inSpace: Co-Designing the Physical and Digital Environment to Support Workplace Collaboration

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Abstract. In this paper, we unpack three themes for the multidisciplinary co-design of a physical and digital meeting space environment in supporting collaboration: that social practices should dictate design, the importance of supporting fluidity, and the need for technological artifacts to have a social voice. We describe a prototype meeting space named *inSpace* that explores how design grounded in these themes can create a user-driven, information-rich environment supporting a variety of meeting types. Our current space includes a table with integrated sensing and ambient feedback, a shared wall display that supports multiple concurrent users, and a collection of storage and infrastructure services for communication, and that also can automatically capture traces of how artifacts are used in the space.

Keywords: Ubiquitous computing, meeting support, interactive furnishings, ambient displays, artifact-based interaction, inSpace.

1 Introduction

Collaboration is an essential component of knowledge work. As a result, substantial research and systems design effort has been focused on supporting various aspects of collaboration in the workplace. This style of research has been embraced particularly strongly within the pervasive computing community. Weiser's seminal vision for ubiquitous computing [29] posited a number of technologies specifically designed to enhance collaboration (as well as the infrastructure to support them): windows providing awareness information from across the continent, seamless and continuous replication of a remote colleague's information and working state on displays in a personal office, and the ability to quickly appropriate large displays to carry out synchronous discussions and manipulate information in groups. One of the foundational assumptions behind pervasive computing is that by making technologies inexpensive, broadly available, and—most importantly—invisible, these technologies will "make individuals more aware of the people on the other ends of their computer links" and "pose no barrier to personal interactions" [29].

Although this vision has guided 15 years of technology design, even in today's most highly computerized settings like workplaces, the promise has not been fully realized. All too often, collaboration is constrained by the design of our collaborative spaces and disrupted by the kinds of information technologies in use. While people are experts at easily exchanging, annotating, and managing information, shifting the topic of conversation, and negotiating social boundaries, the spaces in which people collaborate and the technological substrate intended to support such collaboration are often brittle and difficult to adapt to a variety of social situations.

In most offices, collaboration spaces are geared toward a particular type of social practice—formal presentations in meeting rooms—and technological support is arrayed to support this assumed use, even though these spaces may be used for a wide range of social practices. For example, these spaces are often laid out based on a traditional template: seating around a conference table with a projection surface mounted on a wall at one end and a projector placed on the table or mounted above it. The physical and technical structure of these spaces neither reflects nor responds to the social practices that occur within them, such as free-flowing design meetings, informal get-togethers, and break-out work.

Not only are these spaces typically designed for a single social practice, they are also generally *physically* and *technically* inflexible. Creating particular configurations of technology may require fumbling with cables (to connect a laptop to a projector) or manually moving information from one device to another (passing USB drives or copying files to and from network servers). Unlike the ease with which we take notes on paper or distribute paper copies of notes or slides to colleagues, digital note taking and information sharing often requires that users shift their attention and action away from the meeting itself. The technical and physical infrastructure in these spaces is not fluid enough to support the information exchange and ad hoc reconfiguration that are necessary to facilitate easy collaboration.

Finally, the physical and social cues that we rely upon during collaboration—whether a particular person is getting ready to take the floor; whether someone is preparing to leave a meeting; whether a person is a longtime collaborator or a new partner from an outside organization—vanish in the digital realm, where tangible affordances and feedback are often lost. While a network projector may do away with fumbling for cables, the ability to tell at a glance who is projecting is lost; moreover, the social cue of reaching for a cable to signal a desire to present is also lost.

Our research seeks to address these weaknesses through emphasizing the social uses of collaborative spaces as a key point in our designs. In the work that we describe here we follow three broad themes:

- Spaces and technologies should both reflect and respond to social practices;
- Spaces and technologies should support fluidity in collaboration and information exchange; and
- Technologies should have a social voice of their own, allowing them to be understood and acted upon as active participants in collaboration.

In this paper, we unpack these three themes and describe a prototype meeting space named *inSpace* that explores how a synergistic hybrid of physical and technical design grounded in these themes can create a user-driven, information-rich environment supporting a variety of meeting types. Our current space includes a number of technical artifacts that work together to support collaboration, including a table with integrated sensing and ambient feedback, a shared wall display supporting multiple simultaneous users, and a collection of storage and infrastructure services for communication, which can be used to automatically capture traces of how artifacts are used in the space. In the following sections we discuss our design approach in more detail, present the design of the individual technical components of inSpace, and reflect on the role that our themes played in the design of the various artifacts.

2 Design Approach

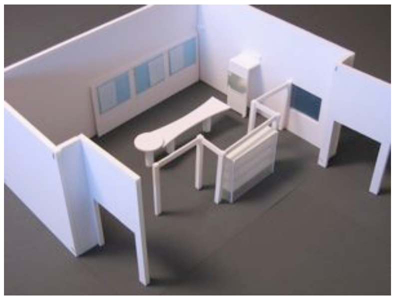
The inSpace project is an interdisciplinary collaboration between [university] and [corporation], bringing together researchers with experience ranging from human-computer interaction, interaction design, software development, industrial design, furniture and interior design, and architecture. A central goal in this research partnership was to understand how guiding principles in the design of the physical world should inform the design of the digital, and more importantly, how these two layers should be co-designed. In this section we expand on the three design mantras that have guided our exploration.

First and foremost, **social practices dictate design**. Although physical design is dominated by choices of form, function, and aesthetics, and digital design is dominated by characteristics of functionality and usability, our perspective is that the social practices of collaboration must be the driving factor for both. Grounding design in social practices is a well-established technique; our research builds on this existing user-centered design paradigm by demonstrating how social practices can provide common ground among members of an interdisciplinary design team.

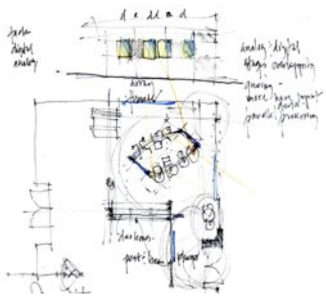
One strategy employed by the industry members of our team was to establish certain social patterns [1] based on ethnographic observation of real-world meetings as the top-level requirements in the design of workplaces; these patterns included "extended face-to-face engagement on a shared topic," "the pre-work of arriving at a meeting," "pulling away for a private exchange," among a number of others. To immerse the rest of the team in these patterns, we co-designed a new workspace for the team, relying extensively on paper prototyping and crude life-size mockups before arriving at the current design. Figure 1 depicts artifacts resulting from this design process, which we used to reflect upon the social patterns we wished to support. From these, we derived a set of interwoven physical patterns that supported the social patterns. The physical patterns additionally guided our requirements for how information services should reveal themselves in the environment. These patterns stand in significant contrast to traditional meeting room design, which is oriented around a single social activity (presentation) using a single technology (the projector).

Our second design mantra emphasized the need for **fluidity** in both physical and technical dimensions. Because we observed meeting participants moving fluidly

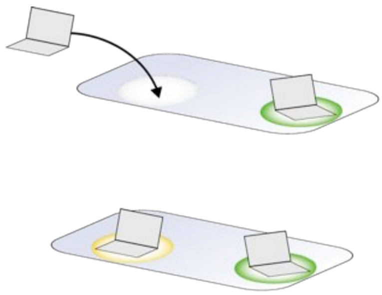
(a)



(b)



(c)



(d)

Fig. 1. inSpace design artifacts, including (a) photographs captured during meeting observations, (b) Foamcore mockups of the meeting room physical design and layout, (c) sketch-based analyses of space usage and spatial collaboration dynamics, and (d) part of an interaction storyboard showing lighting feedback on the table.

among different styles of social interaction within a single meeting, we made it a priority to design an environment that responds to users as they transition from one group of social practices to another. This guided us towards emphasizing physical and digital forms of gesture, control, and social awareness. As we discuss later, one way this mantra was made manifest in the inSpace prototype was through our efforts to interleave the discrete digital artifacts shared by participants into a coherent stream characterizing the flow of the conversation. Our approach reflects an awareness that users should be able to easily appropriate physical and digital aspects of the environment as part of their engagement within the meeting space.

Finally, our third mantra is that **technology must have a social voice** in the collaborative environment. Even invisible, digital services must make themselves accountable and intelligible in a way that allows them to be appropriated by social processes. This voice must be coherent and appropriate for the social context. In current projectors, for example, when the projector connection is embodied as a physical cable, participants may negotiate over it using the same cues they would use for any desirable shared resource. Not only must we ensure that these affordances are not lost when we move to digital services, we must also ensure that they are designed in a socially appropriate manner.

3 Related Work

3.1 "Smart Spaces"

Much of the recent work in "smart space" environments is based on the premise that computational intelligence can detect human context, infer users' behavior and intent, and then proactively support users in their tasks. Some of these systems use audio and video analysis to monitor meeting activities and provide support services that do not require explicit human-computer interaction (e.g., [28]); others use a combination of intelligent agents and semantic web ontologies to provide relevant services and information to meeting participants based on their situational context (e.g., [5]). This approach poses a quandary for interaction design: when it works well, it relieves users of the need to explicitly interact with the system, but may also mean that the abilities and actions of the system are not perceptible to the users within the space; in other words, the system is not available for social negotiation since there is *no* interface. Further, when these systems incorrectly infer users' behavior or intent then users are forced to interact with them directly to resolve problems [3].

An alternative position underlying a second body of smart space research places agency with the human users of the system. However, designers cannot simply place users in a smart space and expect them to be able to get useful work done. Bellotti and Edwards argue that throughout the design process, spaces must embody both *intelligibility* (can users tell what the space can do, and what it is doing) and *accountability* (can users tell what other users are doing in the space, and how his or her actions may affect those other users) [4]. A number of recent ubiquitous computing projects have focused on providing users this kind of intentional control over the technical infrastructure in the room (e.g, [16, 18, 20]). In the work we present here, we focus on approaches that rely on human intentionality rather than context-based inference of intent, further, we aim to make these systems intelligible and accountable in such a way that they become artifacts for social negotiation.

Another notable theme in "smart space" research has been the *co-design* of the physical and the virtual (e.g., [23, 24, 25, 26]). This approach focuses not only on the function of the artifacts and services in a space, but also their form. Different phases of this work have focused on enhancing different aspects of a work environment. For example, ConnecTables [23] provided flexible, dynamic furnishings for fostering productivity and creativity; Hello.Wall [24, 25] provided ambient information to encourage sociability. Our work exists at the intersection of these artifacts and shares many of the perspectives underlying this research; our goals are not to simply bring digital enhancements to physical spaces, but to concurrently design the environment to support these services.

3.2 Tangible and Ambient Displays

Our work builds on prior research on interaction methods designed to better bridge the physical and digital worlds, including tangible user interfaces (TUIs) and ambient displays. Tangible user interfaces [15] seek to embody digital information in physical objects, surfaces and spaces. Central to this approach is the coupling of the control and representation of digital information, in order to bring our digital interactions closer to the way we naturally interact with objects and devices in the physical world.

A holistic view of the tangle of relationships between the physical, social, and information contexts of the user plays a key role. Since early experiments with ambient displays [30], there have been a number of efforts to explore the integration of information with architecture and interior design. Some research has focused on visualization through traditional media displays [17], while others make use of physical media [14]. The context-relevance of information displayed also varies, from stock market quotes on your coffee table [2] to real-time feedback based upon social activity within the physical space [8]. Our intent is to provide systems information relevant to the meeting—in the spirit of Rhodes' Remembrance Agent [21]—using displays that are part of the room itself.

3.3 Meeting Capture

Much work on augmenting meeting spaces has focused on explicit capture of the audio-visual record of the meeting. These systems, including Streams [7], the NIST smart space and meeting room project [22] and media-enriched conference rooms [6] use cameras and microphones to capture the actions of participants in the meeting space; these data are then processed into a structured audio-visual artifact, sometimes associated with meeting notes or slides, which can be used to review the meeting, and can assist those who were not at the meeting in "getting up to speed." While this approach holds promise, it also faces a number of challenges including how to distill the meeting capture so that it can be reviewed in something less (hopefully *much* less) than real-time (e.g., [11]) and how to protect meeting participants' privacy.

These systems also neglect the important digital activity that happens in that room—files that are exchanged, emails that are sent, slides that are displayed. All of these represent important facets of the meeting that are not typically visible to meeting capture systems, and yet may be essential for enabling fluid collaboration [12]. We focus on capturing a record of the *digital artifacts* used in the meeting by leveraging the digital connections and actions in a space to record, and tag for later retrieval, the ephemeral digital artifacts that form the basis of much collaborative work. This approach allows digital artifacts to be fluidly repurposed and shared, without explicit exchange of email addresses, or setting up shared folders, that may distract from collaboration. A number of prior systems have examined the use of automatic tagging of digital artifacts to reflect the context of use of those artifacts, and to support later retrieval (e.g., [9]). Some prior work has even focused on the use of such digital artifacts in collaborative situations (e.g., [10]). However, to our knowledge, no prior work has examined how such techniques can be used in environments with a rich range of digital services, which can potentially greatly increase the value of tagging.

Fig. 2. A plan view of the inSpace environment. The inSpace Table (highlighted in blue) is flanked by two inSpace Wall installations (highlighted in green) in the lower-right corner of the space.

4 inSpace Design

The inSpace lab was iteratively designed and constructed over the course of 18 months in a shared laboratory space at [anon]. The space was created to facilitate small group meetings (6–10 participants) and features areas for meeting participants to congregate before and after meetings; a primary gathering area, where much of inSpace's technology was deployed; and several semi-private areas that might be utilized for small group break-out sessions or as places that individuals could use to step away from an ongoing meeting for a moment (Figure 2).

In this section, we detail the technical features of our space, and how these were motivated by our themes. We begin by describing a cooperating set of services in our space, some of which are embedded in the meeting room or artifacts within it, and others running on personal devices such as laptops. We then describe the software infrastructure that supports these services.

4.1 The inSpace Table

During our field studies of real-world meetings, we observed the important role that the traditional conference table plays as a transition point between the private activities of meeting participants (the "personal workspaces" they create at the table) and their public, shared activities. With our prototype, we sought to embody these transitions as directly and *fluidly* as possible. This suggested that the mobile devices that users bring into the conference room are important *social actors* in the relationship between the physical and information environments [24]. We sought to integrate them into the room using the metaphor of the "table as stage." Devices and objects placed on the table are "on-stage" and engaged in the group activity.

(a) (b)

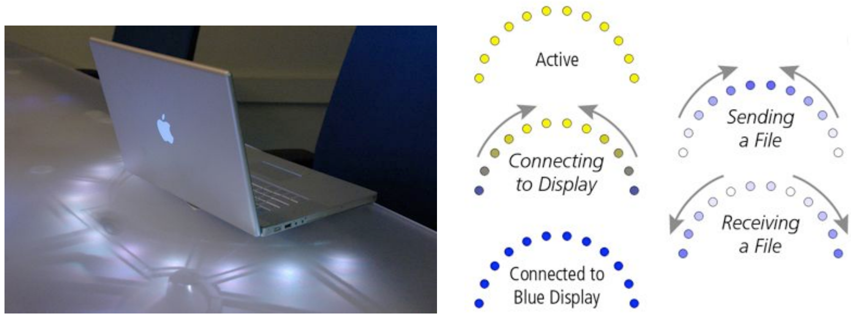
Fig. 3. The inSpace Table, displayed (a) as situated in the meeting room environment, and (b) with the translucent top layer removed to expose the internal structure and configuration.

Meeting participants place devices or objects on the table to bring them into the context of the meeting. A software service running on the client devices is informed of its connection to the table, which allows it to discover other services on the table, and in the room; the table also provides the client device with its physical position on the table. Further, the table provides ambient feedback on activity involving devices on the table via lighting effects visible through the table's surface.

Once "on stage," devices on the table display a GUI with a spatial representation of the room and controls for accessing other services and devices in the meeting. Thus, we divide control and feedback between the public/physical and personal/digital realms: control is kept personal (on the device itself), yet feedback is detectable and *socially actionable* by others in the room (through lighting in the table).

Table Construction. The table, shown in Figure 3, uses high-frequency RFID sensing to detect objects and devices placed on the table. RFID was selected over alternatives such as cameras or IR sensing because of its flexibility, extensibility, and the ease of introducing new devices into the system. The table uses TI-S4100 multi-function reader modules coupled with hand-built antennae mounted on acrylic forms. Personal devices are tagged with small stickers that transmit the device's unique identifier to the sensing system. A one-time registration process maps between tag ID and system name that can then be exchanged for the device's current IP address via the multicast DNS discovery protocol used by our system. In effect, the coupling of multicast DNS with RFID sensing provides us with a physically oriented discovery protocol that yields IP addresses for items on the table (in contrast to simply devices on a given subnet).

Our lighting system consists of 50 Color Kinetics iColor Flex nodes, mounted in semicircular arcs defining each table position. The lighting infrastructure allows each light element to be individually addressed, and controlled for both color and brightness. A computer embedded in the table controls the lighting and sensors, and runs a service that detects individual tags, looks up tagged devices on the network via the inSpace Message Broker (described below), and pushes location information to the service software running on devices.



(a) **(b)**

Fig. 4. Lighting feedback on the inSpace Table. (a) Feedback indicating that the laptop computer is connected to the meeting room. (b) Selected lighting animations used by the table.

Lighting Feedback. When the user approaches the table, they see a number of positions delineated by semicircles of dim light. Placing a tagged device on the table within the semicircle triggers the table to connect to the device and provide it with information on its surroundings. Once the device responds to the handshake initiated by placing it on the table, the lights in the table brighten to indicate it is "connected" to the room (Figure 4a). The lighting at the table position animates and changes color in response to interaction with services in the room. Figure 4b illustrates some of these states. Animations are symmetrical along the central axis of each semicircle, and include both state transitions and repeating loops.

This lighting arrangement was dictated by our three design mantras. The semicircular layout of each lighting position delineates the personal workspaces defined by users with devices, creating a physical embodiment of the *social practice* of defining personal work areas on a shared table. The animations bring socially relevant technological facts (such as who is controlling which display) into the physical environment, while giving users the ability to *fluidly* shift between different social patterns with a minimum of disruption (such as changing presenters, or moving from the main discussion around the conference table to a side discussion elsewhere in the room). Our goal with the lights was to make them a "subtle and public" *social voice* [13], such that they would be incorporated into the environment of the room and not interpreted as yet another information device.

4.2 The inSpace Wall

The inSpace Wall is a large LCD display surface that facilitates collaboration over shared artifacts, such as documents, images, videos, and shared windows. The Wall also provides the room a *social voice* about the state of the physical and digital components of the meeting space. When a laptop is placed on the table, a client

Fig. 5. The inSpace Wall, displaying artifacts shared by three meeting participants. The meeting participant represented by the green color is currently uploading a new file to the Wall, indicated by the status bar display at the lower left.

application appears on the laptop, allowing users to select and connect to a Wall for sharing information (such as images, slides, and so forth).

The Wall display presents multiple thumbnails representing the artifacts sent to it by connected devices (Figure 5). Unlike a standard VGA projector, multiple parties can be connected at the same time, and screen real estate is *fluidly* managed to display information from each. Contents are grouped according to owner and tiled throughout the Wall's display space. When a user initiates sending an application or presentation to the Wall, the action is represented in a status bar at the bottom of the screen. This bar indicates that an artifact is in the process of being sent to the wall. Once the transfer is complete, the Wall displays the artifact. When in the default state, all content shared on a Wall is shown with equal weight in small preview form.

One problem with network-based projectors is that it can be difficult to tell *who* is displaying on a given screen at any given time. Thus, as mentioned earlier, each device "on stage" has a unique color associated with it. The unique color is used as a visual cue around the thumbnail shown on the Wall and via lights at the participant's location at the table. The color is transmitted as metadata with the artifact sent to the Wall. By presenting a visual cue through multiple surfaces in the meeting space, we are able to give a *social voice* to the digital artifacts, allowing them to communicate their ownership and origins to the participants in the meeting.

Implementation. The Wall supports two modes of connections. First, it allows "live" connection over the network, emulating a direct, physical connection such as through a VGA cable (albeit with additional context displayed, and the ability for multiple parties to connect at the same time). This facility relies on an embedded VNC server in the client application, as well as a VNC client in the Wall itself [27].

However, because of the delay inherent in sending full-screen updates over the network, we also support a second mode in which content is transferred to the Wall and rendered locally. When sending content directly to the Wall, the client application provides controls to manage the displayed content remotely (such as paging through slides or removing displayed content from the Wall).

In addition to supporting a richer range of functionality for information presentation (supporting live, real-time screen capture albeit slowly, versus transferring content that is then rendered locally at full performance), this approach yields another advantage: when the original digital artifacts are transferred to the Wall, we have the opportunity to implicitly capture, tag, and store these artifacts in a way that preserves contextual information (e.g., who sent the artifact, what preceded the artifact on the Wall, and what additional actions were applied to the artifact while it was visible) without requiring users to change their existing *social practices*.

4.3 The inSpace Message Broker and Artifact Store

Although the table and the Wall are the two most user-visible technological components in inSpace, they are supported by a range of system-level services that provide communication and storage facilities. The most important of these infrastructure components is a message-oriented middleware framework called the inSpace *message broker*; this system implements an asynchronous, topic-based public/subscribe message-passing model. Clients discover the message broker through the combined RFID and multicast DNS mechanism described earlier. Clients can subscribe as recipients of certain types of messages, and may subscribe to receive multiple message types. All communication among devices and services—including events, commands, and content—is exchanged over the message broker.

This arrangement puts the message broker in a privileged place in our architecture. For example, it not only accepts and routes messages between all devices and services, but it can also transform messages in the process. These transformations are used to "tag" messages (and content encapsulated within them) as described shortly.

This loose coupling of artifact publishers and recipients frees clients from needing to know about the types, existence, or number of available recipients, enabling *fluid* reconfiguration of the devices and services in the space. Instead of sending a file to, for example, all Walls manually, a client can just mark it as intended for the "Walls" topic, and send it to the broker. The broker would then take care of sending it to all clients subscribed to that topic.

Messages are composed of headers and a payload. The headers encapsulate all of the metadata about the message and are used by the broker to route the message. For example, a user could send a message containing a PowerPoint presentation. The headers for such a message would include the file type ("ppt"), the time sent, the name of the file ("Status.ppt"), and the target topic(s) (e.g., "Wall", "Presentation"). Clients can subscribe to single topics (e.g., "Presentation") or to any key-value set like "FileType='ppt.'" Wildcards are also permitted, allowing a client to subscribe to all topics, all file types, and so on. Messages are serialized into XML before being passed over the network, allowing a wide variety of platforms to communicate with the broker.

Our requirements led to a unique architecture that differs from others that have previously been used to create augmented physical spaces. One key aspect of our architecture is that it is centralized on a per-room basis: each meeting room hosts a separate message broker service. This aspect is similar to systems such as the Stanford EventHeap [16], but from systems such as Speakeasy [19], which use a decentralized, peer-to-peer architecture. Also, our message broker service is used for both content and control messages; messages may encapsulate not only commands between services, but also the digital artifacts (such as slides and other files) that are exchanged between those services. This aspect is central for our ability to automatically capture and tag the digital artifacts exchanged during collaboration, and is unique when compared to architectures such as the EventHeap, which use a separate out-of-band mechanism for exchanging content. Finally, the publish/subscribe approach used by our message broker inherently supports the ability of multiple subscribers to "listen" to messages transmitted on the bus. Although this facility is present in the EventHeap, it is absent from frameworks such as Speakeasy, which lack the ability to have multiple services respond to a single message.

Artifact Tagging and Storage. Generating useful metadata for captured meetings can be problematic. Other systems that rely on metadata, such as the Stanford iRoom [16] and TeamSpaces [11], rely on users to generate tags or other forms of metadata meant to preserve context. The capabilities of the inSpace message broker enable us to tag artifacts automatically as they are transferred through the system. In essence, as artifacts travel through the broker from one endpoint to another, they can be tagged at any step along the way.

Tags are stored in the message headers as simple, string-encoded key–value pairs, e.g., "owner:john@doe.org." As a result, tags may be read and written by both human users and automated components. The generic and simple nature of our tag format allows inSpace to handle a wide variety of metadata while requiring little overhead to process and organize artifacts. In addition, since the broker can associate control messages with users and specific artifacts, we are able to tag artifacts at a fine level of granularity (indicating, for example, who controlled a particular slide presentation, and when).

The benefits of our tagging system are twofold. First, as mentioned, it obviates the additional overhead of users generating metadata for meeting artifacts. Second, the tags and artifacts combine to create a reflection of the meeting that preserves the social context. The flow of information and focus of participation become available in useful ways that other meeting capture systems fail to provide. For example, even if content that was sent to the wall is displayed for a long period of time, our system provides affordances for recognizing if the meeting was focused on that one artifact or if it was merely ancillary to other artifacts that more accurately capture the content of the meeting.

Our storage mechanism is tightly integrated with the tagging functionality. It preserves artifacts as well as their associated metadata between sessions and allows for easy retrieval via the metadata handles. The storage component runs independently of the broker as a stand-alone client in the distributed network. Storing an artifact is done by sending the data in question with the header "Archive" to the broker. The artifact will then be routed towards the storage component and stored along with its attached (and inferred) metadata. Retrieving items is similarly accomplished by querying the storage mechanism—again via the broker—providing search terms in the form of tags, storage IDs, or a small predicate script that acts as a search filter. Currently, we provide access on artifact granularity only, but future plans include mechanisms for accessing data at a finer granularity, for instance accessing the inner elements of an XML document using *xpath* queries or extracting files from a ZIP-format archive.

5 Discussion and Conclusion

This research project was a design experiment, exploring innovations and barriers in integrating the physical and digital design of a collaborative space. The two teams represented expertise in both physical and digital design. Identifying and then experimenting with social patterns of meeting room collaboration provided important common ground for moving forward with an integrated design. Our concepts of "table as stage" and mixing items together on the Wall were directly inspired by observed social patterns of collaboration that tended to engulf these physical technologies. Both concepts maintain notions of the individual and the group and presented opportunities for exploring how to imbue meeting room technologies and artifacts with social affordances. By focusing on these two areas of interaction and moving forward with the notion of making technology translucent, rather than transparent, we were able to unify the experience with a common visual language. In turn, this shared visual language creates a social and technical platform enabling a variety of collaborative activities.

A constant challenge for the pervasive computing community is providing facilities for the fluid redistribution of computing resources. These efforts have traditionally focused on moving agency from social interactions into the supporting technology. Our team discovered a fruitful middle ground in creating technology that was neither invisible nor anthropomorphically intelligent, but played a role in the social shaping of a space. By giving the technology a social voice and providing it with an active role in the collaboration, the furniture and services in the room become leverage points for enabling fluidity within and between collaborative activities.

While the move to networked, digital services has the potential to provide new capabilities to conference rooms, these capabilities may come with the loss of physical affordances and feedback. inSpace is intended to stimulate thinking about gaps in conference room usability for personal device users, as well as the ways in which those devices might be more fully connected with the physical environment. By augmenting furniture to provide context for otherwise invisible uses of technologies in the room, we have attempted to add some of the physicality back to these interactions without sacrificing the advantages gained by wireless and ubiquitous technologies. We believe that helping meeting participants understand the technological activities of their peers is an important factor in the social context of the meeting space, and look forward to exploring other potential methods as part of the inSpace project.

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