

The Conference Room as a Toolbox: Technological and Social Routines in Corporate Meeting Spaces

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ABSTRACT

HCI, CSCW, and ubicomp researchers have developed new technologies and interaction techniques to support collaboration, ranging from electronic whiteboards to software supporting display sharing. However, very few longitudinal studies have explored the technological and social routines of individuals using personal devices in conjunction with shared displays under authentic settings in meeting rooms. We extend previous work in this area by studying routines within two multi-purpose meeting spaces at two design and manufacturing-oriented corporations, with particular emphasis on the shared display found in each location.

Our contribution to this space is a *holistic approach* to understanding the dynamics between people, devices, information, and the physical environment of meeting spaces. We argue that while it is important to improve technological infrastructures, such as enhancing display sharing abilities, understanding the social and technology routines that currently support collaboration are beneficial to technology designers aiming to enhance existing practices. In this paper, we analyze the routines occurring in these two spaces and discuss several routines that are impacted not only by technological limitations, but social conventions. We explore the types of interaction with devices and displays and identify other factors that contribute to the communities of information—items discussed, presented, or displayed—within these environments. To further explore the integrity of these routines, we introduced a second shared display to each space and observed groups responding very differently to the new technology, some integrating it into their routines while others dismissed it. We argue that meeting spaces need to be toolboxes containing many tools, some redundant, to successfully support information sharing routines.

Categories and Subject Descriptors

H5.m. **Information interfaces and presentation** (e.g., HCI):
Miscellaneous.

General Terms

Measurement, Design.

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Keywords

Meeting spaces, large displays, interaction, routines.

1. INTRODUCTION

Studies indicate that knowledge workers spend up to half their workday away from their individual desks in both formal and informal meetings [2,4]. This increase in time spent in meetings is due to trends within organizations of moving away from traditional employee hierarchies to more flat hierarchies consisting of self-organizing teams [19].

Many research prototypes of advanced meeting spaces (e.g. [3,12,15,22]) consist of multiple displays, devices, and specialized software to promote collaboration. However, anecdotal evidence suggests most existing conference rooms outside of research lab applications are much more simplistic, typically having one shared display such as a projector, large LCD display, table, chairs, and a whiteboard. Meeting spaces may also contain personal devices that individuals bring into the space such as laptops and smartphones. We seek to explore technology interactions in these widely ubiquitous spaces in the context of routines, both social and technological, to understand how users use shared displays.

In this article, we report on two case studies examining how two communities share information in their multi-purpose meeting rooms during the day-to-day operations at their company. We specifically focus on environments in which users are not computing professionals to see how these types of individuals approach and use technologies. To further explore the nature of these routines, we introduced new technology into each space halfway through the observation process by adding a second large shared display. We sought to examine how routines changed—if at all—when new collaborative technology becomes available. Our contribution to the HCI community is a holistic approach to understanding the technological and social routines of these users within these meeting spaces.

In this paper, we report findings of technology usage that is influenced by technological limitations, social protocols, and meeting routines. We describe several of the routines common across both spaces and multiple meetings and describe a display-device interaction model that captures these factors. Furthermore, we describe factors other than poor design that are barriers for technology usage.

2. RELATED WORK

Technology researchers have long explored meetings (e.g. [18]) and have also created several visions of futuristic meeting spaces, most notably the Interactive Workspaces project [11] and i-LAND/Roomware project [21,22]. More recent work explored creating technology services for meeting spaces that support common activities such as connecting to a projector [15]. Other researchers have used meeting spaces as vehicles to explore new interaction techniques with tables and surfaces, and also examined the disruptive impact of laptops in meetings [16,17]. Additional work explored developing computer systems to support group decision-making process [6]. We further extend on this body of work by taking a holistic approach to understanding the technology and social routines of workers at two corporations.

Other research explores display placement in meeting situations. Hawkey *et al.* studied the impact of physical distance on collocated collaboration, specifically examining the arrangement of people towards each other and displays [7]. They found that collaboration increased when participants were positioned close together and that display interactions were felt more effective when participants were placed close to the display. Wang and Blevis studied a group of collocated industrial design students to gain insight for integrated technologies and environments [24]. Their study, although short-term in nature, attempted to explore how their specific population worked and what design interventions could be proposed for future work. It is not clear, however, that the observations occurred in a regularly used space, nor if the group of students had ever worked together before. In this study, we report on two meeting spaces that are routinely used by employees of two companies who had existing working relationships.

Few existing longitudinal studies involve meeting space displays and technology usage. Huang *et al.* observed an interactive, large display in use as a groupware system at NASA's Jet Propulsion Laboratory, but their work involved deploying a highly customized application [9]. In our study, the observed populations use commercially available displays, software, and technology devices.

The research described in this paper contains some similarities to more recent work done by Newman *et al.*, who longitudinally studied a single meeting space to examine the application of software services for display accessibility before and after a display technology service infrastructure was implemented [15]. However, the authors admit they did not explicitly characterize the situations in which their enhanced display capabilities were used, and also did not report on the situations in which displays, laptops, and other devices were used during initial observations. Conversely, in this study, we focus on the details of device usage, information shared, and the social protocols of the meetings.

Recently, the IMPROMPTU framework was developed to assist users in sharing information across displays using off-the-shelf products, supporting opportunistic and short-lived collaborative moments [3]. Field studies showed that users found advantages in using the framework, however, we note that the observed populations were two software engineering teams, representing a possible bias towards using and appropriating digital technology.

This research differs from existing recent research by focusing meeting spaces within two companies during their day-to-day operations. The observed populations, as described in the

proceeding section, are not computer scientists or programmers by trade, but rather come from a wide variety of disciplines such as industrial design, marketing, and accounting. We note that these types of individuals will likely approach, use, and appropriate technology in very different ways than academic professionals or software development teams might. We seek to understand the information sharing, technology use, and social routines of these workers within these meeting spaces.

3. STUDY

Meeting spaces exist in a variety of sizes and configuration. We examine two points in this space by examining the usage of two conference rooms at two companies that we refer to as Alpha and Beta Corporations. We seek to understand three different aspects of routines occurring in the spaces: information sharing, analog and digital technology usage, and social protocols (standards of courteous behavior). Furthermore, we interview a subset of users halfway through the observation process as well at the end of the observation period. Our approach is motivated by recognizing that meetings are larger social constructs than merely a collection of people and technology.

3.1 Sample populations

Alpha Corp. is a global company designing and selling office furniture, technologies, and services. Headquartered in the United States, Alpha Corp. has 13,000 employees worldwide and manufacturing facilities, dealers, and research centers across the globe. The corporate structure of Alpha Corp. is similar to other organizations of its size, representing a mix of white and blue-collar employees. A variety of different departments, divisions, and sub-units exist within the company, such as marketing, finance, sales, manufacturing, quality assurance, sourcing and shipping. Typically, employees report directly to a manager within their particular department.

3.1.1 Project Room Population

One population observed for meeting space usage is the supply chain department of the company, a largely "mobile" group where approximately two-thirds of the 80 employees have no permanent cubicle or desk. Rather, each mobile employee is outfitted with a laptop computer, mobile phone or Blackberry wireless device, and one locking storage drawer to store personal belongings. Throughout the day, the individuals migrate throughout shared open-areas, conference rooms, enclaves (small enclosed rooms with seating for 2-4 individuals), or travel offsite to suppliers or manufacturing plants.

The supply chain group is collectively responsible for ensuring the availability of commodities for products within the company. In addition, they seek out ways to reduce costs and expenses. Managers oversee different product categories within the company. For example, one manager is responsible for all products within the seating category, making sure plants get components they require, such as plastic shells, casters, pneumatic cylinders, and fabric. Members of the supply chain routinely interact with individuals outside the immediate physical area, such as suppliers and manufacturing plants. Such interactions occur in both on-site visits and phone conferences with more remote locations, such as an Asian manufacturing plant.

The age of the population observed and interviewed ranged from 26-61 years. Employees observed and interviewed included



Figure 1. Project room at Alpha Corp.

managers, product buyers, product suppliers, and account management.

3.1.2 Conference Room Population

Alpha Corp. wholly owns several smaller companies that develop and manufacture specialized products for office environments. One such company is Beta Corp., which specializes in developing and selling ergonomic tools such as VESA-mountable monitor arms, task lighting, and keyboard trays. Beta Corp. operates as an independent small company, but is able to leverage its parent organization's global sales network and resources.

The employees of Beta Corp. range from engineers, industrial designers, marketing experts, financial analysts, to project managers. All individuals observed and interviewed during this study were issued laptop computers as their primary computing device. Each individual has a cubicle or desk; several individuals used docking stations for their laptops when at their desks. The age of this population observed and interviewed ranged from 29 to 45.

3.2 Observation Sites

Often overlooked by technology designers for meeting spaces is whether a meeting space is a *shared* or *owned* resource. Shared meeting spaces typically do not hold any persistent content (i.e. pictures, poster boards, stick-it notes, or charts) after the meeting attendees leave the room and a cleaning staff comes through. Owned meeting spaces are typically dedicated to a particular subgroup of individuals who regularly use the space and typically have persistent content in the room. Sometimes these types of spaces are known as "war rooms."

Two observation sites were chosen to explore ownership status: a shared conference room within Beta Corp. and an owned project room used by individuals in the supply chain division of Alpha Corp. These were two spaces used on a regular basis by respective company employees in which we received permission to conduct observations.

3.2.1 Project Room

This 20x20-foot meeting space is "owned" by the supply chain group and is designated a task room (Figure 1). This space consists of four sectional tables placed around a central power and data hub. Seating for up to eight individuals is provided. Initially,

this space was not outfitted with a permanent projector; individuals wanting to share information typically retrieved a shared projector from a storage unit and placed it on top of the central hub at the table. Due to a lack of space for a projection screen, participants projected onto a portion of the whiteboard.

Attendees made use of the wall space in this room. One wall supports a large marker board surface. The other two walls host an abundance of physical and persistent displays including progress/update board (referred to as "accountability boards"), charts, Post-It notes, and various paper documents. The exterior wall consists of a semi-transparent full-height glass wall with six plastic holders containing paper documents.

3.2.2 Conference Room

This meeting space is a shared 20x40-foot space for the Beta Corp. organization (Figure 2). This room is one of several shared resources, including a large informal "family media room," several enclaves, and project rooms identical in size and lighting to the supply chain's project room. We note the availability of such rooms since individuals within Beta Corp. have a choice in reserving meeting rooms.

This meeting space has four large tables pushed together surrounded by seating for up to 12 individuals. The space is equipped with a dedicated table-top XGA projector aimed at an electrically-retractable projection screen on one of the 20' walls. One of the 40' walls contains a large whiteboard surface, half of which is electronically capturable. The wall directly across from the whiteboard contains promotional images for the company.

A power strip is placed on top of the tables, providing electrical power for attendees. Internet access is provided via wireless signal, however due to frequent dropouts of signal, employees purchased and installed a network switch with retractable cables.

3.3 Observation Method

Several previous studies of meeting spaces leveraged video capture to gain observation [15,24]. Newman *et al.* took image snapshots at one-minute intervals from three different camera angles while Wang and Blevis used continual video observation. Both sets of researchers noted that image capture was less intrusive than direct observation and required fewer man hours.



Figure 2. Conference room at Beta Corp.

However, in this study, we observed actual companies and their employees on a day-to-day basis, requiring a balancing of privacy and confidentiality. Because material discussed at meetings could have proprietary information, several individuals expressed concern about using a continual video observation of the spaces. Furthermore, research by Hayes showed that users were reluctant to enter a space under continual surveillance, even if they had the ability to “purge” the video capture [8].

We also decided against using image sampling at regular intervals as our method of observation due to the fact that we could potentially miss quick interactions with technology. If, for example, a camera captures approximately a one-second snapshot every minute in time, approximately 98% of a 30-minute long meeting would not be captured. During preliminary observations, the temporal resolution of several interactions with technology occurred in about 30-second durations, such as quickly checking a phone or Blackberry wireless device for a message. We sought to minimize the possibility of missing such interactions in this study.

Therefore, despite its increased costs in time commitments, we chose direct in-person observation to gain insights into the routine, everyday usage of technology in meeting situations. Participants in both study samples felt comfortable with an individual residing inside or immediately outside of the meeting space to take observations with the caveat that the observer would leave the space when asked to. Furthermore, if the observer was outside of the space, privacy could be obtained simply by closing the door. The door was not closed on a frequent basis; on one occasion the observer was asked to leave the project room while an employee review was conducted, and on three occasions, the observer arrived to the conference room to find the door closed.

We recorded interactions with technology, both room-based and personal devices, and time-stamped each observation along with the context of usage. To supplement this data, a digital camera was used without a flash to capture instances of technology in use. Post-study interviews indicated that individuals were largely unaware that pictures were taken.

3.4 Preliminary Observations

Preliminary observations of the Alpha Corp. space indicated different patterns of occupancy. Managers often used this room in the morning to respond to emails, conduct staff meetings, or work

individually. Occupancy in the afternoon was variable; individuals presumably traveled to plants, conducted off-site meetings, or resided in the open spaces of the building.

Preliminary observations of the Beta Corp. space occurred when the space was scheduled and did not conflict with observations occurring in the project room. However, this conference room was not utilized consistently nor often. Workers reserved this room (according to the online schedule system) about 25% of the a typical workday. However, having the room scheduled did not necessarily result in the space being used; on several occasions, individuals arrived to find someone else in the space using the phone. Instead of interrupting, attendees would find another open room. In addition, several meetings were canceled or rescheduled and the reservation was not pulled from the scheduling system.

3.5 Intervention

Halfway through the eight-week observation process, we placed a second large display into each space. We chose to add a second display to further illuminate the routines observed within these communities. We wished to examine whether routines would generally change with the presence of new technology, or perhaps if individuals would adapt technology use to further support existing routines.

Placing a second shared display into each space was a minimal change to the existing meeting rooms that seemingly had potential benefits for users. In the domain of personal desktop workstations, evidence illustrates performance benefits of having more screen real-estate to manage content. Due to the nature of meetings—multiple individuals sharing information—it seemed that increasing shared screen real-estate would be a simple and welcome enhancement to spaces. Regardless, our goal was to use this technology intervention as a catalyst to explore existing routines.

The shared display was connected to an off-the-shelf video switch (ATEN 8-port), allowing this display to be shared by multiple individuals. The original large display in each room was not touched and the video switch was introduced only on the new display to avoid any social nuances associated with usurping the original display, if being used by a speaker. We specifically chose the physical video switch due to it being readily available and requiring a minimal of training for use. We acknowledge

researchers have built several software-based systems, but none of these are widely adopted.

We placed a 37" LCD display running at a native resolution of 1366x768 into the project room and a 46" LCD display running at a native resolution of 1920x1080 into the conference room. For consistency, the second display might have been identical to the primary displays, however since both spaces used tabletop projectors, we used LCDs as the secondary display to minimize extra heat and noise at the table level.

An additional intervention occurred in the project room at the start of the observation period. Several deficiencies appeared in the space complicating the display intervention. First, a lack of a resident projector created a concern that the second display would end up being used as a single, primary display, and individuals would not borrow the projector as they typically would. To ameliorate this concern, we added a dedicated projector into the space.

Second, attendees used the white board as a projection surface, resulting in excessive glare and significant loss of usable surface area. When probed about this, attendees indicated it was the only surface that did not have other materials on it; the only empty wall space was the glass wall, which was not suitable to project onto. To free up the marker board (and, as an added bonus, make it easier to place in a second display), we cut a piece of foam core and placed it on the glass surface. Participants could use this piece of material as a projection surface (Figure 3).

4. Findings

In total, we observed 15 meetings in the project room pre-intervention with 17 meetings observed post-intervention. In the conference room, we observed 6 meetings pre-intervention and 9 were observed afterwards. To supplement observations, we interviewed 5 Alpha Corp. and 8 Beta Corp. employees both halfway through the observation process and again at the end of the study. We analyzed field notes, pictures, and interviews using inductive coding. We group together findings under emerging themes in this section.

1. Information Sharing Routines.

Shared Displays. In the project room, attendees used the room projector 50% of the time before the second display was used. The type of information shared on the shared display ranged from spreadsheets, internal documents, internal Web pages, to sharing contents of an email with the larger audience.

Two distinct routines occurred with the projector usage in this space: 1) traditional presentation of material or a common-source for collaborative work, and 2) public display of information that individuals were working on. The latter routine generally occurred when two or three individuals were in the space working on individual tasks but required intermittent communication with each other. The individual whose laptop was connected to the shared display would leave the projector running, allowing others to maintain awareness of what the other individual was doing.

After the display intervention, the projector was used in 70% of meeting while the shared secondary LCD display was used 53% of the time. Similar content was shared as prior to the display intervention. The two display usage routines were enhanced by the presence of the secondary display. When an individual was presenting material, a second individual would often put up

supporting or reference material on the second display rather than just verbally summarize content from their computer or turn their laptop around so others could view. Likewise, when individuals were working on separate tasks, there were several occurrences when two individuals would maintain public broadcasts of their work to others in the room, thus adapting technology usage to an existing routine. The video switch was not used aside from making the initial connection to the shared display.

While project room large display usage went up, the conference room projector usage went down from being used 67% of the time before the display intervention and 44% afterwards. Attendees used the shared second display only twice, one of which it was used as the sole display to present material. There were several occasions though, that the secondary display was turned on out of curiosity but was never connected to a source. By-and-large, existing routines did not change or incorporate the new display. The existing display, however, was typically used for traditional presentations as well as for collaboration on documents.

Content displayed on the primary projector ranged from spreadsheets, Web pages, and annotated digital images. In two observed meetings conducted by the president of the company, elaborate spreadsheets with integrated charts (referred to as "Dashboards") of product sales were displayed. He often minimized the Dashboard and displayed other related material.

We asked conference room attendees about the relatively low use of the projector and second display. Attendees attributed the lack-of-usage towards a combination of perceived technological glitches (discussed later in this section) and that the VGA cable was physically distant from many of the seat locations. This reiterates a key finding from the iRoom project [12] where researchers concluded users should have control of displays from their seats. Furthermore, physical proximity to controls was also discussed as a problem in [15].

One routine regarding display usage was common across both spaces. Approximately 75% of the time an individual connected to a display in either space, the physical connection between the VGA cable and laptop was made within the first five minutes of entering the space. In other instances, users connected as needed. For example, in the project room space, before the display intervention, individuals were observed to sometimes leave the projector on in the default blue-screen mode while occupants

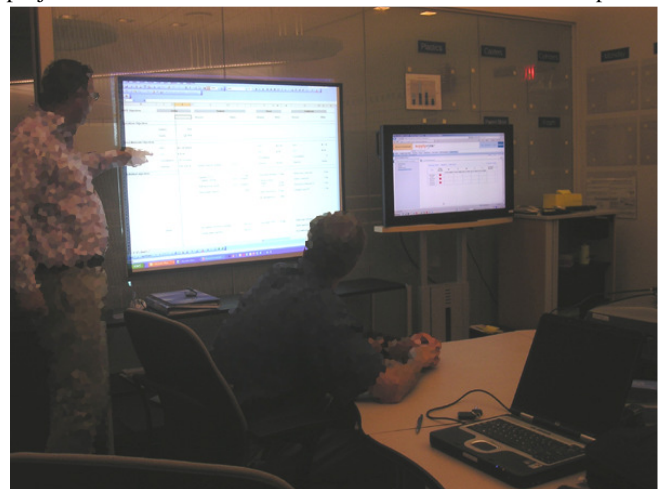


Figure 3. Project room attendees using both displays.

worked individually. When an individual wanted to share content, he or she would reach for the VGA cable at the center of the table and connect their laptop to the display.

Static Displays. As noted earlier, users of Alpha Corp's project room made heavy use of wall space for persistent information displays consisting of charts, posters, and post-it notes. One main goal of this was to provide at-a-glance awareness of issues and project status. One participant remarked the benefit of such displays is that while a meeting is occurring, one can immediately change the status on the board in view of others present. Furthermore, physically updating a chart seemed to offer a visceral experience according to one attendee:

"There's something satisfying about actually going up to the chart and updating it or taking an item down when we complete a part of a project."

However, the introduction of the second shared display influenced this particular routine. One manager remarked how she and her team was experimenting with moving content from the physical walls onto the second shared display to complete a set of tasks, allowing this material to be accessible to other team members who are not in the space:

"I'll call up a set agenda topic on the mains screen and then someone puts up the electronic accountability board on the other one. So when something comes up, someone can type in what person is supposed to do that...[it was] very helpful."

The conference room at Beta Corp. did not have static information on the walls due to its shared nature. However persistent information did appear to be relevant at meetings, but occurred in the form of paper handouts. 67% and 37% of meetings had some form of paper handouts to meeting participants pre- and post-display intervention, respectively. These handouts were typically meeting agendas or reference material.

Whiteboards: In both the conference and project rooms, the whiteboards were used with regular frequency, approximately 34% and 40% respectively. Whiteboards were frequently used for short sketches, scheduling, and brainstorming activities in both spaces. In one meeting in the conference room at Beta Corp., participants placed Post-It notes on the board during a brainstorming activity and used markers to annotate concepts.



Figure 4. A laptop partially closed during a meeting in the conference room at Beta Corp.

We did not observe individuals in the project room attempt to capture the contents of a whiteboard. In the project room, a section of the whiteboard was used to schedule the space. This space was not marked explicitly for preservation, however there was an implicit knowledge amongst the individuals sharing this space to not erase this part of the board. Two meetings within Beta Corp's conference room had explicit attempts to capture whiteboard content. In one meeting, the attendee used the installed capture system. In the second meeting, the organizer could not figure out how to use the whiteboard capture system and simply wrote "Do not erase!" next to the content.

However, the next group of individuals using the space wanted to use the whiteboard to work on tweaking the industrial design of a product. They recognized the handwriting of the "Do not erase!" comment and attempted to contact the "owner" of the content via cell phone. Unable to reach her, they debated about how to preserve the content on the board. Ultimately, one attendee used his cell phone camera to take several pictures of the whiteboard and email the pictures to the owner. When asked why he used his phone versus the built-in system, he explained that he knew exactly how his phone worked and was not quite sure how the capture system in the room worked. He also indicated that attempting to figure out how the system worked and where captured images were placed would have hindered the start of the meeting.

2. Personal Device Routines.

Laptops. As noted earlier in this document, large shared display usage is part of a larger ecology of people, devices, and information. Individuals frequently brought into and used devices in both meeting spaces. Upon arriving, individuals went through the same process of finding an open seat, retrieving and placing devices or papers down on the table. Laptops were often connected to the electrical power system and sometimes connecting to the network via Ethernet cable. This period of connecting devices was inherently social; individuals often made small talk with other individuals in the room talking about current events, vacations, or the stock market.

Project room attendees brought in and used laptops about 88% of the time before the display intervention and 73% afterwards. Laptop usage occurred in intervals within the project room, perhaps attributed to the mobile nature of group members, as well as the overall feel of the project space as a "war room." In fact, the project room often seemed to transform into a shared office. Some meetings consisted of being "alone-together [4]", where managers sat around the table working either individually or in pairs and occasionally would share information with each other. This was viewed as a great asset to individuals, as one articulated:

"I feel like you can get more done in here than in the open area. If you have a Blackberry, you're mobile...you do not have an office or desk. I do wander. But, when we're all in this room together, we can answer things quickly to each other so we can get a lot more accomplished that way rather than waiting for someone to respond to an email."

During these alone-together meetings (Figure 1 shows an example), laptops are almost always open in front of attendees and email was observed as a frequent activity. When more traditional meetings are held in the project room space, laptops generally remained open so attendees could look more closely at documents or Websites.

In Beta Corp.'s conference room, laptop usage was high; 55% of all meeting attendees used a laptop at least once during a meeting before the display intervention and 51% did so afterwards. Laptop usage, except for an individual presenting information via projector, was largely episodic. Individuals who brought their laptops into meetings often kept their laptops partially closed (Figure 4) for a majority of the meeting, then quickly check and respond to email, and then return the machine to a semi-closed state. During interviews, several people indicated that the half-closing of the laptop gesture is a sign of respect to the speaker, indicating that the attendee was paying attention to the meeting. Keeping the laptop ajar resulted in less time needed to check email since the user would not have to reauthenticate. Still other individuals kept their laptops closed completely, only opening up and check email or a file, and then close the laptop again.

This routine did not appear to change with the addition of the second shared display. Furthermore, individuals were aware of this routine and articulated it in interviews:

"I think a lot of people feel very swamped at meetings like this—and I don't want to take anything away from it—but it [the meeting] might be a little less important than other things on their plate. They think, 'If I bring it in where I can do this and get it done during the meeting—since parts of the meeting won't apply to me.'"

Another conference room attendee remarked that she was extremely busy at the moment and for her to be away from her desk for an hour or two for a meeting was difficult, so she would check her email periodically during the meeting to see if there was a critical issue she could address quickly, essentially being in two places at once.

Cell Phones. Both Alpha Corp. and Beta Corp. provide technical infrastructure for employee cell phone usage. Not only are company phones provided for employees, but also cell signal repeaters are installed within the buildings to provide increased coverage. Several interviewees remarked that mobility was inherent with their positions, and that being able to be reliably reached by team members via cell phone was useful to bridge the physical gap.

Cell phones were almost always brought in both spaces and represented another object competing for users' attention. Approximately half of the meetings had at least one individual make a phone call as well as take a phone call while in the space, while only 13% of Beta Corp. meetings had at least one individual make a phone call while in a meeting. Due to the nature of work in the Alpha Corp. project room, most calls were made to quickly gain information about suppliers, plant issues, or other manufacturing questions and relay that information to other individuals, thereby contributing to the information ecology within the space.

3. Technology Failures and Recovery

We observed hardware and software glitches in both spaces regarding the shared displays. In the project room, one attendee accidentally bumped a power strip, turning off power to both of the large displays. In the conference room, a defective VGA cable resulted in a shimmering image on the projector. Hardware failures such as these were generally resolved quickly and individuals shared a laugh over the mishap.

One notable technology failure involved a Beta Corp. meeting attempting to use the shared display to edit a spreadsheet with their counterparts in a remote-location using commercial collaboration software. A worker arrived early to set up the session and left to get coffee. Upon returning, and other employees arriving, the sharing session had terminated. Employees on both ends tried to restart the client to resolve the issue (the only troubleshooting method they knew). Unable to get the software to work again, they resorted to placing the spreadsheet on a shared network drive. This type of struggle with software was not irregular, according to one participant:

"That happens all the time. We put it [a file] onto the S drive and tell them [the remote party] to go there and take a look at it. We don't know if they are doing it then and there, or going and looking at it later. That's a classic case of technology interfering because it's not working right."

This specific incident was mentioned in four interviews after the study concluded. These individuals felt apprehensive about a software-based display connection solution due to repeated malfunctions and a difficulty in users being able to fix problems in a timely fashion. Furthermore, such common and seemingly unpredictable failures of technology to collaborate with remote parties led these workers to create redundant routines as backups. Also, these glitches continually raise the barrier to use of new software-based solutions in respect to established routines:

"People are very comfortable when they go into the room and they know where to plug in, power on, and push the function key on the laptop and up comes the laptop [to the screen]. A lot of people don't want to have to download software to do something new."

5. Discussion and Implications

The purpose of this research is to examine the routines associated with how communities share information within existing meeting rooms at two companies. In particular, we were interested to see how individuals used the shared display in spaces, along with what devices were routinely brought in and used during meetings, in the context of established or implicit protocols.

However, since so many variables can differ from organization to organization, and meeting space to meeting space, one might argue that it is inappropriate to draw comparisons. We argue that similarities across these two spaces can provide insight for understanding how individuals currently work and collaborate in multi-purpose spaces. We report on several implications for technology researchers interested in routines within meeting environments involving devices and displays.

1. **"Device arming" is a common routine created by both technology limitations and social protocols.** As noted prior, device usage within meetings followed a simple 6-step lifecycle of the device 1) arriving into the space, 2) being retrieved, 3) being armed, 4) being used, 5) being put away, and 6) leaving the space (Figure 5).

The majority of users start each meeting with a ritual that we term "arming" which is a process of connecting a power supply, plugging in a network cable and/or mice, and if presenting, also connecting to a display. In addition, many individuals would place paper-based resources such as a notebook or printed handout on the table next to them.

The physical tethering of electronic devices is a result of both limitations of technology in real-world applications as well as social routines. Laptop batteries may simply not provide enough power for a meeting and wireless signals may often drop out or provide slower data speeds than a wired connection. In addition, arming is part of the process of individuals nesting and defining personal spaces at a shared table as well as interact with others. This does not appear to be disruptive, since individuals often take advantage of the relatively low cognitive load of the physical act of plugging in cables to converse with other participants, allowing for a transition into the meeting domain. It is important to note that meetings are more than the dissemination of information; there is an intermix of power relations and social relationships and this was reflected in the observations and interviews. This provides evidence supporting Miner’s call for meeting technologies to not only support meeting tasks, but also to support social aspects of the meeting process [14].

An implication for new meeting technology is to examine the point at which designers integrate the connection to displays in meeting environments, shown by the arrows in Figure 5. In our fieldwork, a vast majority of participants who used the shared displays connected their devices during the arming phase of the personal device usage lifecycle—a mundane and routine act that is visible to other attendees and facilitated the social component of the meeting process. Other studies, such as Newman *et al.*, offered a software infrastructure to support connecting to a VGA projector, but seemed to do so at the “use” level where a device is already powered up and running. Thus, connections are occurring in the 4th stage of the device usage lifecycle. It is not clear whether or not this influences the social aspects of the meeting process.

Therefore, we argue that designers should take care to *not* fundamentally change interaction models such that social and technology interaction is *driven* by technology rather than technology *facilitating* interaction. The six-stage lifecycle portrayed in Figure 5 categorizes device/display usage in real environments. We argue that analyzing *when* to make the connections is important in hybridizing existing meeting spaces with technologies that can support it, rather than using a technology to fundamentally alter the mediation. In the previous section, we report instances where individuals did not use or quit using technology because they felt they were fighting against it versus having the technology support their collaborations. Furthermore, we report instances where users opted to use the second display since it enhanced informational routines already in place.

2. Ephemeral personal device usage. Anecdotal evidence suggests multi-tasking is quite common in academia. At the CSCW 2008 conference, for example, a record number of devices (over 305) were actively using the wireless Internet connection during a paper session (505 individuals were in attendance) [1]. Multi-tasking was also common during meetings at our observation sites, but varied considerably between and within each space. Both the project room and conference room attendees frequently brought in laptops and cell phones to meetings. In the project room, for example, individuals sometimes worked on another task in parallel to another meeting activity, thus multi-tasking episodes were often longer in duration. In the conference room, however, most personal device usage was very short-lived aside from the presenting individual’s use of his or her laptop.

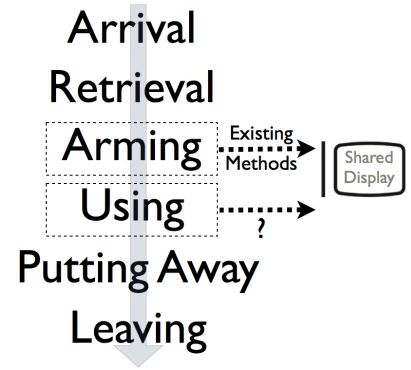


Figure 5. Personal device usage lifecycle.

We hypothesize this ephemeral usage occurred as a result of the social relationship amongst meeting attendees in this space. During interviews, it was often viewed as being disrespectful to be typing away during another person’s meeting or presentation. However, interviewees acknowledge that staying on top of email is a necessary evil because being away from their desks for long periods of time could result in potential costs for the company. Therefore, as a compromise, email checking occurred, but not on a regular basis. Closing or lowering laptops during meetings was a way to signal engagement to other attendees (Figure 4). Furthermore, this type of ephemeral usage also appeared within the project room when more formal meetings were occurring, rather than the “alone-together” types of meetings.

Ephemeral device usage is an important consideration for co-located collaborative technology designers. One cannot assume that every meeting attendee will have their devices open, at the ready, with a data connection for the entire duration of the meeting. When developing software infrastructures, designers need to also account for the possibility that devices may be offline and need to be powered on, software reinitialized, and IP addresses reassigned. These processes may result in additional time needed for a user to get up-and-running and may present a significant barrier for adoption. The users in both populations were wary of using technology that creates a perception of slowing down the meeting process. One such instance occurred when a meeting participant used his cell phone to capture whiteboard contents instead of figuring out how to use the provided capture system.

3. At-a-glance information is important. One of the most important features of the project room was the ability to use wall space to display at-a-glance awareness of projects, issues, and status (Figure 1). Likewise, meetings in the conference room often had paper handouts. This corresponds to Huang’s discussion of the importance of at-a-glance information to groups [10]. Therefore, it is not surprising that the project room groups used the shared display on a frequent basis, since they performed very information-rich work, as well as used the second shared display to show persistent content.

Large displays idle within the project room space represent an opportunity to provide additional at-a-glance information of awareness. For example, performance metrics are captured and reported daily on internal Web pages within Alpha Corp. This information can easily be placed on an idle room display to increase awareness of peripherally relevant information. The

ambient display and peripheral display research community within HCI offers evidence that information can be pushed into environments in non-distracting and visually interesting ways [20]. As a result, meeting spaces should continue to support at-a-glance information, either in digital or analog formats.

4. Physicality comforts and reassures. Physically plugging in one's laptop to a VGA cable allows both physicality to users and a way to visibly communicate to others. Individuals remarked that having a physical connection has a comfort factor; they know when their machine is unplugged they will not accidentally display personal information, avoiding a potential privacy pitfall.

This notion of physicality agrees with the importance of visibility pointed out in other areas of CSCW and HCI such as networking [5] and air traffic control [10]. Furthermore, this also stresses the importance for technology designers to incorporate visibility of connectivity as they design both hardware and software mechanisms for the sharing of information amongst individuals.

Furthermore, physicality offers benefits for troubleshooting. In this study, individuals attempted to troubleshoot and resolve issues when a physical component failed. However, when software-related problems cropped up, individuals either attempted to solve the problem via restarting the computer, or else created workarounds. As designers create technologies intended for non-computer technical individuals, they should consider incorporating some physicality in their design for troubleshooting purposes. Furthermore, researchers note that often times interactive workspaces must be deployed with a minimum of system administrators [12]. If formal support is minimal, mechanisms such as including physicality must be included to ensure that users can troubleshoot and fix problems, or else they may avoid using the technology for fear of it hindering progress.

However, we note that too much physicality can lead to a sense of complexity. One individual in our study remarked that he felt the video switch was not used in the conference room space simply because the video switch and cables created a false-sense of complexity:

"[The goal is to avoid having] too much technology. You need it done neatly so folks can still feel comfortable and homey and still have good conversations amongst the technology [rather than having conversations about the technology]".

5. Non-technical factors are critical for success. Outside of the technology per se (i.e. "high tech devices"), the physical spaces themselves have important and under-appreciated impacts on meeting work. Some spaces, such as the project room, are owned resources and are treated much differently than shared spaces.

When technology designers research meeting spaces, they traditionally focus on the area of their expertise, such as software infrastructure, interactive displays, and technology services. Lighting, seating, and physical layout of the space also influence how people feel about the space. Obviously, if individuals do not enjoy spending time in a space, he or she is not likely to engage in any activities (such as using a shared display) that may prolong the meeting experience. Individuals may have a choice in spaces, as the employees of Beta Corp did, and interviews indicated having other more comfortable meeting rooms was a reason for the particularly low utilization of the conference room.

None of the individuals observed and interviewed came from a computer science technical background. In fact, one advantage to

studying user populations involved in the design and manufacturer office furniture and equipment is gaining additional insight into meeting space design. Many individuals commented on physical aspects, such as changing the paint color, lighting, or seating. Improvements to technology were infrequently desired, corresponding to similar findings in Newman *et al.* These findings support Streitz *et al.*'s point that technology designers need to not only consider the software and technology aspects of meeting spaces, but the physical aspects themselves [21].

6. Rooms must be versatile. A common criticism of case studies is a lack of generalizability of findings. In our fieldwork, we note many factors influenced the information access habits within meeting rooms, such as corporate culture, power relations, connectivity, and personal preferences. Furthermore, users undertake a variety of tasks within meetings [13]. We also note that it is difficult to generalize findings from one location to another—and even one particular space may see different usage.

This variability and lack of generalizability is in fact a key design implication for technology designers in creating effective meeting spaces. Meeting spaces need to support a wide-range of tasks and we argue they should have similar characteristics to a Swiss Army Knife. Technologies, whether digital or analog, should be simple, adaptable to the task at hand, and provide the tools necessary to support the type of work being accomplished.

Furthermore, spaces should support redundant methods of supporting tasks and routines. We reported on instances where technology failed or hindered collaboration with remote participants and attendees used other using other resources to collaborate, mainly a shared network drive and conference phone. A second example illustrating this concept is capturing white board content. The conference room was equipped with a built-in capture system, but a user opted to use his personal cell phone to take pictures of the contents to preserve them and avoid having to learn how to use the capture system. Yet, in another instance, the built-in capture system was used as the quickest way for that user to preserve content. The same goal was accomplished differently.

Finally, interviews from individuals in the study showed that traditional mediums such as whiteboards and Post-It notes are still quite effective at supporting some tasks that people wish to accomplish. It is not necessary to *replace* existing paradigms that work well if users are not able to see compelling benefits to change their routines.

6. Conclusions

Academic research largely focuses on developing new technologies, infrastructures, or interaction techniques with displays and information. Such work is valuable because there are many everyday interactions that can arguably be improved, such as experience of connecting a laptop to a shared display in a conference room or making it easier to collaborate on a shared document. Rather than focusing on developing new technologies, our research looks at a very different aspect of conference rooms: social and technological routines.

In *Unremarkable Computing*, Tolmie *et al* espouse a need to acknowledge the subtleties of the often complex but unremarkable details of everyday routines [23]. Through our observational studies, we uncovered technological, social, and information sharing routines that intermingle with each other throughout the collaboration process. Some routines were common across both

spaces, such as ritual of arming devices. However, other routines, such as how individuals use their laptops during meetings varied between and amongst each space. These routines are impacted by the goal of the meeting as well as the established social protocols. Furthermore, technology limitations and social routines come together to influence how and when individuals connect their laptops to shared displays. We also provide evidence via our intervention that users will appropriate a new technology, mainly a second shared display, if it supports or enhances existing routines.

The lack of generalizability of findings from case studies is often a criticism of such evaluations. However, by understanding the similarities and differences across users, spaces, and needs, common themes emerge. Considering meeting rooms from a holistic perspective, designers should view meeting spaces as toolboxes that provide users with many different, and sometimes redundant, tools. It should be up to the user to decide which tools are best suited to their existing information sharing routines.

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