall; a section indicating tasks that should be checked again before passing them on to the QA team; and requirements for the next release.
- **Scheduling**. Eight sections about who needs to do what by when. These sections included the current assignment of developers into the mobile or desktop sub-team; an area indicating whether someone was coming in early one morning and therefore might be looking for someone else to pair with; and a list of developer names indicating the next person to do the weekly company-wide demo session held each Friday afternoon.
- **Commitments**. Four sections about commitments the team of developers had made to other groups in the organization. These sections included information about the next scheduled release candidate; developer priorities; and information about release dates.
- **Continuous improvement**. Five sections about ideas of ways to improve how the team of developers does their work. These sections included "adventure ideas" to try during the Friday afternoon "free time" the company allocates to each developer; ideas from brownbag discussions; and other things to improve the development process.

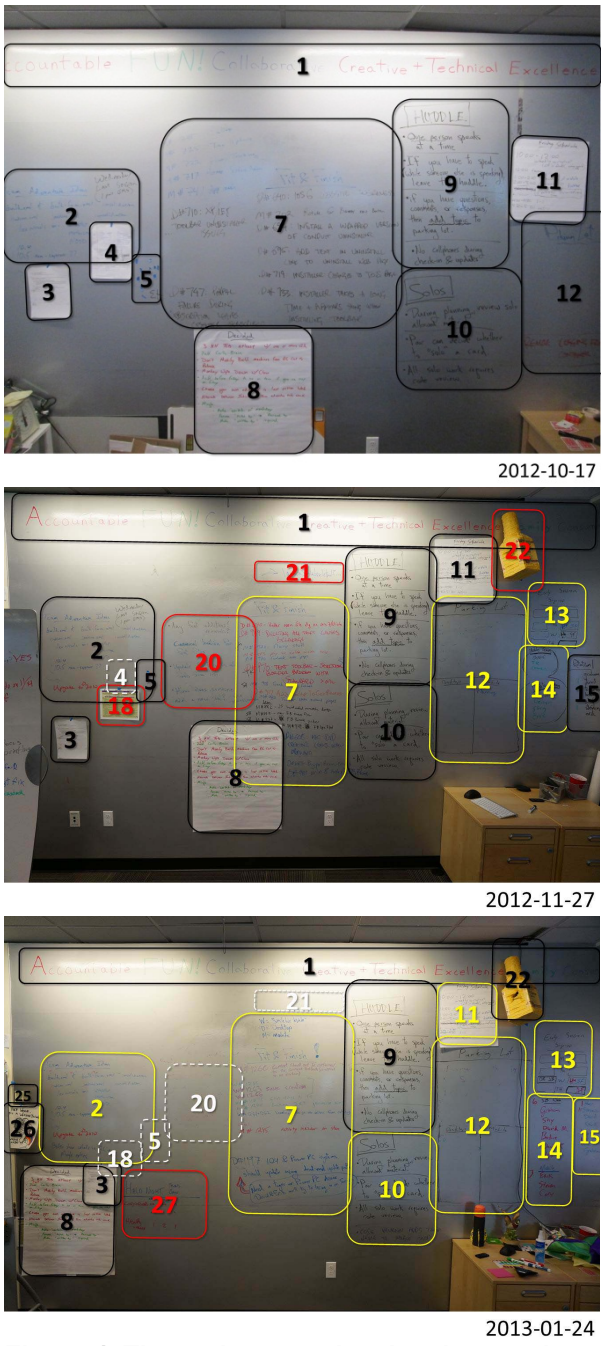

Figure 4. Three photographs showing sections from the initial 14 week of the study. Sections are color-coded according to whether they had not changed (black), are new (red), had new content of the same type (yellow), or had been removed (white with dashed lines).

- **Technical design**. Six sections containing information about the technical design. These sections included issues regarding Google compliance; a diagram of the code repository branch structure; and a diagram about the various test stages.
- **Information from other teams**. Four sections containing information provided from other teams that the developers felt were important enough to display on this whiteboard wall. These sections included a holiday schedule with milestones of other teams; a set of personas; and a proposed quarterly work plan for 2013.
- **FYI**. One section listing the phone number for the VP of Engineering.
- **Teambuilding**. Three sections related to teambuilding. These sections included a sign-up for a Halo game night; and a set of 12 "personal shields", one created by each of the developers to describe their gifts to offer, challenges, personal objectives, things you might want to know about me, and motto.
- **Art**. Nineteen sections containing artwork. These sections included the piñata; T-shirt designs from a previous teambuilding exercise; and several sketches done by artists in the content creation team and then presented to one of the developers.

We also observed 8 other sections of information on the smaller movable whiteboards with wheels from when these were placed near the whiteboard wall. These moveable whiteboards often appeared to temporarily extend the surface of the whiteboard wall with related material. The edge of one of these is visible on the left side of the November 27, 2012 image in Figure 4. The affordances of these moveable whiteboards allowed them to fulfill a variety of roles:

- Three sections were about technical design, such as a callback diagram.
- Three sections were about bookkeeping, such as release candidate stuff, and requirements for the next release.
- One section was about teambuilding: another Halo night.
- One section was about scheduling: showing the interview schedule for a candidate.

In general, the developers frequently use these smaller movable whiteboards for design discussions and diagramming, after which they often are wheeled to a developer station for easy reference during programming. Retrospective meetings typically use one of these movable whiteboards so that the retrospectives can be held in a more casual location in the office, and then rolled over to the whiteboard wall for future reference by people, including those who did not attend the retrospective. The material on these movable whiteboards generally lasts for at most a week before the whiteboard is erased and reused.

The whiteboard wall is not static. Even though large portions of the wall do not change for days or weeks at a time, there was at least one change on each of the 21 days: new sections are added, existing sections have their content changed, and old sections are removed.

The typical lifecycle of a section consists of four phases: creation, use, ignored, and repurposed or discarded. Each section is created to fulfill a need. It is used for a while to fulfill that need. Most sections eventually outlive their original usefulness, but some time may elapse before anyone bothers to remove it. When the physical space occupied by a no longer used section is needed for something else, the section is removed and discarded, preserved elsewhere (e.g., as art), or transitioned to a new role.

Different sections change at different frequencies. In general, there is a wide variety of lifetimes and temporality among sections. For instance, section 1 (organizational values) has been in this position, unchanged, since the organization moved into this office space in 2009. Furthermore, these values were in a similar position at the top of the largest and most prominent whiteboard they had in the prior office space since the company was founded in 2005. On the other hand, section 7 (fit & finish) typically changes on a weekly basis, and section 12 (parking lot) changes multiple times a day, with most inscriptions being erased within minutes.

Different physical materials are used in different sections. Many of the sections consist of inscriptions made by whiteboard markers, providing an easy malleability. Other sections contain flip charts sheets that have been brought from other discussions, such as retrospectives. Some sections are smaller printed sheets of paper produced by other parts of the organization. Some are three dimensional artifacts, such as the piñata that appeared sometime between October 17 and November 27, 2012 and has remained there ever since.

The whiteboard wall was intentionally designed to be organically modified in content and form as needed by the software developers in this organization. No particular person is responsible for the wall. Instead, developers add, modify, move, and remove content as they wish in order to display the information that they believe is important. It is common practice to announce before removing a section, unless the section is clearly no longer useful, to give people an opportunity to express opposition.

These sections were not preplanned. Leadership encourages the team to use the whiteboard wall as the team desires, such as for displaying artwork. This

resulted in the whiteboard wall acting as "a powerful social binder" empowering the team and becoming a "group creative outlet".

The developer stations were intentionally placed near the whiteboard wall, leaving sufficient space between for their huddles. This creates a natural container in which developers easily make use of the affordance of the whiteboard when and as needed during huddles and for the ad hoc design/planning discussions that often occur directly after huddles.

The list of values (section 1) prominently displayed in this central location acts as an information radiator [3]. Even though the list of values has not changed since the company was founded, and thus does not entirely conform to Cockburn's definition of information radiator, the fact that they have *not* changed radiates information about their stability. The developers have changed *every* other section of this whiteboard wall, but not the values. The values are continually visible and available for reference by the developers, the rest of the people in the organization, and visitors.

5. Discussion

We hypothesize that this whiteboard wall has three characteristics that substantially increase the chance that a self-organized team will appropriate and use such a wall to suit their purposes: it has a *large* expanse of surface, that surface is *whiteboard* material, and it is *collocated* next to where the developers do the majority of their work (huddle area and developer stations).

The *large expanse* allows the team to use whatever amount of physical space, temporality, and type of material is most appropriate for the purpose at hand. There have only been a few times in this organization when there has not been a sufficient area on this wall for all of the purposes that the developers wanted it to serve. Those times were accommodated by using one of the movable whiteboards for things like interview schedules or certain design works. Otherwise, there has always either been a sufficient amount of blank space for the new need, such as for sketching during as an ad hoc design conversation, or there has been a sufficient area of no longer used sections whose area could be repurposed for the new need.

Each section persists for its natural lifetime. A section does not need to be removed "just in case" the area is needed for something else. Instead, developers can observe how a section evolves over time, uncover insights into how well that section does its role, and experiment on different ways to configure or use a section. There is no need to rush a section to an untimely death. One of the benefits of this is that some sections evolve into reminders. For instance, at one point the developers created an "RC clock" consisting of a paper plate with an arrow pointing to the number of weeks before the next release candidate. Even after they stopped using this RC clock, they kept it on the side of the board as artwork. Occasionally, when the need reemerged to manage the awareness of how long before the next release, someone would point to the RC clock and suggest it was time to do that again, though the new section they created would usually have a different structure to fit their current RC need. The "RC clock" helped remind them of practices that had worked in the past, and became a cultural meme.

We hypothesize that allowing each section to last its natural lifetime helps developers evolve the section to fulfill both the original *tactical* need as well as a *strategic* need of growing the team's capacity. The only section that we observed that was explicitly created to fulfill a strategic need was section 1 (organizational values). Its intended purpose was to help create a more effective self-organizing team. Every other section was created for a tactical reason supporting a short-term need, often of providing value to an external stakeholder. However, developers often would adapt that section to *also* fulfill a strategic role of improving the team. We conjecture that this happened partially because the sections could persist long enough for this evolution to happen in spare cycles.

We also hypothesize that whiteboard surfaces that are "too small" will devolve to fulfilling only tactical roles. The continual pressure to get rid of a section in order to gain space for a new section will not allow the team to keep a section that is not fulfilling an existing tactical need. This may prematurely halt a section's evolution. Furthermore, if sections of the whiteboard are continually repurposed for the next important tactical need, the whiteboard will not have sufficient space to hold more strategic sections. Indeed, the smaller moveable whiteboards were almost always used for tactical reasons. This will reduce the chance that the whiteboard will become a long-term focal point of the team. In other words, for a whiteboard wall to be effective in sufficiently fulfilling the emerging needs of a self-organizing team, it needs to have sufficient "slack" area to repurpose as needed (this is in analogy to the slack time that Tom DeMarco argues is essential for effectiveness [5]). A whiteboard wall that never has empty space is probably too small.

The large expanse also means that developers can attach different types of material to that wall, such as flipchart sheets, without being concerned about unduly restricting the ability of others to use the wall. This makes it easier for developers to use the appropriate

material for some sections, and reduces the cost of creating some sections.

The *whiteboard* surface of the wall is important because whiteboards are designed to be written upon, modified, and erased. They are inherently malleable with respect to inscriptions. This makes it easy to use any portion of this wall for such inscriptions. The medium is the message [7], and the medium of the wall may give developers implicit permission to own and modify the wall to suit their needs. This permissiveness was further encouraged by explicit affirming comments by management when someone put up something like a piece of art, or added a new section.

The whiteboard wall is a focal point of the software development team. It is highly visible and near the nexus of the team's work (huddle area and developer stations), providing a space on which the team can easily create, modify, and reference artifacts that facilitate their work. In this way, it structures and mediates the way in which the team works. It defines a set of accountability practices that are in force and enforced during each huddle as the members of the team stand next to this wall, each accounting for their work since the prior huddle, and each holding the others accountable.

The whiteboard wall is a visible manifestation of aspects of a team that are largely invisible in many organizations. It is created by the team, and helps to create the team by publicly and visibly displaying the information that the team currently believes is necessary to be publicly displayed. By making their work visible the wall enables the team's role as designers of their own work practices [13]. The whiteboard wall and team are two facets of the same system.

6. Conclusion

The whiteboard wall described in this paper provides a rich and versatile material that this software development team has used for a wide variety of different roles with different lifespans and temporal patterns of change. The wall mediates many different aspects of this team's work in ways that continue to evolve. The wall has become part of the cognitive and collaborative fabric of the team, as well as being a reflection of the team, visible both to the members of the team and the rest of the people in this organization.

These uses and impacts have implications for practitioners. While whiteboards are widely recognized as being valuable for design discussions, this paper suggests that a large expanse of whiteboard wall can provide additional, more diverse, value for a small collocated team of software developers. It may be a more broadly valuable tool for a collocated self-organizing team, helping them organically create and evolve a set of tools to mediate the particular complexities of their daily tactical work, while also supporting the strategic goal of growing the team's capacity, and providing substantial long-term benefits at a relatively low cost.

7. Acknowledgments

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8. References

[1] Beck, K. *Extreme Programming Explained: Embrace Change*. Addison-Wesley Longman, Inc., Reading, MA, 2000.

[2] Cherubini, M., Venolia, G., DeLine, R., and Ko, A.J. Let's Go to the Whiteboard: How and Why Software Developers Use Drawings. *Proceedings of the SIGCHI conference on Human factors in computing systems - CHI '07*, (2007), 557–566.

[3] Cockburn, A. *Agile Software Development*. Addison-Wesley Professional, 2001.

[4] Corbin, J. Grounded Theory Research: Procedures, Canons, and Evaluative Criteria. *Qualitative Sociology 13*, 1 (1990).

[5] DeMarco, T. *Slack: Getting Past Burnout, Busywork, and the Myth of Total Efficiency*. Crown Business, 2002.

[6] Heath, C. and Luff, P. Collaborative Activity and Technological Design: Task Coordination in London Underground Control Rooms. *Proceedings of the Second European Conference on Computer-Supported Cooperative Work*, (1991).

[7] McLuhan, M. *Understanding Media*. McGraw-Hill Book Company, New York, 1964.

[8] Schwaber, K. and Beedle, M. *Agile software development with Scrum*. Prentice Hall, Upper Saddle River, NJ, 2002.

[9] Sharp, H., Robinson, H., and Petre, M. The role of physical artefacts in agile software development: Two

complementary perspectives. *Interacting with Computers 21*, 1-2 (2009), 108–116.

[10] Sharp, H., Robinson, H., Segal, J., and Furniss, D. The Role of Story Cards and the Wall in XP teams: A Distributed Cognition Perspective. *Agile 2006 (Agile'06)*, (2006), 65–75.

[11] Sharp, H. and Robinson, H. Collaboration and co-ordination in mature eXtreme programming teams. *International Journal of Human-Computer Studies 66*, 7 (2008), 506–518.

[12] Suchman, L. *Plans and Situated Actions: The Problem of Human-Machine Communication*. Cambridge University Press, Cambridge, MA USA, 1987.

[13] Suchman, L. Making work visible. *Communications of the ACM 38*, 9 (1995), 56–64.

[14] Teasley, S., Covi, L., Krishnan, M.S., and Olson, J.S. How Does Radical Collocation Help a Team Succeed? *CSCW'00*, (2000), 339–346.