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Beyond presentation: Shared slideware control as a resource for collocated collaboration

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ABSTRACT

Traditional models of slideware assume one presenter controls attention through slide navigation and pointing while a passive audience views the action. This paradigm limits group interactions, curtailing opportunities for attendees to use slides to participate in a collaborative discourse. However, as slideware permeates contexts beyond simple one-to-many presentations, there are growing efforts to shift the dynamics of collocated interactions. Technologies exist to shift the one-to-many information control paradigm to variations that extend functions to multiple attendees. But there is limited detailed research on how to design such multi-person attentional control and facilitate collocated interactions without disrupting existing work practices. We report on a detailed naturalistic case of using presentation in a design meeting, where participants used Office Social, an experimental slideware technology that enabled open access to shared interaction with slides across multiple devices. We explore how the design of Office Social supported informal collaboration. Our video-based analysis reveals how the orderly structures of conversational turn-taking and bodily conduct were used in conjunction with the affordances of the socio-technical ecosystem to organize collective activity. We suggest that supporting collocated interactions should take account of the existing conversational methods for achieving orderly collaboration rather than superimposing prescriptive technological methods of order.

Keywords: Presentation interactivity; Interaction design; Audience participation; Collocated interaction; Collaboration; Open systems; Design meeting

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1. INTRODUCTION

Slideware (Toong & Gupta, 1984) applications such as PowerPoint, Google Slides, or Keynote are a well-established feature of collaborative knowledge work. Such visual representations can provide a useful resource to accompany the verbal dissemination of information in group settings. In a typical scenario of slideware use, slides are displayed on some form of large display to be controlled from a connected device by the person presenting. Such a set up offers a very particular socio-material arrangement that is optimized for one-to-many forms of discourse (Bumiller, 2010; Tufte, 2003a, 2003b). With control over these visual resources being restricted to the presenter in this way, the presenter is privileged in how they can be used to steer conversation and coordinate action. Limited opportunities for co-present others to act on the slides can reduce the scope for richer forms of collaborative engagement and encourage more passive forms of participation in the discourse (Doumont, 2005; Kernbach, Bresciani, & Eppler, 2015; Parker, 2001). This, of course, may be appropriate for certain scenarios where the primary purpose of the collaborative context is *informative* in nature. But for more *generative* and *evaluative* kinds of collaborative work (e.g., Bostram & Anson, 1992; Bostram, Anson, & Clawson, 1993), where there is a greater emphasis on the creation/structuring of new knowledge and on analysis and decision making, the single presenter model of slideware is limiting to richer forms of collaborative participation and engagement that may be useful.

In this paper, we explore how we can enable opportunities for richer forms of collaborative participation and engagement through design interventions in the material

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ecology of slideware use. The aim of such interventions is to create new opportunities for action on slideware documents that can be deployed by actors to effect these new dynamics of collaboration. More specifically, these interventions consider ways in which interactional control over slideware artifacts can be distributed across multiple surfaces and devices of different form factors and affordances. Of concern here is not simply an extension of interactional control from one actor to many, but rather, with how our interventions create slideware and document ecologies that enable independent and coordinated action to come together in meaningful collaboration. In this paper, we unfold this discussion through a detailed inspection of an episode of co-present collaboration with Office Social (Chattopadhyay, O'Hara, Rintel, & Rädle, 2016), a new prototype slideware system. The system allows slides to be presented on a public display as well as viewed and controlled from the mobile phones of other participants in the meeting. Before moving on to present the system and analysis in more detail, we first discuss some of the conceptual ideas underpinning the work drawn from related research on document-centric collaboration.

1.1. Co-present Collaboration around Documents

Co-present collaboration around documents has been a central concern for the field of CSCW for decades (e.g., Bly, 1988; Bly & Minneman, 1990; Harper & Sellen, 2000; Heath & Luff, 1991; Luff, Heath, & Greatbatch, 1992; Spinelli & O'Hara, 2001; Whittaker, 2003). Interactions with documents are inherent to how collaborative knowledge work is conducted. Research over the years has highlighted ways in which shared document and information spaces play a range of roles in the ways that collaborative talk and information synthesis work come to be organized. Documents are bound up in the ways that ideas are communicated and the ways that ideas can be synthesized, organized, and transformed to make decisions, achieve consensus and assign responsibilities for future actions (e.g., Jay, 1976; Begeman et al., 1986). Documents also support discussion by organizing turn-taking and conversational control. For example, people can signal intentions to speak and assume floor control through document-centric actions.

In thinking about the position of documents in these collaborative contexts, it is important that we do not just consider them in terms of their representational qualities; as entities that are coherent and self-explicating bits of information in and of themselves visual and textual representations of information. Rather, we need to understand them in terms of the embodied practices of which they are an inherent part (e.g., Dourish, 2001; Heath & Luff, 2000; Goodwin, 1994, 2000; Lynch & Woolgar, 1990; Hartswood, Procter, Rouncefield, & Slack, 2003; Alac, 2008). Goodwin's notion of *professional vision* is useful here in the ways that it considers documents and other representational forms as sites for the collaborative production of meaning. Crucial to our understanding is an articulation of the ways that documents as representational entities are situated in practice and the part they play in the production of meaningful action. Coordinated action, meaning making, and intersubjective understanding are shaped by the embodied actions that happen around these document artifacts—how they are constructed, manipulated, attended to, pointed at, and used by participants as constitutive of practice. These actions are part of the routine ways through which features, interpretations, and uncertainties are made visible and accountable to others (Hartswood et al., 2003). It is the availability of these actions to others

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and the availability of others' actions to ourselves that are fundamental to the ways that collaborative action around documents can be realized. Related arguments can be found in the work of Lynch and Woolgar (1990) who describes the "externalised retina" of the settings in which the documents are impressed and the actions through which interpretations and relationships are rendered mutually visible for analysis and decision making. Lynch's work further highlights the ways that this work may happen simultaneously across multiple sites of visual representation (whether these are multiple images, documents or interactive surfaces) which continually and mutually influence what is being viewed in each. This is especially pertinent in relation to the multi-artifact ecologies we consider later in this paper.

What follows from this is that the dynamics of document-centric collaboration and meaning making are occasioned through the repertoire of embodied actions that is available to enact in relation to the documents. This repertoire of action opportunity is in turn intertwined with socio-material and interactional circumstances of the document ecology. Many past studies have shown that the socio-materiality of documents influence the ways in which document-centric actions can be used as resources in conversation and coordination—how the documents can be viewed together or independently, from where, how they can be moved, navigated, arranged, pointed at, and gestured around (e.g., Harper & Sellen, 2000; Heath & Luff, 2000; Luff & Heath, 1998; Whittaker, 2003). In considering how these action opportunities are manifest in particular socio-material arrangements, we consider a number of key themes within which to think about them.

First, when thinking about the use of slideware presentations in meetings (and document-centric collaborations in general) it is very easy to characterize this as an attentive audience synchronously focused on the large display at the front of the room, displaying the slides that the speaker is talking about. Such a characterization, though, simplifies a much richer picture of coordinated action and downplays the variety of different personal document resources that people bring to these settings, such as phones, tablets, and laptops as well as various paper artifacts (notebooks, printouts, etc.). Critical to our thinking about document-centric actions in slideware use is an acknowledgement that these scenarios are organized around a rich multi-document and device ecology.

Second, there is an important distinction highlighted here between *personal* and *public* document resources in terms of the ways that these are acted upon and deployed in the context of collaboration. The distinctions here relate to the kinds of permissions available to an individual to act on a document representation at any time. These permissions are not inherent to an artifact itself but rather are oriented to in an occasioned manner throughout the meeting. When a document resource is rendered public during collaboration it is made available to all. This can be an important enabler in the production of coordinated action and attention. But the public nature also creates certain constraints on document-centric action. Changing the view or marking up the document is, in essence, something that has to be achieved collaboratively; something that has to be negotiated with other present parties. Typically then, people use some form of conversational device or embodied action to signal and negotiate changing the document view. Personal document resources, by contrast, are not shared and as are not subject to any negotiated forms of interaction. Rather, they can be manipulated without social consequence and dependency (O'Hara, Perry,

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Churchill, Russell, 2003). What is public and private here is not something inherent in the document itself (though may be more or less emphasised in different form factors). Instead, it is a continually enacted boundary (cf. Altman, 1976; Palen & Dourish, 2003) manifest in embodied action on the document.

The relationship between personal and public document resources in these settings points to a further thematic consideration in how we conceive document-centric collaborations around slideware, namely the extent to which collaborative action is *coupled* (e.g., Gutwin & Greenberg, 2002). Collaborative action in these settings can be seen as ranging from very *tightly* coupled action to more *loose* couplings of action depending on the extent of coordination, synchrony, and action dependency. When collaboration during meetings is tightly coupled between particular collaborators, they are synchronously involved in interaction with each other. Their actions and attention are closely interleaved and choreographed around shared information artifacts and particular document views with an ongoing contribution to the talk. With looser coupling, actors may be part of the same meeting and larger collaborative context but at various times engaged in independent or parallel activities as individuals or small subgroups. Loosely coupled activity here does not simply refer to an individual activity, but rather the in-the-moment collaborative relationship between people. For example, if two people are involved in a brief side discussion, their interactions with each other will be tightly coupled together but will be loosely coupled with the rest of the people in the meeting. Collaborative work then can be seen to consist of both tightly and loosely coupled activities as well as the fluid transition from one form to the other. It is further important to recognize that tightly coupled work may inextricably stem from moments of reflective loosely coupled work (and vice versa), for example, where participants reflectively prepare what to say before actively coupling more tightly in talk.

Enabling these loosely coupled activities and supporting the ability to transition to tighter couplings is an important consideration in our thinking about slideware. Fieldwork has shown how this may be achieved through the simultaneous use of multiple representations of the same document (O'Hara et al., 2003; Muller-Tomfelde & O'Hara, 2010), such as paper printouts of slides used in conjunction with the projection of the slides on a large display surface. In one episode, as discussion is happening around the large display, one of the members navigates through his paper printout to read somewhere else on the document (loosely coupled action). Using one's own paper document can be done without negotiation while the shared view of the large display remains undisturbed. Having reflected on the point through his personal reading, the participant orients this same printout to his adjacent colleague. The embodied action of orienting of the paper document towards the colleague is observable and invites him into a sub-discussion around the paper document. A few moments later, when they observe the main thread of the larger group conversation was complete, they remotely control the projected display to draw everyone else's attention to the part of the document raised in their side discussion. Key here is a *trajectory* of interdependent actions from loose to tightly coupled work that are distributed across multiple surfaces and artifacts.

Related to this, several authors have highlighted the importance of shareable interfaces and interaction mechanisms that provide multi-entry point access to the document space,

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i.e., the ability to manipulate and act on documents made available to all. Where control is restricted to a single device or access point, collaboration dynamics are shifted according to who has access to control (e.g., Hornecker, 2008; Rogers, Lim, Hazlewood, & Marshall, 2009; Rogers & Lindley, 2004; Mueller-Tomfelde & O'Hara, 2010). Imagine if you must put your hand up every time you want to talk in a group setting. That would rapidly become burdensome and ultimately affect the fluidity with which group discussion could take place. The same is true for single entry point document interaction mechanisms. Shareable interaction access points to documents are significant for how people can closely choreograph their talk with reference to document artifacts.

Significantly, these interaction access points to be able to act upon a document must be available at hand to be responsive to the ongoing circumstances of the collaboration (e.g., Harper & Sellen, 2000). If too much time or effort is required, then other means progress the conversation (Perry, O'hara, Sellen, Brown, & Harper, 2001; Spinelli, Perry, & O'Hara, 2005; Spinelli & O'Hara, 2001). For example, in Spinelli and O'Hara's (2001) fieldwork of a design review meeting, a line of conversation was raised for which an earlier PowerPoint slide in the presentation would have proved to be a useful conversational resource in support of the immediate discussion. However, the time taken to flip through the slides to find the necessary slide was long enough for an uncomfortable silence to build up at which point someone else resumed the conversation without the use of the slide. Physical adjacency to a document or its controls has been argued to be important in giving access to document-centric actions (O'Hara, 2003). For example, being next to the large display makes it available to point at it and thereby affording action-centric influence over the conversation. Over and above, this getting up to move near the document control can be socially intimidating or require a "big idea" justifying a "take-over" of the stage, like getting up to use a whiteboard or flip chart (e.g., Bostrom, et al., 1993; Nunamaker, Dennis, Valacich, Vogel, & George, 1991). In this regard, *remote control* possibilities in which action input can decoupled from representational output enable alternative ways to access and interact with the document resources in collaboration.

1.2. Distributed Action in Slideware

With these themes in mind, we can start to think about the ways in which we can offer new opportunities to distribute action across slideware artifacts. Indeed, there has been a number of efforts to date in which slideware has been reimagined to offer capabilities for distributed interaction and control. For instance, the Pebbles SlideShow Commander program proposed sharing presenters' slides with the audience via handheld computers, allow attendees to post notes on slides, and take turns in controlling the slideshow (Myers, 2001). Notelook introduced dedicated meeting rooms that allow attendees to use tablets and review a common view of a shared document through video channels and create shared annotations (Chiu, Kapuskar, Reitmeier, & Wilcox, 1999). Classroom Response System (CRS) or clickers, another widely-used multi-user interaction technology is typically used in large sized classes in higher education (Roschelle, 2003). CRS allows students to answer multiple-choice quizzes using a handheld device; the anonymous responses are then visualized on the public display to assist the instructor in reviewing class progress and informing class discussion. In a similar vein, Mischief allows multiple students to interact with a shared document during a PowerPoint presentation using multiple mice connected

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to a single machine (Moraveji, Kim, Ge, Pawar, Mulcahy, & Inkpen, 2008). Here, while interaction control opportunities are distributed across multiple input devices, collaborators share a single common view of the document. In O'Hara and colleagues' work (O'Hara et al., 2003; Mueller-Tomfelde & O'Hara, 2010), they present a system called MeetingWizard, in which multiple tablets distributed around the meeting table are used to share navigation, gesture, and annotation control over a shared slide deck presented on a public display. While this system was still limited to a common view of the slides, they highlighted how tablets and public displays were combined with personal paper printouts of the slides to achieve particular collaboration dynamics.

More recently, second-screen technologies have been introduced that involve the use of a personal mobile device to enhance the user experience of consuming content from another shared screen (Cruickshank et al., 2007). For example, FXP Touch (Freeman, 2017) or ConnexMe (Evenium, 2017) mirror a shared document from the public display to attendees' personal devices in real time. Again, while this affords a level of personal control over the positioning of the device, there is still the limitation of synchronized viewing which limits the potential for independent review and other forms of more loosely coupled collaboration around the document. Attendees cannot navigate the shared document on their personal device to review the previous or next slide. If the presenter designated certain interactions with the currently viewed slide, such as questions, qualitative feedback, or polls, attendees might respond to them. Other second-screen technologies, such as MeetingPulse (2017) and Microsoft's Bing Pulse (2017) gather audience engagement metrics through polls, "pulses", questions, reactions, or comments. A related set of technologies in the market called solutions for smarter meetings, such as the Cisco Spark and Intel Unite, enable multi-person interaction around presentations using proprietary combinations of hardware and software.

PowerPoint (Microsoft, 2017) itself provides some shared attentional control and ownership, although not in as open a model as Office Social. The Office Presentation Service lets a presenter upload a deck and then send others a link to a web view of the presentation. Attendees can be granted access to a copy of the deck for independent review, but only a presenter can control live slide navigation. In Skype for Business, a presenter can upload a PowerPoint deck to the meeting which others download. Presenters can allow simultaneous multi-person pointing and annotation, but not navigational control. Attendees can individually navigate back and forth and synchronize with the presenter using a "Return to Presenter's View" control. If an attendee wants navigational control, they can use a "Take Over as Presenter" control, which sends a request to the current presenter. This remains limited to a one person at a time control model that may be restrictive to the nuances of choreographed talk and action. In addition, these capabilities are currently limited to desktop versions of the software rather than mobile form factors which limits the potential for micromobile document-centric action during collaboration (e.g., Luff and Heath, 1998).

Each of these technologies points to interesting new ways in which the dynamics of slideware can be altered through the distribution of action opportunity. Building on these, we present a prototype slideware tool, Office Social, that combines a number of these capabilities and form factors informed by the thematic concerns presented above. In

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particular, it enables simultaneous multi-person control of a slideware presentation from a mobile phone device. The system enables independent review of the document on a personal mobile device or synchronous control of the public display from the personal device. As well as navigation opportunity, it also supports simple forms of gestural enactment and bookmarking for reference and links from personal to shared views. In studying the design of Office Social in use, we focus on its openness and whether the shared simultaneous navigation and pointing can leverage and even facilitate social interactional systematics during the work activity (Simone & Schimdt, 1993). This aligns with more general capabilities of collaborators to manage their turns at talk in multi-person interactions through embodied actions. Before moving on to the analysis of Office Social in use, we will first describe the system in further detail.

2. OFFICE SOCIAL

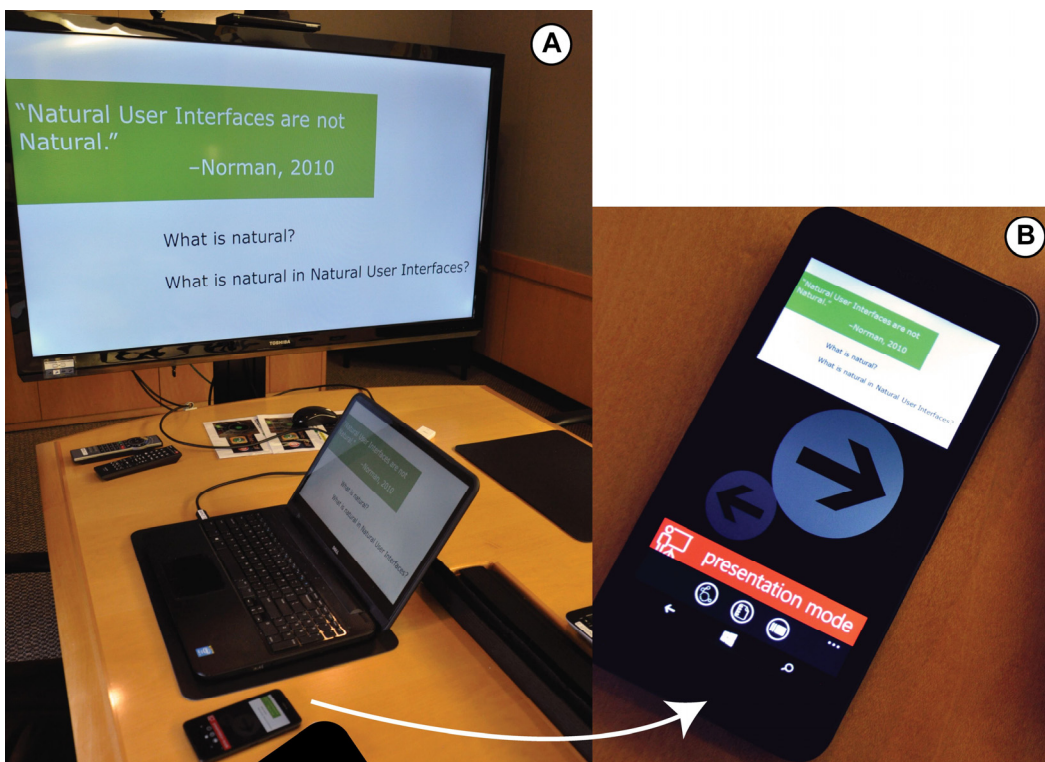


Figure 1. Office Social is designed as a PowerPoint add-in (A) and a companion smartphone app (B). When a slideshow is launched, the slide on the laptop screen is mirrored on the presenter's smartphone and the public display. Henceforth, the presenter can use Office Social as a remote control during the presentation.

Office Social is an experimental slideware system extension to the Microsoft PowerPoint product, consisting of a PowerPoint add-in to the desktop application and a companion stand-alone smartphone app (Figure 1; Chattopadhyay et al., 2016). Its feature set overlaps somewhat with using PowerPoint via Skype for Business, but it runs entirely locally and does not require the Skype for Business infrastructure. The technology design draws on the concept of an open system (Hewitt, 1986), a non-prescriptive system that

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enables articulation work, i.e., supports meeting participants to manage prevailing work practices instead of disrupting them by imposing new workflows (Schmidt & Bannon, 1992; Ellis, Gibbs, & Rein, 1991).

Office Social is based on Microsoft’s Office Remote application, which allows a single smartphone to remote control a PowerPoint slideshow on a PC using a Bluetooth connection (Office Remote, 2013). The basic native functionalities of Office Remote are all preserved on the smartphone app: slides can be linearly navigated by tapping back and forth or nonlinearly using a list view of slides, presenter notes can be viewed or not, slides are numbered and elapsed time is shown. However, Office Social also runs a server on the presenter’s PC that allows multiple smartphones to connect via Wi-Fi, with a choice of two roles, presenter and attendee. Unlike Office Remote, Office Social supports multiple co-presenters and multiple attendees. Office Social generates a unique session code per launch that all users need to input into the smartphone app. Once the session is found, users may then choose a presenter or attendee role.

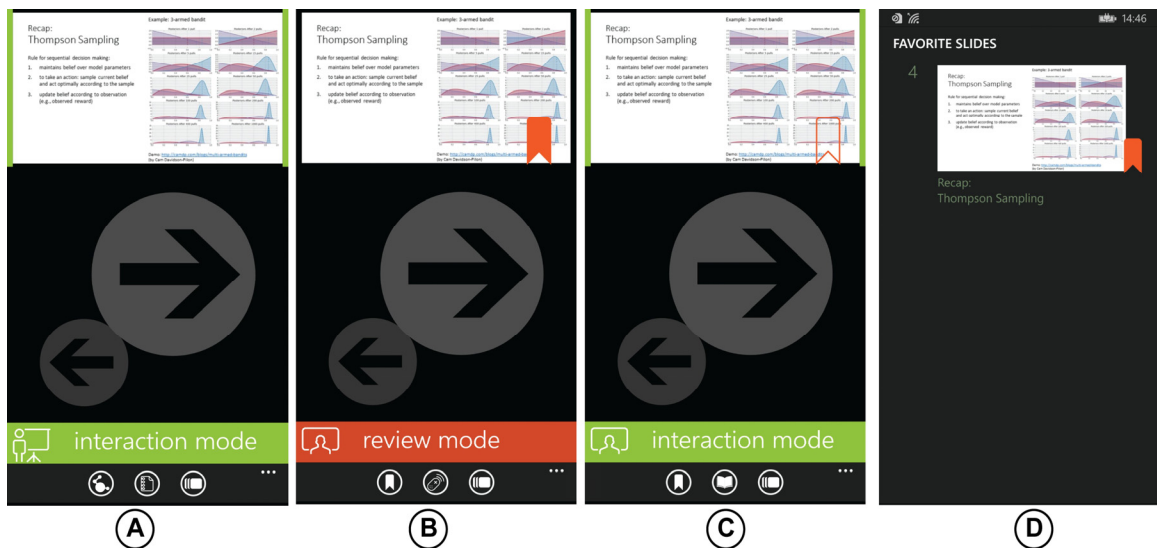


Figure 2. Different states available in the smartphone app, a presenter in Interaction Mode (A) with either attendee in Review Mode (B) or Interaction Mode (C). A list of bookmarked slides (D).

Presenters need to enter an additional four-digit PIN displayed only on the presenter’s PC. Presenters initially join in Presentation Mode, which allows remote control slide navigation forward and backward through the deck, an on-screen pointer (generated when a touch point is detected on a slide in the phone and is tracked until the finger contact is lost), and the ability to turn an Interaction Mode on or off—more on which shortly. The need for a PIN to take on the Presenter role allows presenters to control how exclusive or collaborative navigation and pointing will be.

Attendees initially join in Review Mode. Review Mode allows an individual user to either passively follow along—as the presenter forwards to the next slide, the attendee slide also moves forward—or to independently navigate forward and backward using a copy of

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the presentation deck. This independent navigation does not act as a remote control over the publicly viewed presentation. Attendees in this Mode can also bookmark slides and review those in a list, again independently of what the presenter is doing (Figures 2C and 2D). The Review Mode is how Office Social enables a limited version of *sharing document ownership*. While attendees cannot edit or download the actual document file, for the duration of the presentation, attendees do have their own image-based copy of the deck that they can use to review or bookmark slides.

If presenters want a session to be more collaborative, they can turn on Interaction Mode (Figure 2A). Attendees receive a notification that they can stay in Review Mode (Figure 2B) or enter Interaction Mode. Attendees choosing to enter Interaction Mode gain temporary access to navigation and pointing features (Figure 2C). So attendees can review slides independently in either Mode (that the presenter chooses), but control a public display only in Interaction Mode. Once in Interaction Mode, all presenters and attendees may engage with the publicly viewed slide deck. Anyone can navigate forward and backward through the deck for everyone else to see, and anyone may control the single on-screen pointer without requesting explicit control from anyone else by touching the phone screen when no-one else is doing so. The public display does not indicate which group member is currently controlling the slides or the on-screen pointer (e.g., by displaying name tags on screen), thereby emphasizing an ambiguity of information and compelling group members to make sense of the system within the meeting context (Gaver, Beaver, & Benford, 2003). Presenters can turn off Interaction Mode at any time, returning attendees to Review Mode.

In sum, this open model of control departs from rigorously defining presenter and attendee roles. The presenter/attendee distinction is only used to regulate the exclusivity of a presenter to launch Presentation Mode and decide when to switch to Interaction Mode. Once a presentation is in the Interaction Mode, the design strives to facilitate communication and negotiation among group members regarding the use of slides as a resource to participate in a collaborative discourse—but refrains from imposing a pre-determined, formal negotiation protocol to enable collocated interactions (Berg, 1998).

3. DELIBERATING LOGO DESIGNS USING SLIDES

3.1. Setting

Design meetings are a particularly interesting site for exploring the democratization of slideware because design itself is multifaceted and discursive ('design is argument', Rith & Dubberly, 2007: p. 73; Luck, 2009, 2012; McDonnell, 2009). Design meeting participants ask and answer questions, make and respond to assessments, and in conjunction with collocated talk, use gestures (Glock, 2009; Bekker, Olson, & Olson, 1995), paper sketches (Jonson, 2005; van der Lugt, 2005), and models (Hoover & Rinderle, 1991). The material environment of a design meeting is continually produced, renewed, and modified through their mutual elaboration (Matthews & Heinemann, 2012; Oak, 2011). Design meetings require both tight and loosely coupled work, such as discussing a slide with the group (or some group members) or individually reviewing and reflecting

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presented information (Olson & Olson, 2000; Pinelle, Gutwin, & Greenberg, 2003; Tang, Tory, Po, Neumann, & Carpendale, 2006).

While seeming quite nontraditional in terms of slide presentations, the setting in which we study Office Social has many features typical of work collaborations in which there is a public display for overall focus and attendees bring along their personal devices, such as smartphones, tablets, and laptops for various levels of engagement. Instead of a workplace meeting, in this study, the design meeting occurred in a home. This setting is representative of the trend towards ‘anytime, anywhere, any device’ work practices in both enterprise and freelance contexts, in which people increasing work from home, cafés, and other public spaces (Land, 2015).

Sara (female, 26) is one such freelance designer working with her client Zoe (female, 26) to design a logo for Zoe’s startup company, which provides technology consulting and training. Sara works from home regularly, communicating with her clients in Skype meetings and collocated meetings in cafés or at home. During these meetings, Sara usually prepares a PowerPoint presentation and prints a paper copy for each participant to facilitate annotations. If at home, she uses the television screen to display her logo designs, demonstrating how the design would look on a billboard, website, or poster. With Zoe, Sara has had three collocated meetings, one at a café using her laptop as a shared display and two others at the client’s house, using Zoe’s television as a shared display. In those meetings, Sara and Zoe had discussed the design requirements and some design iterations. Our study was undertaken during their fourth and final meeting (henceforth, ‘logo design’ meeting).

In the logo design meeting, three participants are deliberating a range of design alternatives and working together to decide upon a logo. Zoe has invited her friend Mel (female, 30) to the meeting to advise her. The meeting occurred in Zoe’s house and lasted for approximately two hours. We deployed Office Social to all three participants’ phones. Throughout the meeting, the participants remained in an L-shaped formation. Sara sat on a chair near the television with her laptop on a nearby side table, and Zoe and Mel sat side by side on a sofa facing the television and center table, and orthogonal to Sara (Figure 4). During the meeting, there was a range of access points for essentially the same document (presentation slides): paper, laptop, a large television display, and phones. A paper printout of the slide deck lay on the center table; Sara had her laptop connected to Zoe’s large television display, and all three participants ran Office Social on their phones.

The logo design meeting is a multi-device, multi-artifact ecosystem where meeting participants would use slides to engage in generative and evaluative kinds of collaborative work.

3.2. Method

The design meeting interactions were captured using a room camera and GoPro cameras focused on each phone (using chest harnesses). The four video streams were aligned temporally to facilitate qualitative multi-modal analysis focusing particularly on the interactional location and sequential features of talk (Heath & Luff, 1992; Kendon,

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1990; Luff et al., 2013; Mondada, 2006). Transcripts of talk follow a simplified version of the Jefferson system (Jefferson, 2004). The main transcription conventions to be aware of are: colons represent that the prior sound is elongated, arrows represent a sharp rise or fall of the intonation, and numbers in parentheses represent a timed pause.

Our approach is grounded in the phenomenological paradigm of technology studies, exploring how design accommodates context and how to support human-computer interaction without interfering the work activity (Berg, 1998; Harrison, Sengers, & Tatar, 2011). Within the scope of constructivist studies of technology, our approach draws from the *enactment* perspective, framing what users do with technology, not as appropriation of existing structures embedded within technology, but emergent structures shaping the situated use of technology (Knoblauch, 2008; Leonardi & Barley, 2010).

Our analysis emphasizes how the interplay between slide control and turns at talk is organized, managed, and treated by participants as an *in situ* achievement of orderliness (Garfinkel, 1967). The social orderliness that we are interested in is primarily visible in and enacted through *turn-taking* (Sacks, Schegloff, & Jefferson, 1974, pp. 698–699): the methods for identifying, proposing, and allocating actions in talk and moments in turn production that generate speaker exchange. Turn exchanges occur systematically; a current speaker may cede the floor by selecting another person to take the next turn, another person may take the floor by self-selecting to take a next turn, or a current speaker may hold the floor by self-selecting to take the next turn (Edelsky, 1981; Goffman, 1964: pp.135–136; Sacks et al., 1974: p. 696, 705, 707). Turn-taking relies on many mechanisms. For example, a first pair part by one speaker may propose a responsive second pair part by a different speaker. This is known as an *adjacency pair*, the canonical example of which is a Question—Answer sequence. Turn-taking is also accomplished in part due to recipients listening and anticipating *transition-relevance places*: moments when a turn in progress is possibly complete enough for a recipient to either take a turn or be allocated a turn by a speaker (Sacks, 1967: p. 716; Sacks et al., 1974), although people may or may not accept or self-select (p. 703).

While all turn-taking is systematic, as social context increases in formality (often associated with institutionality) turn-taking also increases in prescriptiveness. Institutional contexts, such as healthcare, courtrooms, and classrooms (Atkinson & Drew, 1979; Drew, 1992; Heath, 1981; McHoul, 1978) often involve divisions of labor, allocation of responsibilities, and different types of expertise or norms, all of which are at least partially enacted through prescribed rules around who should speak when (Heritage, 1998: p. 105). Design review meetings are associated with an institutional context of designer and client roles, but it is important to note that despite the formality of context and even technological affordances for control, turn-taking can almost never be completely prescribed because the live production and reciprocity of talk requires people make all kinds of adjustments to ensure continuity. Corrections and repairs are inherently part of the systematics of turn-taking (Schegloff et al., 1977: p. 362). The point to take forward, then, is that turn-taking is systematic and it must be achieved moment-to-moment.

In studying the use of Office Social, turn-taking in controlling the public display also becomes relevant. In traditional slideware technology, a presenter has an exclusive right to

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self-selection, but Office Social in Interaction Mode allows any participant to effectively self-select a turn using the technology as a supporting resource (via control of slide navigation or pointing). This opens up many questions related to turn-taking: How would such turn-taking opportunities in control unfold? Would people self-select at transition-relevance points? How would transition-relevance points for talk be (re)defined to accommodate turn-taking in control? To get at these questions, we present detailed examples of participants' interactional practices, where interaction with information resources is distributed across multiple devices and form factors. Our analytic interest here is how collocated participants interact during a presentation in a design review meeting and what it reveals about the design of Office Social. In particular, we focus on how turn-taking in control (i.e., turn-taking in controlling a document on the public display) interplays with turn-taking in talk.

3.3. Analysis

During the design meeting, participants frequently took turn in controlling attention to the shared document, navigating to particular slides and using the on-screen pointer. Fragments 1-3 reveal how interacting with slides was used publicly to achieve group members' mutual attention by positioning turns at talk to propose decision-making discussion. Fragments 4-5 show how participants used different approaches to attentional control to prepare for their turn in talk during the meeting. Fragment 6 demonstrates how participants engaged in creating an ad-hoc aggregation of devices and artifacts to facilitate tasks. Fragments 7-8 show how attendees use shared access to the on-screen pointer to enrich group discussions by directing the group's attention to relevant parts of a slide, viewed on the public display as they take their turns at talk. Finally, Fragments 9-10 show how shared control did sometimes result in conflicting operations but that participants were able to resolve problems using conversational methods.

In the first example (Fragment 1), we see an implicit negotiation of the need for, and then the enabling of, shared attentional control. Sara has just finished presenting the entire slide deck, showing all the design variants and iterations. As she finishes talking ('and yeah↑ that's it', line 1, Figure 3), Mel inquires Sara about serifs (Figure 3). Sara had been talking about logos, classifying them as ones with serifs and ones without. She is in Presentation Mode. Mel is in Review Mode and does not have access to Interaction Mode as Sara has not yet enabled it (Figure 3A); Mel cannot control attention to the public version of the slides being shown on the television.

Mel latches onto Sara's talk uttering "so when if we go back" (line 2, Figure 3) suggesting her desire to navigate to a previous slide, presumably to comment on them; but she does not explicitly ask Sara to put the presentation in Interaction Mode. Instead, Mel looks down and taps back on her phone (line 4, Figure 3) which changes the slide on her phone, but not on the television, as she is in Review Mode. Mel looks up at the television screen, finds it not mirroring the slide on her phone, and looks at Sara. Sara treats Mel's bodily conduct (attempt to change a slide and her gaze) as an implicit request to put the presentation on Interaction Mode, and says 'oh should I put you on' (line 5, Figure 3). Mel and Sara's talk overlaps (line 5, Figure 3), indicating that Sara had already orientated to Mel's previous talk and bodily action (line 4, Figure 3), thus explicitly verbally displaying

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an interest to grant attentional control by putting the presentation in Interaction Mode. Sara switches to Interaction Mode during the four-second pause (line 6, Figure 3), then looks at Mel and says calmly ‘okay’, announcing the transition of the presentation to Interaction Mode and the end of her turn in talk.



1	S: and yeah↑ that's it=	
2	M: =so [when if we go back like when you	A M in Review Mode
3	Z: [cool	
4	M: [say serifs	M taps back
5	S: [oh should I put you on	
6	(4.0)	S taps Interaction Mode
7	S: okay	
8	M: when you say serifs I'm still kind of hang on oh yea	B M taps Interaction Mode
9	I'm on interaction when you say serifs which	
10	S: oh serifs are like the bits on the end of the letter a:m	
11	so some things in like times new roman or	

Figure 3. Fragment 1: Sara finishes her presentation (A). When Mel refers to a previous slide, Sara switches to Interaction Mode (B). In Figures 3 to 12, S = Sara, M = Mel, and Z = Zoe.

Mel self-selects her turn at this transition relevance place (‘when you say serifs’, line 8, Figure 3) and taps back on her phone. However, she is still in Review Mode and has not switched to Interaction Mode. So when she looks up at the television for the second time, the slide has not changed. Mel then looks down at her phone, while continuing her turn in talk (‘hang on’, line 8, Figure 3), and switches to Interaction Mode; the television now syncs with her phone and she restarts her question for a second time ‘when you say serifs which’ (line 9, Figure 7). Sara does not let Mel finish formulating her question and interjects, displaying her understanding of Mel’s confusion regarding the technical word ‘serifs’ (line 10, Figure 3). Mel begins navigating the document on the public display (tapping back 11 times) and then using the on-screen pointer on a relevant slide as Sara

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keeps on talking. While Mel and Sara continue tightly coupled work using the slide viewed on the television, Zoe starts reviewing slides privately on her phone (Figure 3B). *Parallel work* ensues.

In this fragment, Mel did not explicitly request that Sara, the designated presenter of the meeting, share attentional control. A request to put the presentation in Interaction Mode was made implicitly, through verbal and nonverbal behavior (line 2, Figure 3), and permission to control the public display was also implicitly verbally granted (line 7, Figure 3). The designated presenter of the meeting did not remember to put the presentation in Interaction Mode to enable attendee interaction immediately following the end of her talk. This resulted in failed attempts by an attendee to control the shared display, but was ultimately resolved via talk and bodily conduct. The presenter treated these visible failed attempts as a permission request to share attentional control. Furthermore, a tightly coupled collaboration between Mel and Sara emerged from the loosely coupled work of Mel listening to Sara's presentation.

In the next fragment (Fragment 2, Figure 4), no permission negotiation is enacted for enabling attendee interaction because the presentation is already in Interaction Mode. Using the opportunity to control and review slides, participants branch in and out of loose and tightly coupled interactions.

The presentation is in Interaction Mode, and Zoe is providing her opinion and controlling the slideshow (also in Interaction Mode). Sara and Mel are looking at the television to follow her lead while holding on to their phones. Zoe pauses at a particular version of the logo that she likes and starts deliberating certain modifications (line 1, Figure 4). When she mentions that she would like the logo to be a bit thicker, Sara reaches for her notebook on the center table to note it down, but still holds on to her phone. The phone's one-handed form factor affords easy transitions between notebook entries and Office Social use. Meanwhile, Zoe glances toward her adviser, Mel, to validate her decision (line 3, Figure 4). Mel reciprocates the glance, endorsing Zoe. Zoe then qualifies her directive of increased thickness, saying 'just a bit' and warns about overdoing it ('not like as thick as', line 5, Figure 4), referring to a much thicker logo that Sara had presented before. As Zoe starts tapping next on her phone to navigate to the referred logo (8 slides forward), Mel indicates her agreement by finishing Zoe's talk, 'the really thick one' (line 6, Figure 4). Mel and Zoe start laughing together recounting its apparent absurdity; and by that time, Sara has concluded note-taking. Sara looks up from her notebook to the television in anticipation of the slide with the thick logo and joins the giggling.



1	Z: am but I still I would I still honestly like thi:s but thicker	A	Screen pointer
2	S: okay↓		
3	Z: right↓ no↑		
4	M: yea yea		
5	Z: just a bit thicker not like as thick as	B	Taps next
6	M: hahahaha the really thick one [hahahaha	C	Taps next
7	Z: [haha		
8	S: [haha		
9	one second (2.0) I mean it's cool		Taps next (x 6)

Figure 4. Fragment 2: Sara, the presenter, writes some notes in her notebook following a discussion (A). In parallel, Zoe and Mel discuss the thickness of a logo (B). Zoe, in the Interaction Mode, is controlling the slides on the television. Sara joins back into the discussion as she finishes note-taking (C).

First, by turning on Interaction Mode, Sara had effectively ceded exclusive control of the television as a resource to control the conversational floor without verbally inviting Zoe to take the floor. On the other hand, Interaction Mode allowed Zoe to use the newly granted temporary control of the television as a resource to self-select and take the conversational floor without explicitly verbally requesting control from Sara or explicitly asking to take the conversation floor.

Second, the use of Office Social in this fragment shows how the slide deck is not being simply reviewed by Zoe before she provides her opinion, but how Zoe is actively forming

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an opinion while reviewing and simultaneously seeking the endorsement of her adviser Mel. Thus, Zoe's use of the television was essential in facilitating this tightly coupled work. It is noteworthy that although Mel was also in Interaction Mode on her smartphone, she did not attempt to control the slideshow to bring up 'the really thick' logo (line 6, Figure 4). Mel specifies this logo in her talk but allows Zoe to bring up the slide. We may speculate that if they had been referring to different slides, Mel might have intervened (for a similar example, see Figure 12). What is important here is not that Mel was 'disinterested' in controlling the floor (Cappella, Siegman, & Feldstein, 1985) or deliberately 'evading a conflict' in control. Rather, each person's interest and interactions suggest a participation framework for individuals in the meeting (Irvine, 1996): Zoe, as the *client*, has a primary, perhaps even dominant, status, while Mel, the *adviser*, has a more auxiliary status (Palmer, 1989).

Lastly, we also see a 'hospitality' effect in the dyadic conversation (Conroy & Sundstrom, 1977) between Zoe and Mel, due to a similarity of their opinion (lines 3–6, Figure 4), which may help to resolve territoriality issues. To bring up the 'really thick' logo, Zoe chose a linear navigation; instead of switching to list view of slides on her phone, finding the pertinent slide, and then bringing it up on the television (a loosely coupled action), Zoe opted for tightly coupled work. While navigating linearly to the referred slide on the television, she inserted a turn-holding cue before pausing, 'one second' (line 9, Figure 4). This shows how slide navigation was used as a way to indicate turn completion, particularly, to delay the availability of the floor until the speaker has stopped on a slide.

Fragment 2 illustrated how Sara engaged in note-taking in parallel to Mel and Zoe's continued use of the slides as resources for ongoing talk. As Zoe was controlling the shared display, not a personal copy of the document, Sara was able to join in the conversation after concluding her note-taking. In Fragment 3, Zoe is interacting with her personal copy of slides, available on her phone, and tangentially attending to the ongoing discussion in parallel (Figure 5).

In this fragment, Sara is presenting design alternatives (slide 13), and Mel and Zoe are in Review Mode. Sara looks at Zoe expecting a response to her opinion about the red play button, 'a bit harsh', and moves on to the next slide (line 4, Figure 5). Zoe reciprocates with a terse reply (line 5, Figure 5) and starts privately reviewing the content on her phone. Because Sara has tapped next, the slide that Zoe is interested in reviewing can no longer be seen on the television. If a meeting participant changes the slide on the shared display, Office Social immediately broadcasts this change to all other attendees, keeping the groupware interface synchronized. So to review the previous slide, Zoe taps back (line 6, Figure 5). Meanwhile, Mel and Sara's conversation is emerging around the current content that is on the television.



<p>1 S: so yea the play button the rewind having it small and minimal or 2 big a:m (1.0) adding different colors which can change the vibe 3 to make it more fun I felt personally the red might be: am a bit 4 harsh 5 Z: hm it takes away from the word 6 (2.5) 7 M: oh no that looks like edo 8 S: we:ll exactly but we did wanna I did wanna show you because 9 at the end of last presentation we were sort of sketching [and 10 playing around with ideas 11 M: [ah okay 12 S: so it's like this is how it would look digitized and actually even 13 though we were quite excited with the idea once I (.) vectorized 14 it (.) it does look like edo 15 Z: hm 16 M: I think it's a nice idea but yea it looks [like edo 17 Z: [yea it looks like edo</p>	<p>S taps next A Z taps back Z taps back Z taps back Z taps next B</p>
-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Figure 5. Fragment 3: Zoe reviews slides privately (A) while attending the ongoing discussion between Sara and Mel (B). Zoe's terse remarks indicate her divided attention (lines 5, 15).

Zoe's conduct suggests that she is either forming or ruminating on an opinion. So while Mel and Sara discuss the current slide on the television (slide 14), Zoe continues to review prior slides privately (lines 6 – 12, Figure 5). The meeting thus transforms from a discussion involving Zoe, Sara, and Mel (tightly coupled work) to a discussion between Sara and Mel (tightly coupled work) and Zoe privately reviewing the document (loosely coupled work). Although Zoe is working independently, carrying out loosely coupled work, she is aware of her surroundings and passively following the conversation ('hm', line 5, Figure 5). When Mel tries to involve Zoe in the talk by turning at her occasionally, she does not respond (lines 7–13, Figure 5). However, after Sara ends her talk with a

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definitive comment ‘it does look like edo’, thereby agreeing with Mel, and Mel again turns toward Zoe, Zoe looks up from her phone to the television, and utters ‘hm’ (line 15, Figure 5). Mel treats Zoe’s response as an indication that she is not self-selecting a turn and considers herself as holding the floor. As Mel starts giving her opinion, Zoe self-selects the floor and moves to tightly coupled work. She looks at the television and overlaps Mel’s talk by agreeing with her (line 17, Figure 5), displaying her knowledge of the ongoing conversation, even though she had been reviewing slides independently.

In both Fragments 2 and 3, we observe individuals branching in and out of tightly coupled work, either to accommodate auxiliary activities like notetaking or to engage in a deeper reflection of content crucial to decision making. But while in Fragment 2, shared document control is used to hold the floor in talk, in Fragment 3, limited shared document ownership is used to reflect on content and *prepare for turn-taking in talk*. In Fragment 3, Zoe branches out of the speaker’s flow and reviews slides at her own pace using Office Social in Review Mode (Figure 5). By navigating independently on her phone, Zoe is comparing two logos and forming her opinion without concerning the group. Meanwhile, Sara has moved on to the next logo and having a discussion with Mel using the television as a public resource. This poses a contrast to Fragment 2 (Figure 4), where Zoe had opted to involve the whole group in recounting the really thick logo (line 5–9, Figure 4). Here, instead, Zoe engages in loosely coupled work while Mel and Sara tightly collaborate around the content on the television. Finally, when the group reaches a point requiring Zoe’s input (line 14, Figure 5), Zoe reorients herself to the television and resumes a tighter coupling. She reiterates Mel’s comment, ‘it looks like edo’, as both an affirmation and self-selection of turn-taking. In sum, Fragments 2 and 3 showed how users accommodated their ongoing work by leveraging shared document control and limited shared document ownership, respectively.

These examples reveal that interacting publicly with slides was not just used to achieve group members’ mutual attention, but also to position turns in talk. For example, we saw turn-taking in control as a mechanism to hold the floor in talk (Figure 4) and private review to prepare for an interjection before a transition-relevance place is identified (Figure 5). Prior work has explored how control over artifacts affects conversation participation relative to participants who have no control over the interaction (O’Hara et al., 2012, 2014). Office Social provided people resources for taking the floor—having control over those resources offered special status in conversation. Meeting participants, at least within these fragments, shepherded the presentation collectively, rather than the presenter leading the meeting at all times.

The technology thus facilitated blending of turn-taking in talk with turn-taking in control. Figure 3 showed how Mel’s inquiry about serifs (her ‘turn in talk’) made it relevant for her to control public attention to the slide on the television (her ‘turn in control’). On the other hand, in Figure 4 (line 9), Zoe is navigating the slide on the television silently, using her turn in control to indicate that it is not a transition-relevance place for others to take the floor. Of significance here is not just opening up interaction to meeting participants, but how turn in talk and turn in control become *symbiotic*: the meeting discourse creates opportunities for turn-taking in control and turns in control influences consequent turn-taking in talk. Like the sequencing of talk (Sacks, 1967: p. 525), document

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control—both requests for control and then actual navigation or pointing—is organized through explicit or implicit self- or other- selections, with turns in control evolving around the ongoing conversation and social actions.

Taking turns in talk and control is preceded by preparation. Participants used different approaches to prepare for their turn in talk during the meeting. In the following fragment (Fragment 4, Figure 6), Zoe is preparing for her turn in talk and waiting in anticipation of Mel's turn-completion point.

Mel is talking to the group about a specific logo on slide 13 using the on-screen pointer (line 1, Figure 6) while Zoe prepares for her next turn. Zoe, in Interaction Mode, taps back to look at the previous slide and as a result changes the slide on the television. In spite of that, Mel continues her turn in talk to complete her reasoning ('because'; line 2, Figure 6) but stops interacting with the phone; Sara shifts her glance from the television to her phone. Alerted by these physical movements, Zoe looks up to the television, verbally displays that she realizes her mistake ('oh', line 3, Figure 6), and repairs her mistake by tapping next and returning slide 13 on the television. With the relevant slide on the television, Mel resumes using the on-screen pointer (line 4, Figure 6). Zoe interrupts Mel to indicate her disagreement (line 5, Figure 6) but does not take over Mel's turn in talk. While Mel is talking, Zoe interchanges glances up (to the screen) and down (to the phone) and places her finger on the back button—anticipating a turn completion at the end of Mel's ongoing sentence (line 6, Figure 6). As Mel almost finishes her sentence, emphasizing on 'play', Zoe taps back to slide 12. Zoe waits until Mel finishes her sentence and then self-selects her turn and takes over the floor (line 9, Figure 6).

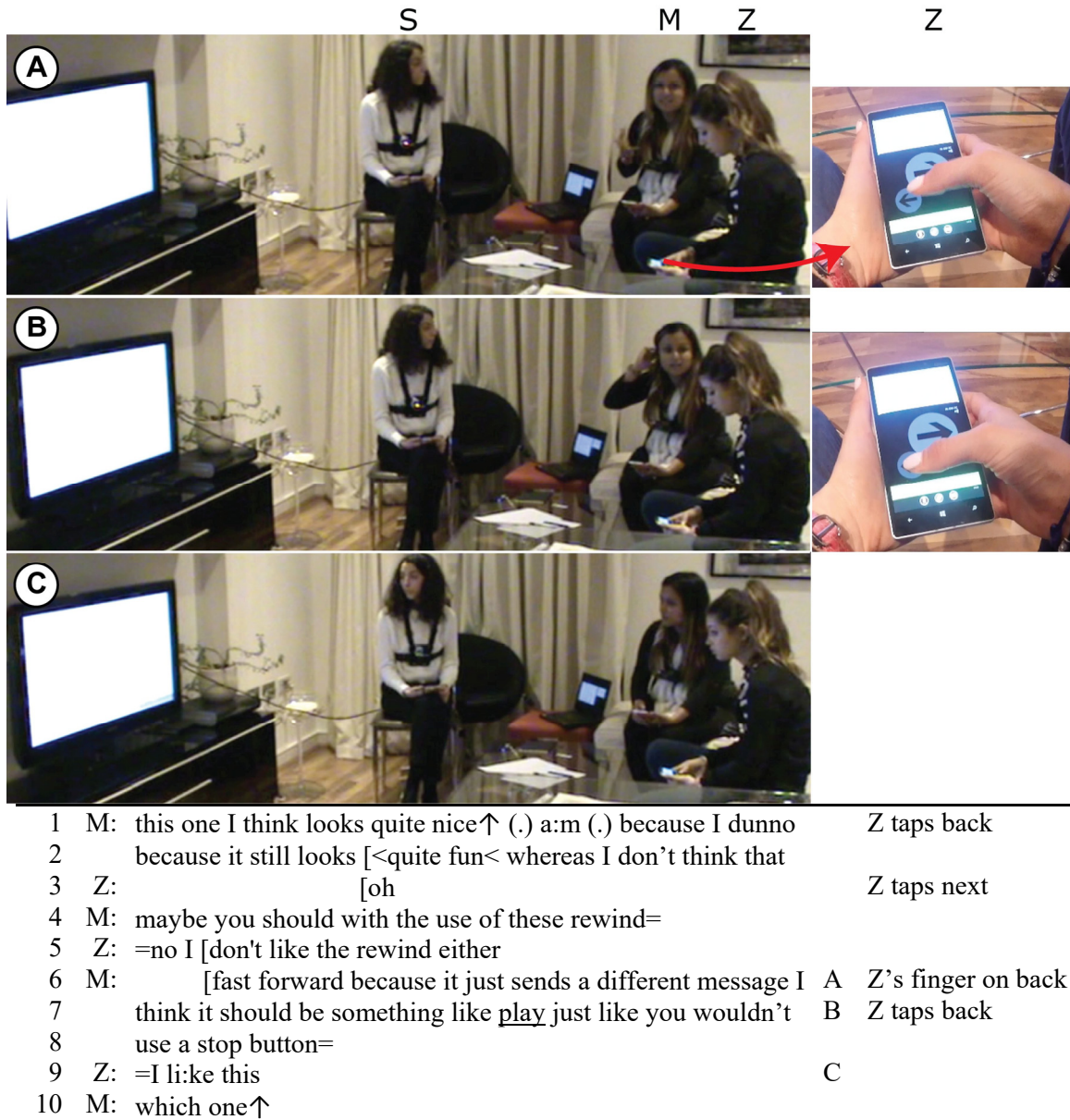


Figure 6. Fragment 4: Zoe is preparing to take control and show a slide while Mel is speaking about another slide (A). Zoe changes the slide on the television in anticipation of Mel's turn-completion (B). After Mel makes her point (line 8), Zoe latches on (line 9) and self-selects her turn in talk (C).

This fragment shows how Zoe is preparing for turn-taking. She is marshaling resources to take control of the television by placing her finger on the back button. She changes the slide on the television while Mel is still talking about a previous slide (Figure 6A). This overt display of preparation in anticipation of turn completion does not trouble Mel, as she continues to complete her turn in talk undisturbed. It is noteworthy that Zoe does not switch to Review Mode after changing content on the television in Interaction Mode and realizing that as a mistake. Switching to Review Mode would have been a cautious move for a user, thus avoiding future mistakes. However, that would imply two extra taps, Mode change,

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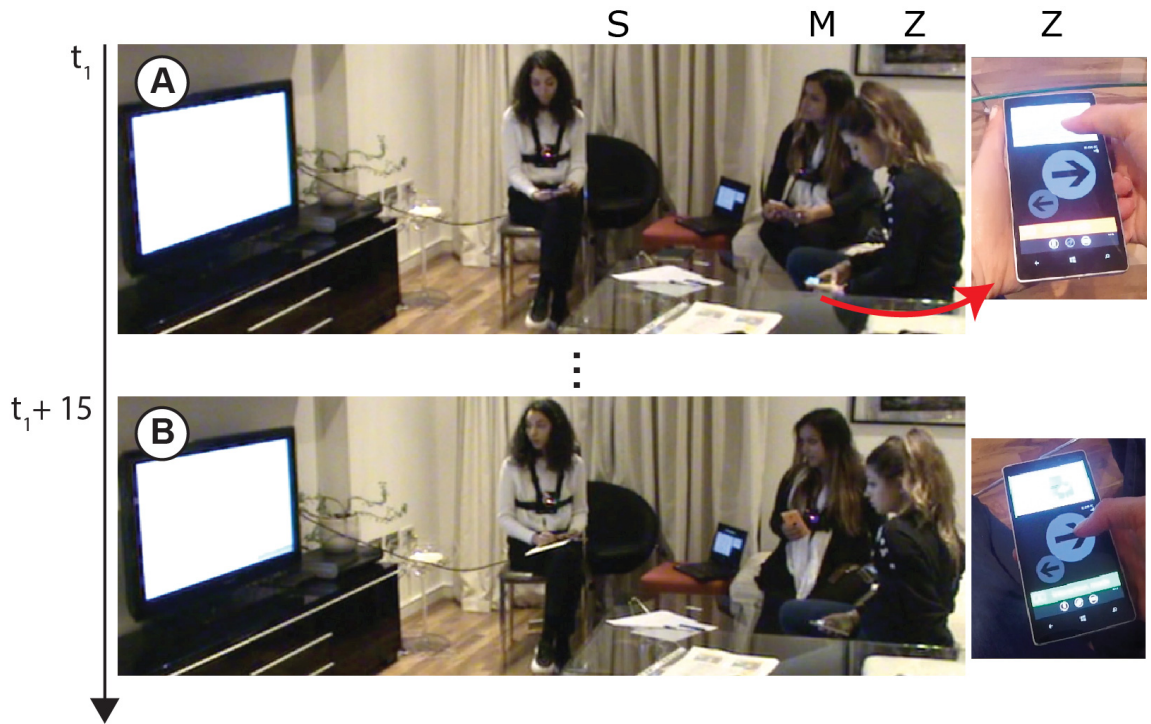
back, and Mode change, compared with remaining in Interaction Mode and waiting for a transition-relevance moment (one tap; back).

Moreover, in this fragment, we see how Sara's non-verbal cue helps Zoe to repair her mistake of changing the slide on the television during Mel's turn in talk. When Zoe changes the slide, Sara looks down at her phone, shifting her attention from a shared resource to a private resource. This is followed by Zoe's "oh" and acknowledgment of the mistake. Furthermore, when Zoe accidentally changes the slide on the television, Mel reacts with a hurried utterance and a sudden stop ('quite fun', line 2, Figure 6), an initiation to self-repair by interpreting Zoe's action as troubling (Lerner, 2004). However, Mel continues to speak, indicating this as an inappropriate time for Zoe to take the floor. This indicates controlling the public display on the television does not solely render a moment transition-relevance place—if the discourse and other social actions do not. Particularly, discourse takes precedence over document control on the public display in forming transition-relevance places.

In Fragment 4, Zoe prepared for her turn in talk by placing her finger on the back button because she needed just the previous slide as a conversational resource. In another instance, bookmarking was used as a resource to prepare for a later discussion. In the first part, illustrated in Figure 7, Sara is presenting. As she switches to next slide, Zoe, in Review Mode, taps back and bookmarks it. Later during the meeting (shown in the second part of Figure 7), Zoe is in Interaction Mode and controlling slides on the television while discussing logo designs. After talking about a specific design (lines 9 and 10, Figure 7), Zoe begins to change slides on the television (Figure 7B). Meanwhile, Sara acknowledges Zoe's opinion, saying 'yea'. And Zoe continues a linear navigation (quickly tapping six times) until she reaches the bookmarked slide, then stops, and indicates a turn-completion point by asking a question.

Unlike Fragment 4's (Figure 6) preparation for an immediate next turn, in Fragment 5 (Figure 7), Zoe is seen preparing for a much later turn in talk by bookmarking a slide. Zoe has anticipated a moment where sharing this slide would be essential to talk. When such a time comes, Zoe holds the floor using slide navigation on the television, similar to Fragment 2 (Figure 4). In that fragment, Zoe verbally displayed her intention to hold the floor ('one second', line 9, Figure 4) along with navigating slides on the television. But in this instance, Zoe simply continues to tap next and control the public display to hold the floor, without any vocal-holding cues preceding her pauses (lines 12 and 13). Thus, document control on the public display is used here as a resource to hold the floor.

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t_1	1	S:	so yea the play button the rewind having it small	
	2		and minimal or big a:m (.) adding different colors	S taps next
	3		which can change the vibe to make it more fun I	
	4		felt personally the red might be a bit harsh=	
	5	Z:	=hm it takes away from the word (2.5)	Z taps back
	6			A Z bookmarks slide
$t_1 + 15$ min	7	S:	yea but it's good to see like options with how it	
	8		[could	
	9	Z:	[this is too beatsy maybe it's the color red and	
	10		blacks: I felt that too to be honest=	B Z taps next
	11	S:	=yea	
	12	Z:	okay no so we don't want this one (.) a:m (1.0)	Z taps next (x 6)
	13		what about this play thing (1.0) this one	Z uses screen pointer

Figure 7. Fragment 5: While Sara was presenting, Zoe was in Review Mode and bookmarked slide 12 (A). During a later discussion (line 6), Zoe is in Interaction Mode and controlling the television. To bring up the bookmarked slide, she quickly navigates from slide 6 to 12 (B).

It is interesting to note here *how* bookmarking was used as a resource. Instead of looking at the phone, opening up the list view of bookmarks, searching for the relevant bookmarked slide, and then selecting it to bring up on the public display, Zoe chose to linearly navigate slides on the television until the bookmarked slide came up. By controlling slides on the public display, Zoe emphasized unavailability of the floor, proposing that no other participant should interject at this moment. Further, during Zoe's linear navigation, she monitored her phone to see if a slide with the bookmark symbol had come up. Her interaction involved tapping the next button six times and exchanging

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glances between the phone and television until the relevant slide was reached. She navigated slides quickly just looking for the bookmarked sign, instead of recalling the relevant slide by examining the content (Figures 2B and 2C shows a bookmarked and not bookmarked slide, respectively). This interaction, compared with opening the bookmarks, scrolling up and down, and finding the relevant slide, involves fewer steps. The bookmark was used here to easily bring up a relevant slide during tightly coupled work. But the list of bookmarks was not used by the participant to shortcut linear navigation, which would include examining the content of all bookmarked slides and choose one (recognition over recall).

In all the fragments described so far, we see each participant using their personal phones to prepare for turns, take turns, or enable turn-taking. Participants also engaged in creating an ad-hoc aggregation of devices and artifacts to facilitate certain tasks during the meeting. For instance, to do a tightly coupled collaborative review (Fragment 6, Figure 8), meeting participants created an ad-hoc aggregation of phones, large display, and paper printouts to facilitate distributed cognition (Hollan, Hutchins, & Kirsh, 2000).

Here, the group is trying to compare logos across different slides and everyone is in Interaction Mode. As Mel mentions she likes the logo Zoe has currently brought up on the television (slide 12, line 3, Figure 8), Zoe asks if Mel likes it more than the two other logos, which happens to be on slides 4 and 5 ('do you, more than', line 1, Figure 8). In preparing to take her turn in talk, Mel needs to conduct a range of tasks to review the slides: control navigation of the shared document, compare and contrast slide content, and finally arrive at a decision. Document review, thus, emerges here as a *hybrid task* (O'Hara, Taylor, Newman, & Sellen, 2002), involving other tasks, such as controlling slides on the television, organizing paper printout of slides, comparing and contrasting slide content across multiple document representations (paper, television, and phone), and decision making. To compare the three slides simultaneously, Zoe proposes using paper handouts on the center table. Note that now the group is preparing together to answer the question that Zoe had previously posed to Mel (line 1, Figure 8) in a collaborative review. To do so, Zoe leans toward the paper handouts (Figure 8B), followed by Sara (Figure 8C) and Mel (Figure 8D) and positions slides 4 and 5 side-by-side on the center table. Then Zoe leans back to have the paper handouts, her phone, and the television within her field of view and begins a comparison. After Sara gives a detailed rationale about aspects to think while making a decision, Mel, instead of making a decision herself, asks Zoe what 'does your gut say'? Zoe takes three seconds to decide and then points to the logo on slide 4. Mel looks at Zoe, displaying an acknowledgment, and then goes on to circle the logo with a pen. While annotating, Mel mentions certain modifications ('darker slightly'), still looking at the paper, but with her body oriented towards Sara, displaying a sense of group work, respecting and maintaining Sara's current role as the designer.



- | | | |
|----|-------------------------------------------------------------------------------|---|
| 1 | Z: do you↑ more than↓ (.) can we put actually one slide next to another↑ | A |
| 2 | M: can you do that↑ | |
| 3 | S: o like reorder the↑m | |
| 4 | Z: not reorder them but as in side by si↑de so we can compare I dunno I guess | B |
| 5 | we can do it on the paper here | |
| 6 | M: oh yea of course we've got the handouts (1.0) | C |
| 7 | Z: just so we put it (1.0) | |
| 8 | M: let's so which one would it be | |
| 9 | Z: just this and this (2.0) | D |
| 10 | M: so they give out completely different messages there (1.0) | |
| 11 | Z: h:m: | |
| 12 | M: [ah I | |
| 13 | S: [we are also thinking timeless like obviously you're a startup so logos do | |
| 14 | develop but you do wanna think would I be happy with this i:n two years' time | |
| 15 | M: wee which one does your gut say↓ do you have an instinct toward which one | |
| 16 | you like (3.0) | |
| 17 | Z: this one= | E |
| 18 | M: =yea I would say the same (.) and darker slightly this one | F |

Figure 8. Fragment 6: The group is vetting different designs; Sara and Mel are looking at their respective phones and Zoe at the display (A). To finally decide between three options, two paper printouts are placed side-by-side and the third slide on the television—a spatial configuration created by ad-hoc aggregation of available devices and artifacts.

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Fragment 6 explored the use of paper in affording a comparison task. The comparison process is known to be cognitively complex, and it helps to minimize the demands on attention, such as visually relocating pertinent pieces of information in each document (Lovelace & Southall, 1983). Such rearrangement requires artifacts with the material affordance of easy spatial manipulation (Richardson, Dillon, McKnight, & Saadat-Samardi, 1988). Paper documents have this important property that allows ad-hoc spatial aggregation and facilitates comparison, particularly because of a reader's ability to lay the documents in a way that they are both concurrently visible. The use of paper simplifies comparing three items side-by-side in this meeting ecosystem. Alternatively, two phones, each in Review Mode showing one set of logos, and the television showing another one, could have been used to see three different slides simultaneously. However, it would not create a public resource suitable for joint attention and discovery—phones are inherently personal resources in this social context. Second, the three slides are not adjacent to each other (slides 4, 5, and 12). Thus, going back-and-forth on the television would not have achieved the comparison task either. In another instance, when comparing two adjacent slides, we find Zoe using the television in Interaction Mode (line 6, Figure 11).

Other than taking turns in controlling slides on the large display, meeting participants frequently referred to assets on the shared display in the course of their activities—using the on-screen pointer. Laser pointers (Meyers, 1991) continue to be a popular way to interact with slide content in presentations, particularly for pointing to areas of interest and consequently directing group members' attention. Attempts to use the laser pointer as a proxy input device and controlling a PC's cursor have been largely unsuccessful, due to limitations of the laser pointer as a device (Kirstein & Muller, 1998; Olsen Jr & Nielsen, 2001). Thus, other hybrid interaction techniques have been proposed which qualify the use of laser pointer to only indicate an area of interest (e.g., “semantic snarfing”, Myers, Peck, Nichols, Kong, & Miller, 2001). Other caveats of traditional pointers in indicating areas of interest on public displays are also noteworthy. First, the use of a mouse and an enlarged cursor take away the flexibility of a speaker to move away from the presentation computer. But their benefits include better visibility for the audience and the speaker's ability to face the audience while talking because the cursor is visible both on the personal computer screen and television (Collins, 2004). Second, a prolonged use of laser pointer is unlikely, because it is taxing to hold the laser beam steady which often flicks when turned on or off (Myers, Nichols, Wobbrock, & Miller, 2004). The on-screen pointer in Office Social combined the steadiness of a handheld, visibility of a cursor, and pointing efficiency of a traditional laser pointer. In Fragment 7, a fine-grained deixis is achieved on the phone, which is closer to the user and provides kinesthetic awareness, compared with finger-pointing in mid-air. It is also important to note how the interactional availability of the phone allowed Zoe, an attendee, to make a visual indication on the television for reference during communication.

Fragment 7 (Figure 9) shows how an attendee uses the on-screen pointer to enrich group discussions by directing the group's attention to relevant parts of a slide viewed on the public display. Zoe is in Interaction Mode and the current speaker. She brings up a slide on the television (line 2, Figure 9) and uses the on-screen pointer to indicate an area of interest (Figure 9B, right column of the slide, ‘the play thing’). During this process, we first see Zoe briefly looking down to place her thumb appropriately on the phone near the

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area of interest (Figure 9B) and then using proprioception to move her thumb while looking at the display and saying, ‘this one’ facing the audience (Figure 9C).

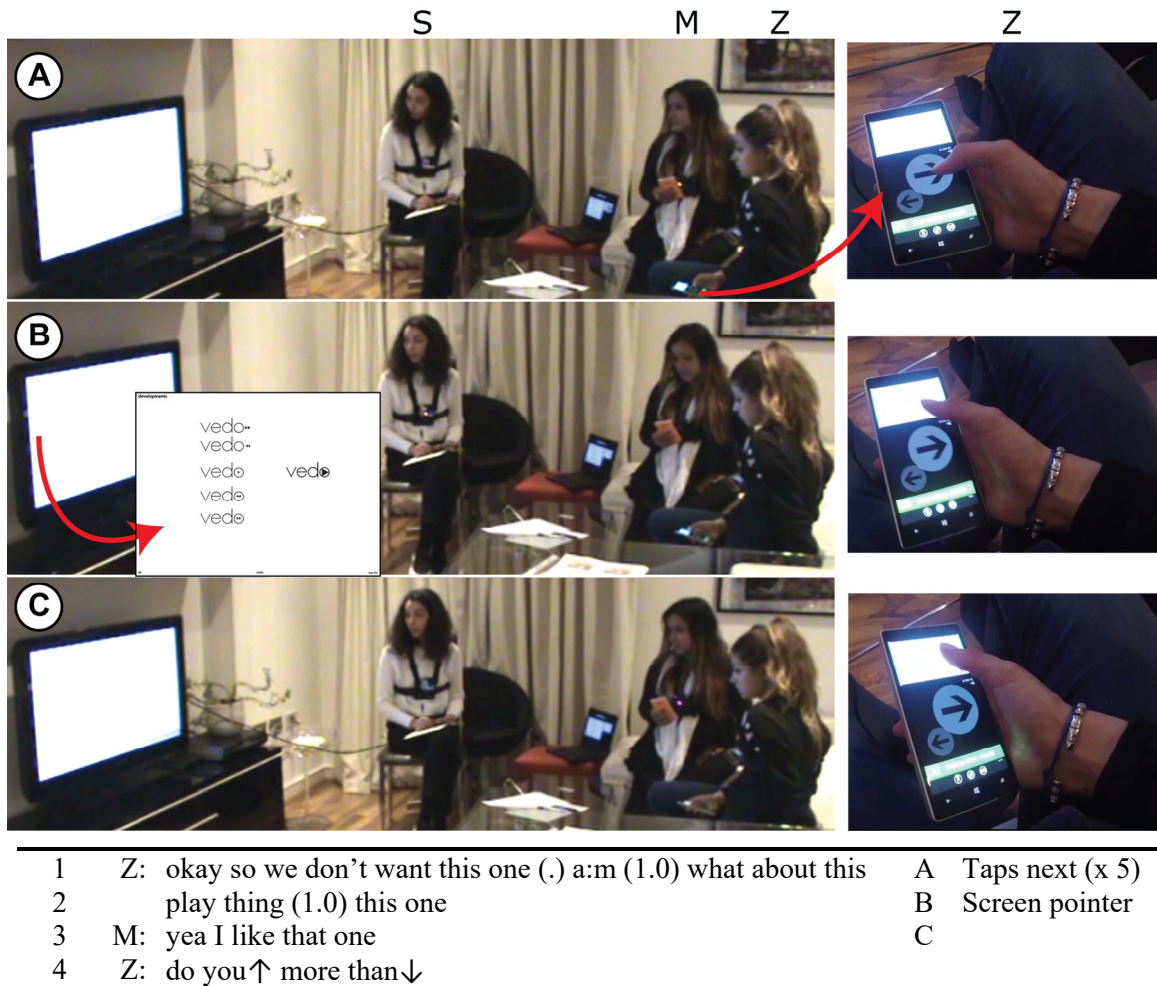


Figure 9. Fragment 7: Zoe, in Interaction Mode, brings up a slide (A) on the television and uses the on-screen pointer to direct the group's attention to a particular aspect of a logo (B, C).

Whether to point from afar or move up to the screen—that is the form of deixis proxemics—depends on the granularity of the information being referenced, fine versus coarse grained, and speakers' tolerance of ambiguity (Mentis, O'Hara, Sellen, & Trivedi, 2012). For fine-grained deictic pointing, in the current model of presentations, an attendee needs to move near the display and take the center stage or explicitly request permission to use the speaker's laser pointer. The technology here supported the need of fine-grained deixis from a distance, for not only the presenter (in Presentation and Interaction Mode) but also for any meeting participant in Interaction Mode. Moreover, by using the on-screen pointer, Zoe maintained her orientation toward the audience and the television, while letting the kinesthetic feedback from the phone inform her proprioception to guide the pointer suitably, and consequently the group's attention. The spatial arrangement of group members in the logo design meeting underplays the significance of preserving the F-

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formation (Kendon, 1990), which is crucial for a naturally flowing conversation. But the ability to face the audience while using a pointer is paramount when a speaker is positioned in front of a public display during a presentation, for instance, to preserve eye-contact with the audience.

In Fragment 8 (Figure 10) the on-screen pointer is used to construct a clarification within the context of deciding a logo design. All participants are in Interaction Mode and Zoe is talking about the logo on the right column of the slide 11 (Figure 10B). Mel had expressed her affinity for that logo (line 3, Figure 9) and the group is deliberating the design (Figure 10). Zoe is unsure why the logo appears unsettling to her (line 4, Figure 10). She places her finger on the logo and slowly moves passed it, synchronized with her utterance ‘ved –o’. The designer has replaced the ‘o’ of ‘vedo’ with a circular play icon. While uttering the word, Zoe displays that the play icon on the logo visually separates the logo into ‘ved’ and ‘o’. Note that Zoe’s use of on-screen pointer is well situated within her talk, which is conveying her reservations to Sara and, simultaneously, allowing Mel to arrive at a similar conclusion and validate her stance.


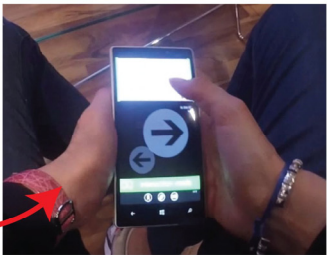
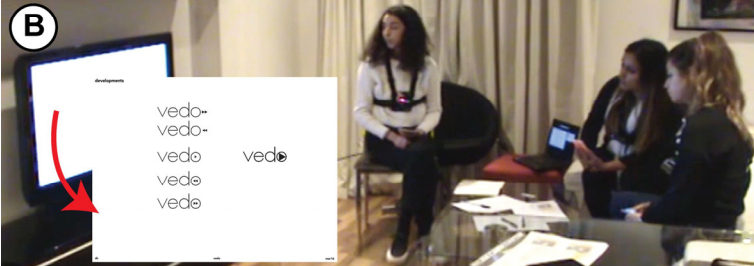
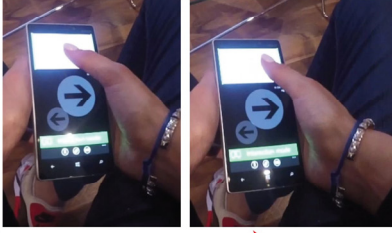
	S	M	Z		Z
(A)					
(B)					
1	Z: yea more thick (1.0) for some weird reason the vedo this one				
2	(.) this one			A	Screen pointer
3	S: yea				
4	Z: for some I dunno why it takes away from the o: like when				
5	you say [o:				
6	M: [oh okay I see				
7	Z: like do you read it as ved –o:			B	Screen pointer
8	M: ah now I'm starting to see it				
9	S: do you see it as ved because that would be an issue				

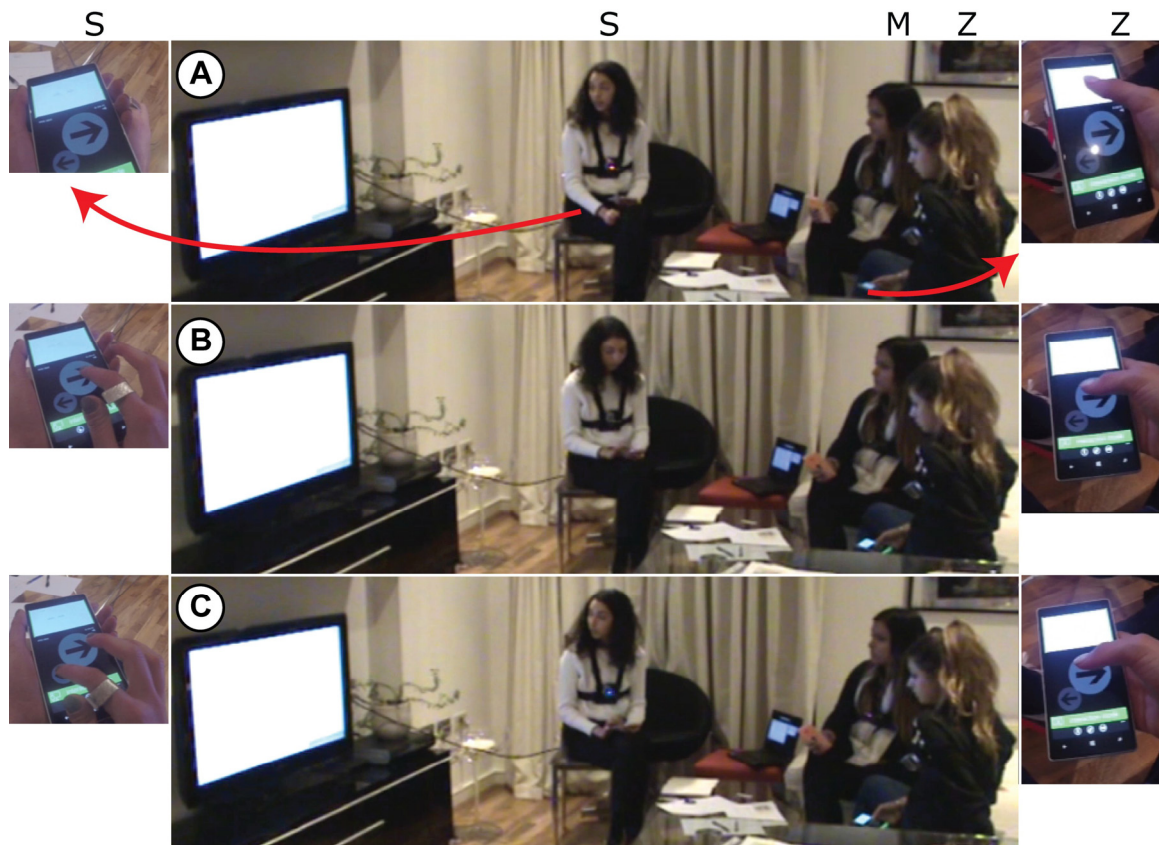
Figure 10. Fragment 8: In explaining a logo (A), Zoe emphasizes a shortcoming by moving the on-screen pointer along the word (B) as she says “ved –o” (line 7).

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This fragment shows how the interactional availability of deixis from the phone entailed Zoe's embodied action of perceiving the logo's visual discrepancy, without requiring her to move near the television or laptop controller. Although Zoe acted on the phone during the construction of her own clarification, the replication of that action on the television allowed meeting participants to orient themselves to that meaning. In other words, the use of on-screen pointer and two representations of the same document in the phone and television produced the meaningful action of noticing a visual defect in this particular setting of a presentation. Office Social was key in orchestrating the orientation and attention of collaborators to that specific feature of the logo. The significance of articulating such ways of seeing images and representations and the role they play in the production of actions within particular settings is well explored (Goodwin, 1994, 2000). Especially, we see in this instance an act of mutual contextualization, through the act of pointing, the talk elaborating the pointing, the orientation of the meeting participants toward the scene of pointing, and the larger activity of design selection. Together, all these elements established pointing as a *situated collaborative practice* (Goodwin, 2003).

Referencing slides or changing slides on the shared display was available to all meeting participants when the presentation was in Interaction Mode, but the identity of who was controlling the pointer or slide was not displayed. Leaving floor control to a social protocol did sometimes result in conflicting operations, as we see in Fragments 9 and 10, but participants were able to resolve problems using the same social methods.

In Fragment 9 (Figure 11), Sara and Zoe are in Interaction Mode. As Sara, enacts her expertise as a designer mentioning that a bold look is commonly used in current designs, Zoe brings up slide 5 on the television and asks 'What's more unique? This or this?' After mentioning the first *this* to denote slide 5 on the television, Zoe glances down on her phone momentarily, ensures her finger is placed on the back button, looks up to the television, taps back to slide 4, and asks *this* again—trying to make a comparison. Then Sara transfers her gaze from the television toward Zoe and Mel and begins giving her opinion about 'the first one' (line 8, Figure 11). Meanwhile, Zoe taps back and forth two more times, unbeknownst to Sara, who is still looking away from the display. To confirm which slide Sara is referring to, Mel points her finger to the television (slide 4) and says, 'so this one' (Figure 11A, right). Sara affirms and starts talking about the 'second one' (line 12, Figure 11). At this moment, both Zoe and Sara attempts to control slide navigation on the television, initiating an *overlapping action*: Zoe taps next (slide 4 to 5) and Sara taps next (slide 5 to 6). To repair, Sara taps back to slide 5 while verbally holding the floor saying 'which is' (Figure 11C).



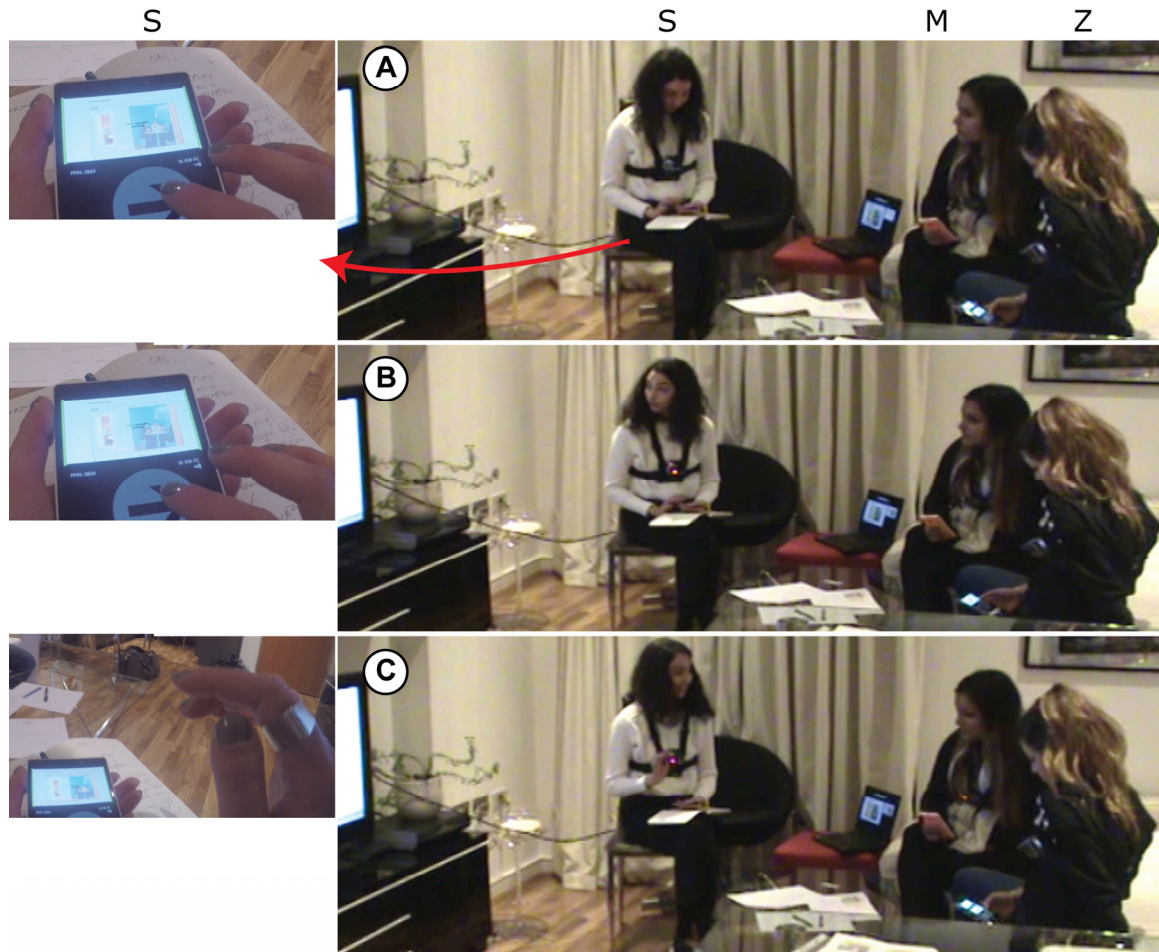
-
- | | | | |
|----|----|-------------------------------------------------------------------|-----------------------------|
| 1 | S: | I'll tell you from a personal like design perspective | |
| 2 | | I've been seeing this like= | |
| 3 | Z: | bo:ld= | |
| 4 | S: | =bo:ld playful look e:verywhere and I feel (.) it's like | |
| 5 | | [been so o:ver used | |
| 6 | Z: | [<okay fine> whats whats mo:↑re unique <u>this</u> or <u>this</u> | Z taps back |
| 7 | M: | yea that'd be good too | |
| 8 | S: | I feel the first one is safer but it's elegant and you'll | Z taps back-and-forth (x 2) |
| 9 | | probably like [it in two years' time | |
| 10 | M: | [s so thi [s one | |
| 11 | Z: | [this one | A Z uses on-screen pointer |
| 12 | S: | yea (.) the second one which is | |
| 13 | | (1.5) | B Z taps next, S taps next |
| 14 | | this one like especially this I feel (.) | C S taps back |
-

Figure 11. Fragment 9: While Sara is referring to a slide (line 9) and attempting to navigate, Zoe taps next (B). When Sara finally taps next (B), a different slide is reached; Sara pauses, taps back, and then continues talking (C).

In Fragment 10 (Figure 12) Mel is asking Sara about a logo design. They are both in Interaction Mode and trying to bring up the pertinent slide on the television. Due to a time lag between any tap events on the phone to a slide change on the television, we find Sara and Mel repeating actions and missing the slide they both want to bring up on television

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(lines 4 and 5, Figure 12). Finally, Mel says ‘I was using it’, which leads to Sara releasing the control of the television and saying, ‘go ahead’.



1	S: okay↓		M browsing slides
2	M: so have you got that one on a website↑	A	M changes slide
3	so that's not that's the wrong one (1.5) so		
4	where is that one on the we:bsi:te		S taps back, M taps back (x 2)
5	S: that one	B	M taps next, S taps next (x 2)
6	M: that one↑		
7	S: oh[sorry okay	C	
8	M: [>I was using it>		M Taps back
9	S: go ahead (1.0) yeah this one		

Figure 12. Fragment 10: Mel is talking about a particular slide (A). Both Mel and Sara try to navigate simultaneously, and chaos ensues (B). Realizing the confusion, Sara recedes control (C), and Mel brings up the slide on the television (line 8).

Fragments 9 and 10 depart from the traditional one-person-at-a-time control in slideware. However, they differ in terms of the onset of *overlap in control*, how overlapping control gets manifested, and in their resolution. In Fragment 9 (Figure 11), Zoe had been controlling slides while Sara was speaking. At one point, Sara and Zoe

simultaneously changed the slide on the public display. This simultaneous turn-taking in control resulted in a single *overlapping action*, a misstep, and was repaired when Zoe implicitly released the floor letting Sara control the document on the television. In Fragment 10 (Figure 12), both Mel and Sara conceived the same moment in discourse as their turn-relevant position (Mel questioning in line 4, Figure 12) and began to control the slideshow. Both participants tried to bring up the same slide on the television, disrupting each other's interaction. This conflict was resolved by Mel explicitly negotiating for the floor, saying, 'I was using it' (line 8, Figure 12) and Sara explicitly releasing her control, saying, 'go ahead' (line 9, Figure 12). These fragments suggest that when problems occur in openly controlling the public view of slides (shared navigation control), meeting participants use talk as a resource to repair the problem and mitigate the conflict.

4. DISCUSSION

4.1. Sharing Control

Technologies that aim to facilitate collocated interactions during presentations in multi-device ecosystems offer different opportunities for attendee participation. Primarily they offer interaction with the presentation to measure audience engagement, whether via polling and responding to questions (e.g., classroom response systems, Mischief) or to control slides on the shared display (e.g., Pebbles SlideShow Commander, Office Social). Techniques have been developed so that participants can join in an ad-hoc meeting and access the shared document using their personal devices. Either attendees can only view the slide on the shared display mirrored on their personal device (e.g., Evenium ConnexMe) or the entire slide deck (e.g., Pebbles, Office Social). However, we still have limited knowledge about how participants can use slides as conversational resources during collocated interactions. Instead, current efforts have been geared toward developing companion tools for slideware, which would allow presenters to gauge audience attention (e.g., with emoticons, questions, polls, or comments). These systems do not shift the one-to-many information control paradigm to one that extends interaction control over slides to many people, like envisioned in earlier groupware prototypes, Pebbles (Myers, 2001) and Notelook (Chiu et al., 1999). These early prototypes had several pragmatic limitations at the time of their introduction, such as sophisticated infrastructure requirements, which are now resolved by recent advances in wireless connectivity and ubiquitous computing. However, what remains problematic, is how social permissions need to be negotiated to enable the availability of slides for use in talk, thereby turning presentations into conversations.

Our position is that without an understanding of in-the-moment organization of talk around slides—that is how their availability for use in talk is constantly negotiated—it is hard to provide an effective permission system for participants to move between loose and tightly coupled tasks. With Office Social, participants in our study used their personal devices to review slides independently, refer to logos, discuss fine details about logos with others, and control the public display as a resource for ongoing talk. Although the identity of the participant controlling the public display was not digitally announced, participants seemed to make sense of the ongoing production of group member's activities through assessing their gaze direction, bodily conduct, and entry or transition in talk. This was

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possible because of the small size of the design meeting (3 participants) and would probably not generalize to much larger meetings. However, the home setting of the meeting did not seem to influence participants' activities; there was no lack of professionalism as visible through talk and bodily conduct. The meeting offered an institutional setting, and participants did bring to bear their expertise and enact roles for the meeting, like the designer, client, and adviser.

4.2. Facilitating Collocated Talk

In design review meetings, a design solution is created among the participants, "as a product of incessant judgement, subjected to critical argument" (Rittel & Webber, 1973: p. 157). In this article, we explored to what extent a technology can offer slides as resources for collocated talk in a design meeting. In contrast to recent HCI work on building digital design studios, with large displays (Khan, et al., 2009) or mixed media (Geyer & Reiterer, 2012), we examined how slides contribute to the socio-material environment of a design meeting, in terms of accommodating existing work practices and structure for achieving social order. Figure 13 provides a summary of the ten fragments discussed earlier.

Fragment	Analytic Relevance
1	switch from Presentation to Interaction Mode; request is made implicitly, via verbal and nonverbal behavior, and permission is granted implicitly
2	attendees switch between loose and tightly coupled work: while presenter takes notes, attendees control slides on the large display and deliberate
3	limited shared document ownership is used to independently reflect on slides and prepare for <i>turn-taking in talk</i>
4	discourse takes precedence over document control on the public display in forming transition-relevance places
5	attendee prepares for a later turn in talk by bookmarking a slide; easily brings up that bookmarked slide on the large display later during tightly coupled work
6	a tightly coupled collaborative review is achieved by an ad-hoc aggregation of two phones, a large display, and a paper printout of slides; each of these devices and artifacts acts as a <i>representation</i> of the same PowerPoint document
7	attendee realizes fine-grained pointing from a distance without requiring explicit permission and, at the same time, preserves the group's F-formation
8	mutual contextualization via the interactional availability of deixis from the phone, thereby establishing pointing as a situated collaborative practice
9	repairing conflict when turn-taking in control; implicit release of control by one of the participants
10	repairing conflict when turn-taking in control; explicit negotiation via talk between two participants

Figure 13. A summary of the ten fragments discussed in the analysis (Section 3.3) and their analytic relevance.

In our study, meeting participants used slides as resources to deliberate on logo designs; clients asked questions, clarifications, and made assessments, designers provided expertise, shared their worldview, and both negotiated intermediately. As in prior studies, talk in this meeting provided *structured orderliness* (e.g., Oak, 2011). Limited shared document

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ownership via phone seemed to provide participants autonomy and agency of design objects, because it allowed them to independently review and bookmark content, within the constraint of both the institutionality of the design meeting and social organization of talk. Common material objects in design meetings range from sketches, mood boards, to models, which are expensive to replicate and thus require contested access and participants' negotiation. In contrast, here we find slides, containing the design objects, existing in multiple affordances, with some forms as shared resources (designer's laptop, large display, paper print out) and others as private, i.e., with uncontested access (Office Social running on participants' phones). Participants' negotiations to control shared resources occurred in conjunction with negotiations involved in design work. Both these types of negotiations, to construct design objects and to control design objects (existing as slides on shared devices/ artifacts) were structured via talk. The malleability of slides across a range of complementary affordances made these negotiations context-specific. In Fragment 9, consequent slides were used to compare two design alternatives, in Fragment 6, slides on a paper printout, phone, and television were used to decide on a design, and in Fragment 8, the on-screen pointer on the phone was used to make a fine-grained deictic reference from afar, displayed on the television, and accomplish intersubjectivity. In sum, slides can play a socio-material role in design meetings, augmenting participants' agency within the structure of talk, with talk and bodily conduct still establishing order in negotiations over slide control.

Traditional presentations, like classroom lectures or keynotes, aim to disseminate information—one to many. Instead, groupwork such as design meetings require more active collaboration, such as generation and evaluation of ideas, opinions, and decisions. By reframing slideware from essentially an informative to collaborative tool, Office Social revealed how document-centric actions in slideware use can be facilitated when meetings require richer forms of collaborative participation spanning multiple devices and artifacts.

4.3. Constructing Order in an Open System

Office Social delegates turn-taking and floor control to social processes. When in Interaction Mode, any meeting participant may control the slides on the shared display. However, attendees may remain in Review Mode to privately browse a version of deck on their personal device. In contrast to offering functionalities according to assigned participant roles (Branigan, Pickering, McLean, & Cleland, 2007), like a speaker and an attendee (FXP Touch) or a student and a teacher (Moraveji et al., 2008), Office Social assigns a state to the slideshow: either Presentation Mode or Interaction Mode. However, there is a technical constraint before document control can be shared among meeting participants: one presenter needs to put the system into Interaction Mode. In our study, the presenter brings up the Interaction Mode when an attendee refers to a prior slide via talk and bodily conduct (Fragment 1, Figure 3). No explicit verbal permission is requested, but democratizing slide control is achieved via implicit verbal and nonverbal conduct.

Once document control is distributed to meeting participants, in the absence of an explicit permission system for turn-taking and no technological protocol for floor control, the use of Office Social runs the risk of conflicting operations (Ellis et al., 1991). Indeed, in Fragments 9 and 10, two participants acted as if each has the floor to control the slide

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on the shared display (see Figures 11 and 12), which was then resolved by one participant voluntarily releasing the floor and explicit verbal conduct, respectively. In Fragment 9, Zoe releases the floor as Sara is sharing her design expertise (“but it’s elegant and you’ll probably like it in two years’ time”) and the institutionality of talk is used by participants to order both the conversation and the shared document control. In contrast, in Fragment 10, Mel explicitly verbalizes her control of the floor (“I was using it.”), and Sara releases her turn. Note here that Mel (the client’s adviser) was asking a clarification from Sara (“so where is that one on the website”), atypical in design review meetings. But since both the participants engaged in controlling the shared display to bring the pertinent “that” slide, conflict ensued; institutionality of talk did not obviously provide for ordered turn-taking in control in this instance, a verbal explication was required. Overall, despite no technical solution for orderliness, mostly participants used their existing social means to achieve an orderly collaboration, namely mutual understanding of each other’s conduct and context of action, as the grounds for intersubjectivity (Sacks et al., 1974). Rather than assuming or attempting to force an idealized “no-gap-no-overlap” discourse (Shriberg, Stolcke, & Baron, 2001), especially when it came to the intersection of turn-taking in talk and slide navigation, the technology accommodated the use of routine conversational repair strategies (Jefferson, 2004; Lerner, 1989; Schegloff, 1992, 2000, 2002).

The lack of strict floor control processes and some gaps and overlaps did not seem to deter participants from taking turns to control slides on the shared display and use slides as resources to participate in the ongoing collaborative discourse, such as taking and holding the floor, and warranting speaker self-selection. The ability to independently review slides on their personal devices during the meeting was used for loosely-coupled parallel work, such as independent review (Fragment 3, see Figure 5), bookmark (Fragment 5, see Figure 7), or to prepare for turn-taking in talk (Fragment 4, see Figure 6). Such loosely-coupled work often led to tightly coupled group discussions, where attendees controlled the slides on the shared display to get everyone on the same page (e.g., line 9, Fragment 4, Figure 6). Shared attentional control seemed to overcome the boundary between producer and consumer of information, central to current models of presentation organization.

4.4. Implications for Multi-Device, Multi-Artifact Ecosystems

In this article, we focused on activities that participants accomplished around the shared display and personal devices to use slides as a resource in talk. However, when engaging in other tasks, such as comparison, annotation, or recording notes, participants used paper notebooks and paper printout of the slides. When using these materials, participants sometimes held on to their phones with one hand, and interchanged glances among the phone, large display, and paper printouts (Fragment 6, Figure 8). The reification of shared document control and ownership via a phone, its form and function, enabled participation in particular ways in the context of the meeting ecosystem. The socio-material organization might be different if shared document ownership and control was achieved via personal laptops or tablets. In Fragment 6, participants used an ad-hoc aggregation of paper, personal, and shared devices to achieve a hybrid comparison task. This does not necessarily imply a lack of readiness in this collaboration technology to facilitate collocated interaction (Olson & Olson, 2000), but rather that certain artifacts and their form

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factors are well-established members of a social context—like paper in a meeting (Sellen & Harper, 2002; Whittaker & Schwarz, 1995) or writing (O’Hara et al., 2002).

Designing technologies to co-exist with other artifacts would allow exploiting their respective affordances in complementary and contextually relevant ways. For instance, participants used their phones to accomplish pointing as a situated collaborative practice (Fragments 7 and 8). In traditional presentations, participants organize referential activities via mid-air hand gestures, trying to point to a specific part of the slide showed on the shared display. For fine-grained references, a presenter would walk up close to the display and use her finger very close to the screen. Even with the availability of laser pointer, many speakers often opt to walk up to the screen, point to the related part on the display (using the laser pointer, finger, or ruler), face away from attendees, and oscillate glances between the screen and audience (Knoblauch, 2008). We rarely encounter such bodily actions from attendees in a presentation; presumably, because fine-grained deixis would require walking up to the central display and is socially burdensome. Office Social did not only distribute the ability to make deictic references to all meeting participants but also enabled fine-grained deixis from afar. The on-screen pointer, signifying the deictic reference, however, emphasized an ambiguity of information (Gaver et al., 2003), by not showing the actor, thus forcing participants to mutually make sense of the action and context.

4.5. Other Types of Slide Presentations

Slide presentations do not always involve or anticipate a collaborative discourse among group members. For instance, the social pragmatics of a keynote or conference talk is unlike that of a small meeting, both in number of attendees and the socio-material role played by slides. In speech-type presentations, speakers are rarely interrupted during the talk, and the conversation—attendees asking questions or making comments—happen at the talk’s conclusion. When interruptions occur during a presentation, it is mostly a request for clarification of the slide’s content. Similarly, a large classroom lecture is also a speech-type presentation, aiming to disseminate information. And clickers, or classroom response systems, serve well in this setting to engage attendees with the presented content. Here we studied a design review meeting where talk and social interactions play out differently than other types of slide presentations.

Reframing slideware to facilitate equitable participation in other types of *structured presentations* might create unwanted disruptions, disorderly conduct, and security breaches, without benefiting the situated work practice. Yet only future empirical studies of collocated interactions in speech-type presentations with shared document ownership and control can reveal emerging problems and design opportunities. Presenters in small-to-medium meetings or studio classrooms frequently use slides as an aid to facilitate group discussions, however, still use the traditional single-user systems. By shifting this single-user paradigm of slideware, groupware systems like Office Social may accommodate emerging collaborative practices during those presentations. However, it remains to be seen how social permissions will need to be negotiated in such contexts, and how shared document control will fit into the work practice.

5. CONCLUSION

Our study attempted to understand how people use slides as interactional resources during collocated collaboration in a multi-device ecosystem. People used slides (as navigational and referential activities) in combination with gaze, bodily conduct, and ongoing talk to accomplish collaborative design review tasks. Our analysis revealed that the limited shared ownership of slides augmented participants' agency within the constraints of collocated talk, and order over shared document control was accomplished by talk and bodily conduct. Rather than fragmenting the ecosystem, the replication of slide content across different affordances, paper, shared large display, and personal handhelds, appeared to enable switching between loose and tightly coupled work. Understanding how people use documents as resources for talk in *multi-device, multi-artifact ecosystems* can inform the design of future technologies facilitating collocated interactions. We contribute by examining slides as resources for collocated interactions. Our analysis reveals how people interweave existing social methods (e.g., turn-taking in talk and bodily conduct) with complementary affordances (e.g., physical and digital assemblies) to achieve orderliness.

NOTES

The groupware system, Office Social, was previously introduced in a note, published at the CHI 2016 conference. That paper is referenced and briefly summarized in this paper, which then goes on to study the design of Office Social in a design review meeting.

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