

Asymmetry in Media Spaces

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ABSTRACT

In any collaborative system, there are symmetries and asymmetries present in both the design of the technology and in the ways that technology is appropriated. In typical CSCW research and development, however, there seems to be more focus on supporting and fostering the symmetries than the asymmetries. Throughout more than 20 years of media space research, for example, there has been a recurrent theme—researchers pursuing increased symmetry, whether achieved through technical or social means. The research literature on the use of contemporary awareness systems, in contrast, displays little if any of this emphasis on symmetrical use; indeed, this body of research occasionally highlights the perceived value of asymmetry. In this paper, we unpack the different forms of asymmetry present in both media spaces and contemporary awareness systems. We argue that just as asymmetry has been demonstrated to have value in contemporary awareness systems, so might asymmetry have value in CSCW research system development, as well. To illustrate, we present a media space that emphasizes and embodies multiple forms of asymmetry and does so in response to the unique needs of a particular work context.

Author Keywords

Asymmetry, media space, awareness, reciprocity

ACM Classification Keywords

H5.3. Group and Organization Interfaces—Computer-Supported Cooperative Work

INTRODUCTION

In any collaborative system, there are both symmetries and asymmetries present in the design of the technology and in the ways that technology is appropriated. The telephone, for example, supports audio symmetry—a person on one end of the connection can hear everything at the other end and vice versa, in equivalent fidelity. Yet with traditional telephone technologies, there is an asymmetry of knowledge about who is on the other end of the “line.” While the person who

initiates the call knows whom she is calling, the person being called does not know who is calling him and yet he is still expected to answer the phone. Social convention helps to mitigate this asymmetry of knowledge; the person who initiates the call is expected to immediately identify herself (e.g., “Hi, this is Diane”). Recent technological innovations such as caller ID and customizable ring tones have also attempted to mitigate this asymmetry.

In Wikipedia, as another example, the transparency of work in the authoring process is symmetrical: any one individual editing an article can see the edits that any other individual has made and vice versa. Yet the initial perceived value of that editing work is not always symmetrical; edits from anonymous users are considered to be “inherently suspect so new users are encouraged to register and get user names” [5]. There is additional asymmetry in the distribution of work on Wikipedia, where less than 10% of the authors are responsible for more than 90% of contributions [30].

Both symmetries and asymmetries are clearly present and valuable in collaborative systems. Typical CSCW research, however, tends to focus on supporting and fostering symmetries. Asymmetries are frequently either overlooked in the research literature or considered a design challenge that must be addressed. Research in real-time shared editors, for example, focused on developing platforms for collaborative writing that enabled a synchronous symmetry of use, allowing all users, simultaneously, the ability to both browse and edit documents (e.g., [29]). Stefik et al. coined the acronym WYSIWIS (“What you see is what I see”) to describe the predominant form of symmetry engaged by the research community in this domain, a symmetry of content and media [36]¹. More recently, the design and development of novel, collaborative technologies for domestic contexts has also foregrounded symmetry in design. Plaisant et al.’s shared calendar system, for example, was explicitly designed to foster symmetrical awareness of family schedules across multiple generations of users [31]. Clearly, symmetry can be a desirable thing in system design, supporting more tight-knit collaboration among colleagues in the workplace or increased empowerment for elders in multigenerational interactions.

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¹While some notable research has considered the asymmetries of roles in collaborative authoring (e.g., [22]), this research represents the exception rather than the rule.

In this paper, we argue that the asymmetries of collaborative technology deserve more attention in CSCW research development. More generally, we caution against implicit assumptions that symmetry should always be the end goal of design.

Nowhere, perhaps, is the dialogue about symmetry and asymmetry more explicit than in the media space literature. As such, we ground our discussion of asymmetry in this genre of CSCW technology. We begin, then, by unpacking the many asymmetries present in media space systems (albeit often implicitly) and discussing related design efforts to mitigate these asymmetries and to support more symmetry in system use. By way of contrast, we then unpack the many asymmetries present in the use of contemporary awareness systems. Here, we highlight empirical findings that describe the perceived value of these asymmetries. Finally, we present one example of a media space designed to embody and foreground many different, often overlooked, and sometimes highly valued asymmetries.

ASYMMETRIES OF MEDIA SPACES

Throughout more than 20 years of media space research, there has existed a tension between the asymmetries intrinsic to media spaces and the desire for some degree of symmetry in how these systems are used.

Gaver argues most explicitly that media spaces are an inherently asymmetrical technology: in face-to-face contexts, it is most commonly the case that if one party can see another, then the reverse is also true, but this is not inherently the case in media spaces, which afford...

...one-way viewing and listening to a far greater degree. In the everyday medium, to obtain visual information is usually to make information available; in media spaces, making information available is an independent act from obtaining it [12].

Within media spaces, then, it is possible to unobtrusively “glance” into a colleague’s office via a video link to assess whether it would be a convenient time to talk. But it is also possible to spy on a colleague, watching her video link over time without her being aware that she is being watched.

Mitigating this fundamentally asymmetrical nature of media spaces has been a constant refrain throughout research on media spaces, where designers and users (often designers-cum-users) work to facilitate some degree of symmetry in the use of these systems. Most commonly, this engagement has manifested itself in the negotiation and re-negotiation of audiovisual reciprocity (e.g., “if I can see you, then you can see me” or “I agree to let you ‘glance’ in on me if you agree to let me ‘glance’ in on you”), and in debates over whether this reciprocity ought to be sought through social and/or technical means.

The particular research dialogue about reciprocity in media spaces actually reflects multiple forms of asymmetries—an asymmetry of media and an asymmetry of engagement, for example. Here, we distill and unpack some of the different

forms of asymmetry present in media space systems: asymmetries of media, fidelity, participation, engagement, benefit and place.

Asymmetry of Media

The different kinds of content that individuals may share through media spaces create one kind of asymmetry—an asymmetry of media. The asymmetry of media is the most commonly discussed type of asymmetry in the media space literature. Researchers strove to achieve a symmetrical “reciprocity” in media use, where one individual reflected *in kind* the type of content that another individual shared: audio for audio and video for video. Violations of expectations about media symmetry were considered socially inappropriate. For example, when one media space participant was discovered to have “disconnected his camera in order to see others without being seen, this behavior was noted and censured by others in the community” [8].

Researchers aimed to mitigate the asymmetry of media through both technical and social means. The Cruiser media space, for example, had an explicit and enforced technical “reciprocity rule”—one could not glance into another’s video feed without being seen as well [33]. Technically enforced reciprocity was viewed as supporting social symmetry, grace, and privacy:

These design decisions are based on a philosophy of social symmetry derived from observations of everyday office life. In the real world, it is generally not possible to see without being seen. By preserving this characteristic of the physical world, we incorporate a certain social grace into computer-mediated interactions and provide an element of social privacy by ensuring that one cannot be observed surreptitiously [33].

Further efforts to ensure greater visual symmetry resulted in experiments with video tunnels, in which cameras and displays were configured so as to make it almost impossible to see the distant video feed on screen without being captured by the camera [35].

The asymmetry of media in media spaces is further highlighted by the extent that media has been found to serve as a form of social currency. When media use is not symmetrical, studies have shown that individuals with “lesser forms of presence information” (e.g., static images in lieu of video) were neglected by other participants and felt, themselves, like “2nd class citizens” [32].

Asymmetry of Fidelity

The different amount of detail provided in media spaces creates an asymmetry of fidelity. Asymmetries of fidelity may be caused by inherent asymmetries in the fidelity of different media (e.g. static vs. dynamic images or variances in video quality, frame rate and resolution) or by personal preferences about how that media is (or is not) transmitted to others and displayed.

Media space research explicitly engaged with the asymmetry of fidelity by exploring the effects of blurred video as a safeguard to privacy while still providing awareness information (e.g., [18], [27]). In addition, studies of the use of media spaces report participants ‘adjusting’ video fidelity by manually covering their video cameras, or turning their cameras around for periods of time (e.g., [2], [27]).

Asymmetry of Participation

The varying degrees of participation in communities surrounding the media space also create a form of asymmetry. In the PARC media space, only a subset of researchers owned end nodes, each explicitly asking to join in [2]. The act of “signing up,” as Dourish argued, was an implicit “acceptance of the social practices and norms which govern[ed] acceptable media space use” for that community [9]. Individuals who owned end nodes and were at the center of the media space community were recognized as participants of the media space. Individuals who did not own an end node but were still peripheral or even accidental participants in the media space community were generally not discussed in early media space research².

More recent media space research has provided more concrete evidence that individuals who do not own their own media space nodes can also be participants in the media space, whether that participation is intentional or not. A study of the Notification Collage, for example, reported an instance in which an individual participated in the media space without even knowing that the system existed:

One telecommuter reported seeing the lights come on after hours in the laboratory and watching a cleaning person (unaware that she was being monitored) going about her duties [15].

This account of media space use challenges any naïve assumptions about what it means to participate in a media space, more clearly disentangling varying degrees of participation from the ownership of a node.

Asymmetry of Engagement

The breadth of attention and focus one may have with media spaces also suggests an asymmetry of engagement. Media spaces support a breadth of practices across a continuum of levels of engagement, from peripheral awareness to more focused interactions [2].

The asymmetry of engagement was also engaged explicitly in research through efforts to support socially negotiated, symmetrical use. The RAVE media space, for example, allowed individual users to customize rules for media space interactions based around predefined services (e.g., a short, one-way video connection glance; a temporary, specifically-requested, two-way audiovisual connection

videophone; an open-ended, long-term audio/video connection office-share, etc...) [9]. While the rules enabled agent-based, technical mediation of system asymmetry, the symmetry in the system was negotiated within the social sphere as individuals with media space nodes had to both agree to a particular scope of engagement before it would be supported by the system.

Asymmetry of Benefit

The varying degrees to which participants benefit from media spaces also create a form of asymmetry that is not typically discussed in the media space literature. We know that a collaborative technology “never provides the same benefit to every group member” [16]; media spaces are no different.

One cross-cultural installation of a document-based media space uncovered an asymmetry of benefit, caused at least in part by the inability of the media to “transcend social boundaries” [6]. This asymmetry of benefit drove participants at one of the sites to sever the network connection and re-engineer their own local version of the media space.

Research has also shown that communication patterns vary according to work relationships; more communication, for example, travels down the organizational hierarchy than in the reverse direction [17]. Although many media spaces were used primarily by close work colleagues within a relatively flat organizational hierarchy (e.g., [28]), other media spaces were used across multiple levels of organizational hierarchies (e.g., [9], [15]). One might speculate, then, that there was an asymmetry of benefit of media spaces among individuals at different locations within this hierarchy.

Asymmetry of Place

The varying cultural norms surrounding the use of systems in different contexts also create asymmetry. Early media space research often focused on the use of systems among symmetrical physical places: office-to-office or common area-to-common area. The asymmetry of place was more prominent in research that extended its focus to address the differential use of media spaces between office nodes and shared common areas (e.g., [2]). More recently, the asymmetry of place has been engaged in research that explores the differential use of media space systems both to connect home and office environments [27] as well as to connect cross-cultural office environments [6].

In summary, media spaces are an intrinsically asymmetrical medium and numerous forms of asymmetries exist in both their design and use. Much development work in media space research has focused on mitigating these asymmetries, which often seem to be perceived as design challenges to be overcome. We question the assumption that asymmetries in sociotechnical systems should consistently be mitigated and present a counterargument about the potential value of asymmetries from the domain of contemporary awareness systems.

² There are occasional references in the media space literature to a “guest” being introduced to others over the video/audio channel, but the guests’ experiences of the system were not considered part of the research foci.

ASYMMETRIES OF AWARENESS SYSTEMS

Looking to awareness systems—particularly, commercial systems that have been widely adopted and appropriated for awareness purposes—helps to shed light on the perceived value of asymmetry by users. In this section, we draw from the following classes of technologies:

- **Instant messaging** has been appropriated in numerous ways to provide awareness information. Instant messaging exchanges, themselves, have been appropriated as a way of maintaining a “sense of connection with others within an active communication zone” [24]. Users also monitored instant messaging buddy lists to create a sense of connection. In addition, instant messaging display names and status messages have been appropriated for providing updates of “momentary happenings” such as one’s current mood, location or activity [34].
- **Blogging** is a “means of relating [one’s] life to others by telling [one’s] continuing story in close to ‘real time’” [25]. These continuing stories were often motivated by a desire to update an audience with awareness information such as one’s “activities and whereabouts.” The activity of blogging also resonates with the often spatial- and community-oriented nature of awareness systems; in studies, “bloggers reached out to connect with and insert themselves into the social space of others in their personal social networks.”
- **Microblogging** is a more terse and volatile form of blogging in which the most common posts present awareness information such as an individual’s “daily routine or what people are currently doing” [19]. Similar to that of blogging, the goal of microblogging seems to be to “enhance one’s cyberspace presence, an elusive concept that seems to refer to being ‘out there’ (wherever ‘there’ is) as much as possible” [23].
- **Social Networking Sites** such as Facebook³ and Friendster⁴ allow users to create profiles and links to others’ profiles (presumably within social networks). These user-defined profiles have been found to enable the peripheral awareness of individuals’ offline social networks [20]. Rather than being a static entity, a social networking profile may also be considered a more dynamic mechanism in support of awareness—“a communicative body in conversation” [3].

These technologies, while perhaps not primarily built to serve as awareness systems, have all been widely adopted and appropriated to that end. These systems are, in some cases, particularly valued because of the asymmetries they embody. Bloggers, for example, valued the asymmetry of engagement among themselves and their readers that is afforded by the technology:

The relationship between blogger and reader was markedly asymmetrical. Bloggers wanted readers but they did not necessarily want to hear a lot from those readers.... Many bloggers liked that they could be less responsive with blogging than they could in email, instant messaging, phone, or face to face communication. They seemed to be holding their readers at arm’s length [25].

In the following sections, we distill and unpack multiple forms of asymmetries of awareness systems.

Asymmetry of Media

There are numerous technologies commonly appropriated for maintaining awareness; this breadth of technology highlights the natural asymmetry of media used for purposes of awareness. Individuals likely do not employ all media and technologies in the production of their own awareness information, but many individuals are likely consumers of awareness information via a breadth of media that is produced by others.

Text is, perhaps, the most common medium for providing awareness information in instant messaging, blogging, microblogging, and social network sites. Photographs can be embedded within instant messages (see also [37]), blogs (see also [7]), microblogs, and social networking sites, as well. Broadcast video can be embedded in blogs (e.g., via YouTube⁵), whereas an instant messaging exchange can transition within the application to a video-based interaction (e.g., via Apple’s iChat⁶). Audio-based awareness information, specifically to what digital music an individual is listening, can be broadcast within instant messaging (e.g., Current Track⁷) or via blog widgets (e.g., the Now Playing Plug-In⁸). Locative information can be shared on blogs [25], photoblogs (e.g., via geo-tags), and microblogs (e.g., via Jaiku⁹). Instant messaging applications frequently provide information about whether a particular individual is online or offline as well as more micro-level awareness information about whether an individual is typing within the instant messaging application.

Asymmetries of media are common within social networking sites like Facebook. In Facebook, different users can attach different applications to their online profile; this kind of asymmetry allows users to customize the way in which they present themselves to others and serves to provide an extremely wide variety of awareness information to others in their social networks, ranging from books that they have recently read, to online games they have won or lost, to the donations they have made to nonprofit causes.

Different individuals likely prefer different media as producers and as consumers of awareness information. The

³ <http://www.facebook.com>

⁴ <http://www.friendster.com>

⁵ <http://www.youtube.com>

⁶ <http://www.apple.com/macosx/features/ichat>

⁷ <http://sourceforge.net/projects/currenttrack>

⁸ <http://sourceforge.net/projects/itunesnowplayin>

⁹ <http://jaiku.com>

breadth of media that can be utilized in this regard is surely valuable; yet, the perceived advantages and disadvantages of different media for providing awareness information remains an open research question.

Asymmetry of Fidelity

The fidelity of media when appropriated for awareness purposes is a function both of the detail conveyed by each piece of information as well as the frequency with which that information is produced. Blogs are generally used to provide richer information detail, for example, whereas microblogs are often used to provide more frequent updates to awareness information [23, 25]. Nearly all appropriable media in instant messaging, blogging, microblogging, and social networking sites can be used to provide the degree of detail preferred by the producer, who controls what and how much is communicated. In the case of plug-ins and add-on applications, the asymmetry of fidelity is also based on what and how many add-on applications are downloaded, installed and used.

Readers of blogs can also exert influence over the asymmetry of fidelity. In many systems, readers can first view a headline and the first few lines of a blog post. They can then decide if they want to increase fidelity to see the detailed posting.

The asymmetry of fidelity is cited as being one of the advantages of blogging. Bloggers preferred that they and their readers maintain an asymmetric relationship with respect to the frequency of interaction: “Bloggers...wanted controlled interaction, not the fast-paced give-and-take of face to face or media such as instant messaging” [25].

Asymmetry of Participation

A good deal of symmetry of participation has been explicitly designed into the use of most social networking sites. In Facebook, for example, one must create a profile and have either a mutually agreed-upon “friendship” or belong to the same affiliational network in order for either party to have access to one another’s awareness information. Similarly, the awareness information that is provided via instant messaging requires both parties to have compatible instant messaging clients. However, depending on the particular instant messaging client, asymmetries in buddy list membership can occur: one person may permit another to add her to his buddy list but not return the gesture. Alternately, one may include another in her buddy list but assign the individual to a group whose membership is rarely made visible on the screen.

More asymmetry of participation is present in blogs and microblogs, most of which are publically available with an Internet connection and a web browser. Blog readers do not have to be bloggers, themselves, in order to take advantage of any awareness information conveyed through blog posts. In fact, blog readers do not have to comment on blogs or otherwise make their presence known in order to take advantage of the awareness information conveyed.

Existing research tells us that varying degrees of participation are a common characteristic of many communities and that allowing and legitimizing these varying degrees of participation, from peripheral participation to central, expert participation are important for drawing in new members of a community [11, 21]. The ability to draw in new members to an individual’s social network was, in fact, one of the perceived values of blogging for bloggers:

They yearned to develop an audience beyond their personal social network. The occasional email from a stranger who responded to the blog was often satisfying and motivating [25].

The characteristics of blogs that enable the development of an audience beyond an individuals’ social network are the same characteristics implicated in its asymmetry of participation.

Asymmetry of Engagement

There is a pronounced asymmetry of engagement within most of the technologies being discussed due largely to the publish-subscribe models employed. Producers of content, particularly bloggers, expend more attention and effort to generate awareness information than do consumers in tracking that content. Syndication mechanisms such as RSS serve to increase this asymmetry of engagement, at least somewhat, between producers and consumers.

Instant messaging status information supports more symmetry of engagement, as many clients automatically update availability status based on implicit activity such as keyboard or mouse input throughout the system. Yet, like media spaces, instant messaging is appropriated for a breadth of practices, from peripheral awareness to direct communicative exchanges. Studies of instant messaging use have documented differences between the amount of attention paid to a single instant messaging exchange by co-communicants [38]. The breadth of levels of engagement supported and accepted within instant messaging has been identified by users in multiple studies as being particularly valuable [24, 38]:

Together, ease of screening, delayed responding, and plausible deniability of presence allow recipients much more control over responding than with face to face interaction or the phone.... Instead of conversations taking place at the convenience of the initiator, IM allows genuine social negotiation about whether and when to talk [24].

“I use instant messaging because it feels immediate, but I don’t have to devote my immediate attention to it.... I can feel like I am having a conversation but I don’t have to...drop everything just to have that conversation” (participant quoted in [38]).

Similarly, the asymmetry of engagement has also been found to be highly valued in blogging. Blogs can be attended to (or ignored) when opportune. Bloggers articulated that blogs were valued, in part, because they are “not intrusive. No one is ‘forced to pay attention’” [26].

This observation by bloggers about the asymmetry of engagement is also confirmed by blog readers:

However, while a reader can “get away” with not reading every post without much notice, it is more obvious when there are lapses on the part of the blogger. Though expectations and obligations may not be symmetrical, the activity of blogging nevertheless exerts social pressures on both bloggers and readers [1].

Asymmetry of Benefit

Research on the use of awareness systems does not provide much insight about the different degrees to which different users benefit from these systems. What this research does convey, however, is the striking asymmetry of the nature of benefit—that there is a disparity among users, particularly between producers and consumers of awareness information, about what benefit they receive from using the technologies. We hypothesize that this asymmetry is due, at least in part, to the many different ways these systems are appropriated: as awareness systems, as computer-mediated communication media, as virtual projections of one’s identity, etc... Whereas one user might find value in the awareness information, other users might find value in alternate appropriations of the technology. Bloggers, for example, may produce content that is valued by others as awareness information, but they may produce that content because they value the ability to influence others or to release emotional tension [25].

Asymmetry of Place

Awareness technologies such as instant messaging, blogging, microblogging, and social networking sites do not provide explicit connections among discrete physical places. Instead, they construct an alternate, virtual environment where awareness information is shared and other communicative and collaborative exchanges can take place. As a result, the physical places where these technologies are used can be widely asymmetric—from one’s private office to a crowded bus stop to an anonymous cyber-café.

The increasing mobility and ubiquity of technology has led to an increasingly diverse set of places in which these technologies, particularly microblogging technologies, are being used. This increased diversity of placeful technology use has the potential to lead to an increased asymmetry of place among users. This increased asymmetry may enhance the value of these technologies for maintaining social connections: rather than posting (or receiving) a status update once or twice a day, the mobility and ubiquity of these technologies make it possible to maintain awareness within social groups at a much more continuous pace.

THE ME-DIA SPACE

Although there are numerous asymmetries present in media spaces, the majority of media space research focuses on mitigating asymmetries to support more symmetry in system use. Our review of research on the use of awareness

systems, however, revealed that some of these asymmetries are, in fact, part of the reason why these technologies are so highly valued by their users. Research and development in media space systems might be well served, then, to reconsider the prevalent emphasis on mitigating asymmetries and to engage those asymmetries as valuable points in the larger design space.

As an example, we present one particular media space that, instead of striving for increased symmetry, takes explicit advantage of these asymmetries. To be clear, we do not argue that the media space we present is somehow a “better” media space, as compared to previous instantiations of media spaces. Rather, we present one very specific instance of a media space designed for one very specific work context in which asymmetries constitute a valuable asset in addressing specific social needs.

Our design is motivated in large part by the diversity of personal tolerances for traditional media spaces. Whereas some individuals may be perfectly content to work in long-term, media space-enabled “office shares” with their colleagues (e.g., [10]), we are cognizant that other individuals may be either reluctant participants or may very rightfully refuse to set foot in an office where cameras are present. In this matter, we agree wholeheartedly with Bly, who more than two decades ago recognized that...

With media spaces, one size does not fit all: To build systems that reflect the changing needs of user communities means they must fluidly be able to accommodate open styles of working as well as closed and private ones [2].

We were motivated to address not only the need for improved communication and awareness for the user who advocated for the development and deployment of the system, but also to address the concerns of reluctant users and members of the community who were uncomfortable being continually captured by video links in open or shared spaces.

ME-dia Space Design

Our ‘ME-dia Space,’ in which the emphasis on the word ‘ME’ signals the asymmetry of participation at the heart of the system, is designed for a part-time teleworker. When “Dave” is in the work office, his door is open (see Figure 1). Colleagues see him and drop in to say hello and engage in informal, unplanned meetings. With the ME-dia Space, our goal is to project aspects of Dave’s presence into the workplace on the days when he is working from home. In particular, the ME-dia Space connects Dave from his home office to his work office (unlike traditional media spaces that would connect him directly with the offices of his colleagues). Dave’s colleagues can then exploit the physical features of Dave’s office to communicate with him.

Dave commutes over an hour one-way to work several days a week. Today, as he does during the remainder of the week, Dave is working from home. As he settles in at his home office, Dave clicks a button in a window on his desktop computer. Approximately 100 km away, his



Figure 1. An overview of the office node of the ME-dia space, taken from just outside the teleworker's office. The inset photograph illustrates the motor mechanism used to open and close the office door remotely.

work office door swings open. Diane, one of Dave's colleagues, arrives at work and notices Dave's open door. She pokes her head in to say "Good morning" and sees a slow framerate video of Dave in his office at home. As she waves to him from the doorway, a quiet notification goes off in Dave's home office—he has a visitor. Dave bumps up the frame rate of his video feed and he waves back, beckoning Diane in. Diane walks into Dave's office, takes a seat at Dave's desk and puts on a headset.

"Good morning, Diane...glad I caught you!" Dave and Diane take a moment to sort out a last-minute change to a budget proposal they are working on. Diane volunteers to call a vendor to get one last quote and promises to touch base with Dave later in the day.

A half hour later, Diane, with information on two different options from the vendor, walks by Dave's office. His door is open, but she sees on the video that Dave is bent over a book. Diane decides to wait until a better time to interrupt.

Around noon, Diane joins her colleagues for lunch in the common area outside Dave's office. Dave's door is closed; he must have stepped away to have lunch, as well. Finished with her sandwich and listening to another colleague's story about her daughter's science fair project, Diane notices that Dave's door is opening. Everyone at the table turns to wave; Dave waves back. Diane excuses herself and walks into Dave's office to share the two options the vendor had presented.

Our ME-dia Space is implemented as a two-node media space, providing a dedicated video and audio link between a teleworker's home office and his office in the workplace. There is nothing unusual about this audio/video link; while it is custom coded, it is similar to many other two-way desktop audio/video systems. What is unusual in the media space design is that while video is always on, audio is not; a call (via a simple button press) must be established.

Great care has been taken to position the video display and camera for use both inside and outside of the physical constraints of the work office. The video display is positioned such that the full-screen video image from the home office is clearly visible from the common area outside the teleworker's work office. The camera in the workspace node is also pointed out the office door, providing the teleworker in his home office with a very coarse overview of movement in the workplace office common area. Additionally, the furniture in the work office is arranged so that when someone comes in and sits down, she will be centered in the camera's field of view.

In addition to the audiovisual streams typically exchanged between media space nodes, the ME-dia Space nodes also share a data channel (implemented using a shared, distributed dictionary data structure [4]). Through this data channel, the teleworker can control a variety of configuration options for the workplace node, including the degree of blurring applied to the video channel (after [27]) and the frequency that video frames are exchanged between the nodes when the ME-dia Space is not actively being used for a conversation.

The data channel also provides remote access to a Phidgets InterfaceKit [14] attached to the workplace ME-dia Space node. The InterfaceKit hosts several physical components, including a commercial, accessibility-oriented swing door opener and a Phidgets motion detection sensor. An electrical switch on the door opener can be controlled remotely using the Phidgets protocol, allowing the distant teleworker to command the door to open or close. The motion sensor is suspended directly over the entry area just inside the workplace doorway; the motion value returned by this sensor is sent over the data channel and used to notify the remote teleworker when a colleague enters, moves around in, or leaves the workplace office space. This sensed motion helps to compensate for the lack of everyday audio cues that signal the arrival of visitors when the teleworker is working from home (recall that audio is not always on).

In the ME-dia Space, we combined traditional audiovisual media space channels with motion sensing and door actuation capabilities to provide a variety of awareness horizons for both the teleworker and his colleagues when the ME-dia Space is in use (see Figure 2). At the coarsest level of granularity, the ME-dia Space allows the door to be remotely opened or closed to provide workplace colleagues with an awareness of the teleworker's general availability and to provide the teleworker with a coarse awareness of activity in the common area. This awareness horizon exploits many of the physical affordances and location attributes of the physical office. At an intermediate level of granularity, low-fidelity video of the remote teleworker is displayed to passersby near the workplace office and motion detection information in the vicinity of the workplace office door is conveyed to the teleworker's home office to indicate when someone might be "dropping by" to initiate a conversation. At the highest level of granularity,

workplace colleagues can fully enter the office, sit down, and converse with the teleworker over the high-fidelity audio- and video-links provided by the ME-dia Space.

Asymmetries in the ME-dia Space

While relatively straightforward in concept, the ME-dia Space emphasizes and embodies multiple forms of asymmetry.

Asymmetry of Media

The traditional media space channels employed in the ME-dia Space prototype (e.g., video and audio) exhibit the same degree of symmetry as many of the previously published systems in the media space literature. Both video and audio channels are exchanged reciprocally between both ME-dia Space nodes.

However, the design of the ME-dia Space does introduce additional asymmetry of media in two significant ways. First, the remotely-operated door is a medium controlled by the teleworker that provides awareness information about his in/out status. While others in the office can open and close that door, they rarely do so without permission; traditional social mores hold that the door is owned by the owner of the office. The teleworker, in return, does not have access to the symmetrical in/out status information of his colleagues; his field of view is restricted to what is visible through the doorway. Second, the teleworker has access to sensed data about the presence of individuals in his doorway that is not reciprocated for his colleagues.

The asymmetries of media present in the ME-dia Space are important as they amplify the presence of individuals into the physical space in ways that provide awareness to participants at both end nodes.

Asymmetry of Fidelity

The information detail that is provided via video in the ME-dia Space can be either symmetric or asymmetric. The video from the office camera is always sent unblurred, so that the teleworker can see who is in his office and so that

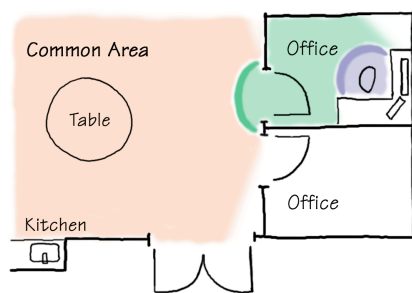


Figure 2. The different awareness horizons supported by the ME-dia Space. At the coarsest level (indicated by orange), colleagues can gauge the teleworker's overall availability based on whether his door is open or closed. At the intermediate level (green), users at both ends of the media space can see low-fidelity representations of activity at the opposite end and motion sensing information captured in the workplace is emphasized at the home office node. At the most detailed level (purple), users at both ends can exchange full-motion video and high-fidelity audio with one another.

he can maintain coarse-level awareness information about activity just outside his office. The reciprocal image from the home office can either be unblurred, exhibiting symmetry, or blurred, exhibiting asymmetry. The teleworker typically only blurs the image projected from the home office in 'do not disturb' situations, such as when he wants to signal that he is there but not as open to visitors or when he wants to safeguard the privacy of another family member who is present in the home office.

In the ME-dia Space, there is also an asymmetry of control over media fidelity. The teleworker maintains all control over the frame rate of the video, which can be toggled between a low-fidelity setting of one frame every three seconds and a high-fidelity setting which operates as fast as individual frames can be captured, encoded, sent over the network, decoded, and displayed (typically, several frames per second). The low frame rate is typically used to save bandwidth when no colleagues are around the work office; the high frame rate is typically used to carry out informal meetings and other focused interactions.

The asymmetry of fidelity in the ME-dia Space is a critical accommodation to the different social needs at the different locations of the end nodes. The variability of video fidelity in the home office reflects previous research findings about the privacy needs of other family members when media spaces are deployed in domestic settings [27].

Asymmetry of Participation

The asymmetry of participation is perhaps the most predominant asymmetry in the ME-dia Space system. Both end nodes of the ME-dia Space are owned and largely controlled by one individual, the teleworker (hence the "ME" in ME-dia). The ME-dia space is an asymmetrical extension of the presence of one teleworker (when working at home) into the physical environment of his office space.

No other participant in the ME-dia Space owns their own node in their own physical space. Rather, they use the physical office and office doorway of the teleworker as a way to mediate their participation in that space. Some participants are more central to the community surrounding the physical office; these individuals work in tight collaboration with the teleworker and use the media space more frequently. Other individuals are much more peripheral to the community surrounding the work office. These individuals know about the media space and can "read" the awareness information (e.g., if Dave's door is open, he is at work in his home office). They may eat lunch at the table in the common area and video of their coarse movements might be projected in to the teleworker's home office, but they may never elect to intentionally use the ME-dia Space for themselves.

The asymmetry of participation was the driving impetus behind the design of the ME-dia Space and was a critical asymmetry leveraged in the system's design to allow members of the community to be more peripheral participants in the ME-dia Space.

Asymmetry of Engagement

Our implementation of the ME-dia Space prototype both requires and enables different degrees of engagement from its different participants. Because the teleworker is responsible for both nodes of the ME-dia Space, he also incurs most of the costs involved with keeping the awareness information provided by the system up-to-date (e.g., making sure that both nodes are running and remotely opening and closing his work office door). The teleworker is also tasked with maintaining control of the framerate of the video feed which, in the context of everyday use, requires either attending to the status of the motion sensor or a low-fidelity video feed.

No additional work is required of other participants to publish their awareness information. If they walk into the teleworker's doorway, this information is communicated implicitly to the teleworker.

The system also supports a breadth of degrees of engagement among participants, providing coarse information about availability that can be completely ignored or attended to as frequently as circumstances warrant.

Asymmetry of Benefit

The ME-dia space system provides the greatest benefit to the teleworker, since using the system allows him increased flexibility in his working location. By using the system, he can project his presence into the workplace office on days when he elects to work from home.

Yet the system also provides benefit to the teleworker's colleagues, as they can choose degrees of participation and engagement with which they are most comfortable. In addition, the virtual presence of the teleworker may have other advantages. Existing research shows a correlation between teleworker prevalence and co-worker dissatisfaction [13]. An increase in face-to-face interaction has been shown to moderate this dissatisfaction. It may be the case that mediated interactions such as those supported by the ME-dia space may reduce dissatisfaction and thus benefit co-workers.

Asymmetry of Place

The asymmetry of place was a significant influence on the design of the ME-dia Space. Distinctions between the use of media spaces in domestic and work environments have been explored in great detail by Neustaedter and Greenberg [27] and the design of our system has been significantly influenced by their findings and design recommendations.

Unique to the ME-dia Space prototype is one additional characteristic motivated by the asymmetry of place: the ME-dia space is only "on" when serving to transport the owner of the spaces from one context (in this case, the home office) to another (the workplace office). This design decision takes advantage of the established social mores surrounding the accessibility and use of the teleworker's work office. Where it might previously have been perceived as intrusive for colleagues to initiate conversations with the

teleworker when he was working from his home office, the asymmetric nature of the ME-dia Space allows the shared social cues of the work office to be applied across the distance spanned by the media space.

CONCLUSION

In this paper we have made the following contributions:

- We have identified six different forms of asymmetry present in media spaces and awareness systems—asymmetries of media, fidelity, participation, engagement, benefit, and place;
- We have identified examples of CSCW research system development directed toward mitigating these asymmetries as well as contrasting examples of empirical findings citing the perceived value of these asymmetries; and
- We have designed and deployed a novel media space installation that foregrounds many of these forms of asymmetry.

Our primary message, however, is quite straightforward: asymmetries can be valuable assets in the design of CSCW systems and as such, they ought to be explored alongside symmetries as part of the active design space of collaborative systems.

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