Telepresence Attendance at the ACM CSCW 2016 Conference

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ABSTRACT
Attendance at academic conferences via telepresence robots is now a reality. Yet our understanding of how telepresence attendance should be facilitated and what effect it has on the remote attendees' experiences is still in its infancy. We conducted a study of remote attendance at CSCW 2016 where we explored the use of dedicated *and* shared telepresence robots for conference talks, receptions, and workshops, along with the personalization of robots. We found that the sharing of robots was an effective way to handle telepresence attendance. The use of personalization items was largely successful, though the shared nature of some robots posed challenges. We also learned that it can be difficult for remote attendees to fully commit to attending conference sessions because of local pressures. These results point to suggestions for future telepresence setups including ways of supporting broader appropriation of robots, providing social and technical support, and enhancing attendee commitment.

Author Keywords
Telepresence; robots; academic conferences

ACM Classification Keywords
H.5.3 [Information interfaces and presentation]: Group and Organization Interfaces - *Computer Supported Cooperative Work*

INTRODUCTION
Telepresence attendance at academic conferences is now a reality where we are beginning to see conferences explore remote attendance via telepresence robots. ACM conferences such as Ubicomp/ISWC 2014 [19], CHI 2014, and ASSETS 2014 [14] have all had people attend remotely using telepresence robots for varying reasons ranging from accessibility needs to cost or time issues [19]. Telepresence robots are even being used for commercial trade shows. While the experience is possible, we still have only an initial understanding of how attendance via telepresence robots should be best organized and designed, and how this effects the experience of the remote attendees. To date, telepresence attendance at academic conferences has typically focused on very small numbers of remote attendees (e.g., no more than seven) and a limited range of activities (e.g., only conference talks).

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As part of the ACM Conference on Computer Supported Cooperative Work and Social Computing 2016 (CSCW), we studied telepresence attendance to gain a deeper and more nuanced understanding of remote conference attendance via telepresence robots (Figure 1). CSCW 2016 had approximately 750 in-person attendees and contained weekend workshops and a doctoral consortium, three days of conference talks across five parallel sessions, a demo and poster reception, and a conference reception. The goal of our study was to explore how remote attendees participated in conference paper sessions, breaks, workshops, and receptions using BeamPro telepresence robots (hereafter called *Beams)*. Compared to past efforts in studying telepresence attendance at Ubicomp/ISWC 2014 [19], we explored a broader set of participation across conference events and an increased numbers of participants. In total, we had 19 people remotely connect into CSCW as telepresence attendees.

Figure 1: Beams at CSCW 2016 during the opening plenary.

We explicitly focused our explorations on two aspects of telepresence attendance that prior literature has suggested is important future research directions [19]: 1) robot personalization as means to represent one's identity with a telepresence robot and 2) the use of dedicated robots compared to shared robots used by multiple individuals. Past telepresence efforts have largely focused around dedicated robots where an individual has access to his or

her own Beam throughout the duration of the conference [19]. This is beneficial in terms of supporting identity construction, however, other models of usage where multiple people share a single robot over time offer promise and reduced costs for renting telepresence robots [19]. As such, we wanted to understand the effects of the experience.

Overall, the telepresence program at CSCW was effective and usable for many remote attendees. It was also a focal point at the conference amongst local attendees. An instant messaging backchannel provided social support with 'eyes on the ground' for remote attendees. Shared telepresence robots were valuable yet raised issues around personalization and coordination of use. Attendees faced various challenges in fully committing to attending the conference as home or work priorities sometimes took precedence over conference activities. We describe these results and articulate the lessons learned for future conference telepresence attendance and robot design.

RELATED WORK

Remote Conference Attendance

Conference attendees have been able to remotely attend academic and industry conferences to varying degrees over the past two decades. Two of the first documented instances of remote conference attendance were the use of avatars at the Teaching in Community Colleges Online Conference (TCC 1999) and the V-Learn Track of the Avatars Conference (Avatars 1999) [11]. More recently, IBM's Academy of Technology conference allowed 502 employees to attend the conference using avatars in Second Life [3]. The Third International Workshop on Massively Multiplayer Virtual Environments 2010 had nine people attend via an avatar and another 10-20 people were present in person [24].

Across these avatar-based attendance examples, we see similar benefits and challenges to remote conference attendance. On one hand, studies of these events show that remote attendance enabled a broader level of participation [3,11,24] and people especially enjoyed social mingling [Erickson]. For example, a poster session at the IBM Academy conference was seen as the most beneficial activity for remote attendees given the high focus on social interactions with others [3]. On the other hand, across these conferences and workshops, social interactions were sometimes challenging because of the capabilities of one's avatar as well as one's ability to recognize others; people faced limitations in creating an avatar that reflected their desired look (if they were able to customize their avatar); and, time zones created issues for attending large portions of the event [3,11,24]. Based on these findings, Erickson et al. [3] proposed the CoFIRe framework, which calls for remote attendees to be able to move into and out of small groups for interaction where they are able to shield their interactions from a potentially larger audience around them.

Most closely related to our study is Neustaedter et al.'s [19] study of 7 participants' use of Beams at the joint Ubicomp/ISWC 2014 conference, which focused on remote viewing of talks and mingling at breaks. Notably absent was remote attendance at workshops and conference receptions. Remote attendance at Ubicomp/ISWC helped people overcome accessibility challenges, time restrictions, and cost limitations; however, important challenges were noted including issues representing one's identity (or realizing the importance in doing so), interacting with in-person attendees, and maintaining a desired level of privacy given the mixed-context (being at home and at a conference at the same time). To address these problems, the authors report the need for better audio and visual feedback, improved visual and audio acuity, robots with adjustable heights, and longer term establishment of social norms around remote conference attendance [19]. The study points to key future work around identity representation and broader participation at conferences, including attendance at workshops and receptions. It also raised the question of whether dedicated or shared robots would be ideal for future conferences. Our current study builds on these suggestions as its main focal points. We also explore the experience of a larger number of remote attendees to understand scalability.

Telepresence Robots

Telepresence robots have been studied in workplace settings and results have pointed to findings that are similar to conference attendance, e.g., issues with the presentation of self, social interactions, and telepresence robot design. Telepresence robots have been found to support group tasks [21] and promote knowledge of availability and social presence amongst co-workers [15], though new social norms have to be established for interactions [15,28]. Co-workers local to the robots have been found to help them out with elevators and charging [15]. In some instances, people treat a remote person like a robot or object rather than a person [15].

Wide field or panoramic views have been shown to be valuable [10,12,13] for supporting peripheral awareness [10]. Similarly, we see mobility as being important for task completion [12,22] and varying audio levels for conversations [12]. Robot height has even been shown to affect persuasiveness [23]. Researchers have distilled the importance of how one looks in a telepresence robot [15] and pointed to the need to present oneself in an appropriate way where one has both visual and audio feedback since it is hard to know how loud one sounds in the remote location and what one looks like [15,20,27, 29]. Some have suggested automatically setting volume based on ambient noise [5]. In addition, Tsui et al. [29] point to the need to show a robot's location on a venue map. Overall, these findings are valuable, yet still remain speculative in the context of attending academic conferences via telepresence robots. Our study builds on this research by further exploring telepresence robot usage in conference settings.

STUDY METHODOLOGY

The goal of our study was to explore remote academic conference attendance with a focus on the use of dedicated *vs.* shared telepresence robots, robot personalization, and broad participation in the conference, including workshops, talks, and receptions. Like past studies of telepresence robots at conferences, our study could be considered a form of breaching experiment where we describe the social practices that emerge due to the disruptions of the normal social order [1,4,18]. In this case, the normal social order is the type of in-person telepresence attendance that academics and industry researchers are used to seeing, in contrast to the addition of remote attendees using telepresence robots.

Remote Attendees

We advertised telepresence attendance at CSCW via the conference web site and social media. Interested people completed an online questionnaire that asked them demographic questions along with their reasons for wanting to participate remotely. Across the entire conference, we ended up having 19 remote attendees. This included 3 attendees at workshops (W1-W3) and 16 at the main conference. Prior to the conference, we had remote attendees select which sessions they thought they would attend. Those with more than five sessions (five people) were assigned a dedicated Beam that they could use at any point throughout the conference (D1-D5), while the remaining participants (three people) were assigned to share Beams with other remote attendees (S1-S3). Those sharing Beams were told they could connect into the conference during only the sessions they pre-selected.

In addition to our predefined sharing, two of the 12 individuals (1 Canada, 1 USA) selected for the main conference program decided to appropriate their dedicated Beam in a manner that also made it shared: they shared their Beam amongst graduate students in their university research group. In the first case, a Beam was shared between one faculty member and two graduate students (D4.1-D4.3). In the second case, a Beam was shared amongst 7 grad students while the faculty member was at the conference in person (D5.1-5.7).

Overall, we had 11 graduate students and 8 faculty as remote attendees. Notably absent was remote attendees from industry. 10 participants were from the USA, 5 from Canada, 2 from Brazil, and 2 from China. One participant faced accessibility challenges that made it difficult to travel, while the rest faced either time or cost restrictions, or wanted to participate simply to try out a novel experience. Nobody was located in the same time zone as the conference; time zones for those at the main conference varied from 1 to 5 hours time difference. Two workshop attendees faced a time zone difference of 16 hours (China) and one was 3 hours different. Remote attendees paid half of the cost of regular attendance given that the setup was still somewhat experimental and we could not ensure its quality.

Telepresence Setup

We used BeamPros (Beams) as the telepresence robots, shown in Figure 1. Beams have two cameras, one facing forward for interaction with others and one facing down to the floor for navigation. Camera resolution is 480p with a field of view of 105° and 3x digital zoom. Remote users can control the robots' movement with a keyboard, mouse or Xbox controller. Beams connected to a dedicated Wi-Fi network at the conference.

The conference spanned two floors of the hotel's meeting space and there was a small elevator that connected the locations (Figure 2). Beams were docked inside a meeting room on the second floor and we placed a large mirror at the door of the room so that remote attendees could see themselves as they left the room; for workshops, we docked the Beams inside the workshop rooms.

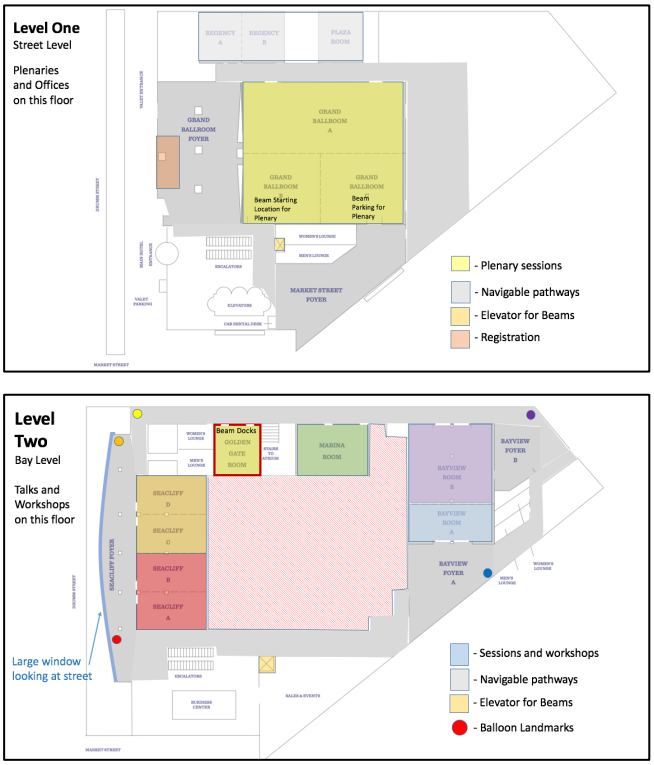

Figure 2: Color-coded venue maps for remote attendees.

The opening and closing plenaries along with the breaks/food were on the first floor and parallel tracks/workshops were on the second floor. We provided telepresence attendees with a map (Figure 2) and schedule where rooms on the map were color-coded to match the timeslots in the calendar. The second floor contained a complete loop that remote attendees could drive around as they went to the talks. We placed bundles of colored helium balloons at each corner of the loop to try and help attendees visually recognize where they were in the loop. Balloons were shown on the map as well.

Remote attendees were asked to complete Beam training from Event Presence (the company who rents the Beams) in the week prior to CSCW. 10 of 19 people completed the training. On the opening weekend of the conference, we offered a tour of the hotel to remote attendees so they could orient themselves; only 6 of 19 people took the tour despite it being strongly encouraged.

We created an instant messaging backchannel in Skype for the main conference days and asked all remote attendees to connect to it while they were at the conference. The goal was to provide them with technical support as needed and give them a channel to communicate with other remote attendees to share tips or discuss sessions. We did not launch the backchannel for workshops since there were only three workshop attendees and we felt email would suffice for support.

Personalization

Prior to the conference, we asked remote attendees to mail us items to personalize their Beams so that each person would be visually distinguishable. Past studies have found this to be especially important for social interactions [19]. We tested various items prior to the conference and found that items that could be affixed to the top of the Beam worked best since they were visible from a greater distance away. Scarves were especially visible since they moved/waved as the Beam moved. Items that hung down low, such as shirts, were unfortunately not good since they tended to block the Beam's downward facing camera.

For these reasons, we asked participants to send us a hat, scarf, nice wig, or a bandana to decorate their Beam. Participants were told that if they did not, we would perform our own customizations using items we had on hand. We received items from seven people, including 3 hats, 2 scarves, 1 hat/scarf/pennant combination, and a shirt (which we affixed like a scarf). Both Beams that were shared amongst their university's research lab sent a single set of personalization items to be used by all people from that institution. Prior to each Beam's usage, we affixed the appropriate person/institution's item to the Beam (Figure 1). We attached a colored balloon to the top of Beams in cases where the person did not send us an item; the balloons bobbed slightly as the Beam moved which was purposeful. Thus, across all 19 remote attendees, 14 had personalized robots and 5 had colored balloons. All attendees had their nametag affixed to the front of the Beam.

Conference Opening Plenary

At the start of the conference during the opening plenary, we introduced the telepresence setup to the local conference attendees in a 5-minute presentation as a form of social training. We showed slides that depicted the common challenges that Beam attendees face such as navigating tight spaces, knowing when others want to interact with them, driving over laptop power cables, using an elevator, etc. Our goal was to ensure local attendees recognized that telepresence attendance was still a learning process and that they should be patient and help out remote attendees as needed. Thus, we attempted to get 'buy in' from in-person attendees.

Data Collection and Analysis

Observations

We observed the remote attendees throughout the conference, during sessions, breaks, and at the demo reception. We could not feasibly observe all of the sessions that the remote attendees went to, however, we did manage to have at least one observer attend 19 of the 27 sessions that remote attendees were at. During these sessions, observers took notes about where the Beam parked, how they moved through the session, whether or not they asked questions, and if and how they interacted with people. We recorded images and videos at various points to capture the different types of setups and interactions that occurred.

Semi-Structured Interviews

To gain detailed feedback of their experience, we conducted interviews with each remote attendee within several days of the end of the conference over Skype [8]. Those who shared a Beam were all interviewed separately. One participant was not responsive to our emails and so we did not interview this person. Another had a very busy schedule so we exchanged emails asking a subset of the interview questions. Our interview questions focused on Beam personalization, Beam sharing, navigation using the colored maps and balloons, social interactions, and potential privacy concerns. In addition, we interviewed one workshop organizer (O1) to understand her experience of having a remote attendee in the workshop. All interviews were audio-recorded and transcribed, except for one where recording failed. We used thematic analysis to understand the main themes within our data. This involved multiple reviews of interview transcriptions and meetings amongst the paper authors to discuss their observations.

Backchannel Messaging

We kept logs of the messages in the Skype backchannel and performed coding on a per-message basis to identify the type of content in the message (e.g., technical question, social comment). We also coded each message according to who was the sender and the (most likely) intended recipient (e.g., support staff, another remote attendee, everybody in the chat channel). Our goal was to understand the main uses of the backchannel and what types of conversational exchanges occurred.

Post-Conference Survey

As part of the general conference survey, we asked local attendees for their feedback on the telepresence setup. Questions focused on people's first reactions to the Beams, their impression at the end of the conference, how they felt about shared vs. dedicated Beams, what value they saw in having the Beams available for the different conference activities (e.g., talks, receptions, workshops), and what they would change, if anything, for future conferences. We received 225 responses: 117 disclosed themselves as

female, and 104 as male. 85 described themselves as students, 103 as academic researchers, 33 as industry researchers, and 2 as practitioners. We analyzed the survey data using descriptive statistics and thematic analysis to understand the main qualitative themes. Survey respondents are listed with an C# in the results.

GENERAL USAGE AND REACTIONS

The post-conference survey showed a generally positive response to telepresence attendance. Many respondents reported on the advantages of telepresence attendance like past studies (e.g., supporting accessibility needs, reducing cost) [19]. 114 respondents said that telepresence attendance should be offered at future CSCW conferences, 67 said maybe, and 13 respondents said no. Reasons for not wanting telepresence attendance again included issues with Beams blocking a person's view of a talk, social awkwardness, and the Beams being a distraction. Some respondents suggested experimenting with alternate telepresence setups like streaming talks. We asked respondents to reflect on whether they thought Beams were a good idea at the start of the conference compared to the end. They selected their agreement with the statement, "I thought having the Beams was a good idea" on a 7-point scale (1-Strongly Disagree to 7-Strongly Agree). For the start of the conference, respondents gave a rating of 5.3 ± 1.6 (median=6), and at the end they gave a rating of 5.4 ± 1.6 (median=6). 143 respondents kept their scores the same, 46 increased their score, and 36 reduced their score.

Table 1: Ratings from local attendees on the value of conference activities for remote attendees.

Activity	Mean
It is valuable having telepresence attendees be able to **watch** conference sessions.	5.6 ± 1.6 (n=175)
It is valuable having telepresence attendees be able to **ask questions** at conference sessions.	5.5 ± 1.7 (n=174)
It is valuable having telepresence attendees be able to **present** at conference sessions.	5.1 ± 1.8 (n=166)
I had valuable interactions with a telepresence attendee during the conference **breaks**.	3.6 ± 2.1 (n=120)
I had valuable interactions with a telepresence attendee during the **Poster & Demo Reception**.	3.0 ± 2.1 (n=84)
I had valuable interactions with a telepresence attendee during a **workshop**.	2.6 ± 1.9 (n=62)

We asked survey respondents about their agreement with a series of statements focused on different conference activities, shown in Table 1. Respondents gave a rating on a 7-point scale (1-Strongly Disagree to 7-Strongly Agree that the activity is valuable). They could choose to not answer or were told to select "N/A" if they did not experience a situation. These results illustrate that local attendees felt telepresence was most valuable during conference sessions, and less valuable during the breaks, workshops, and reception. This is likely because informal interactions with remote attendees were sometimes difficult (described later). We suspect that the scores for 'workshops' are overly low because people commented on them when they had not actually been in a workshop with a remote attendee, despite the survey's instructions.

The amount of time that remote participants attended CSCW varied broadly. We tracked this time using their Beam login accounts. Two accounts were shared amongst multiple people at the institution, so we were only able to track usage for the entire institution. The mean time spent connected to a Beam with a single account was 9.9 +/- 6.7 hours (median=8.3, minimum=1.9, maximum=20.4 hours). Five accounts used a Beam the full 3 days of the main conference program, two accounts used a Beam 2 days, and three accounts used a Beam 1 day.

Beams were very clearly attention magnets at CSCW. On one hand, the attention that the Beams and associated remote attendees received was a benefit. Many participants talked about 'being popular' and having more people interested to talk to them than normal. Yet the downside of the social attention was that the remote attendees had a difficult time being 'invisible,' if they desired. For example, they were unable to easily leave talks in the middle of the session. It was also hard to navigate through the hallways without being repetitively stopped by local attendees.

We now describe usage at each of the conference activities.

Attending Talks and Navigating

Remote attendees primarily attended conference talks and this was relatively successful, from their perspective. They did, however, need to park at or near the front of the room in order to be able to see the presenter's slides. This could be challenging to do though because it was often hard to navigate to the front of rooms with tables and microphones in the way. Some survey respondents said that these locations caused Beams to block their view of the talks.

It was difficult for Beams to get to the microphone to ask questions—session chairs sometimes skipped their questions or were not able to easily accommodate when they wanted to ask questions. This suggests that session chairs may need to be trained on how to acknowledge questions from Beam participants, just as they might recognize questions from people with mobility challenges. Remote attendees sometimes did not know if they should approach the microphone to ask questions as the social norms were not known to them.

Some remote attendees commented that if they were parked next to local attendees, their downward facing camera inadvertently allowed them to see what people were doing on their laptops or phones. This is akin to a local attendee seeing someone using their phone or laptop, yet, in this case, people may not realize that the remote attendee's camera streams the behavior over the Internet.

The conference space was relatively large and this made it challenging for the Beams to get to different locations quickly. Having the conference spread across two floors—talks on Floor 2 and break food on Floor 1—was a major impediment and it meant many remote attendees chose to not attend the break sessions. Some felt that they would become a hassle as others needed to operate elevators for them. Larger conference venues will have even more difficulties when considering travel times between rooms for a Beam. Like past research [19], we found that a map of the conference venue was highly valuable, though our use of helium balloons as navigational landmarks within the conference venue did not seem to aid navigation, as commented by our participants. Alternatively, we feel a better placement for the balloons might have been in the hallways at the meeting room doors as remote attendees had a hard time identifying each room from the small signs placed next to their doors.

Large-Scale Interactions: Receptions and Breaks

Two remote attendees attended the poster and demo reception and made the experience work for them. They were able to move around, see demos and posters, and network with people, though moving in the crowded room was sometimes challenging. It was also difficult to easily move into and out of conversations and interactions with others.

"I liked the layout of the room…I could cut in places where other people couldn't or wouldn't feel comfortable cutting through so I was shortcutting it…If I hadn't gone through the shortcuts I would have had a terrible time getting around people, because you can't tap somebody on the back and say: 'Excuse me I need to get through!' I have to like yell at them or something." – D5.1

Sometimes the added attention that the Beams received made it challenging to look at the posters and demos without being somewhat forced to interact with the presenters.

"People were very interested in talking to me. Normally people are not that interested in talking to me, if you wanted to get someone's attention it was very easy, and people always get your attention and show you cool things, like in demo reception people always wave at me and like 'come here, I want to show you something.'" - D4.2

Nobody attended the conference reception, though they were asked if they wanted to prior to the conference and we had planned to transport Beams, if desired, to the offsite reception location (about a 5 minute drive). The common reason for not attending the demo and conference receptions was that it was too late at night. The demo reception started at 6pm and the conference reception started at 7pm, but given time zone differences, this meant that it was even later at night for our participants.

It was difficult for remote attendees to participate in breaks because of the audio landscape and navigation challenges (breaks were crowded and required an elevator ride to get to another floor). Those who were committed found ways to make large scale interactions work. Others realized how hard it would be and did not try.

Our participants talked about sometimes feeling like they were treated more like an object rather than a person when mingling with people and moving around the breaks and reception (similar to findings from [15]). This made some remote attendees self-conscious about their appearance. The feeling of objectification caused some participants to feel that interactions with local attendees were different than they would normally be if they were present in-person

Small-Scale Interactions: Workshops

Remote attendees were present in two workshops. One worked well and the other not so well. In the first workshop, one remote attendee was present and was able to engage in workshop discussions and activities. The remote attendee watched presentations for approximately an hour and then engaged in small-scale interactions with a subgroup from the workshop. This group interacted for the remainder of the workshop analyzing data and individuals in the group moved between tightly and loosely coupled group work with the remote attendee.

"It went very well for me in general. I'd say it was somewhere in the vicinity of 90 to 95% like being there. It was a little bit of hackathon, so it was like I was coding on my work computer while talking to people who were also coding on their laptops in the event and we were kind of sharing data back and forth and I think it worked very very well for that type of experience." – W1

In the second workshop, two remote attendees were present. One faced recurring connection problems at her location, which caused her to disconnect every few minutes. She had to give a presentation but she was not able to stay connected long enough to give it. Instead, the workshop organizer played a video of the presentation and then used alternate technologies to manage audience questions. Local attendees in this workshop were sometimes frustrated with the delays caused by the remote attendees.

"She disconnected suddenly when it was her turn. The Internet was too bad. They actually knew the Internet condition when they were training, so we had a plan B. We pre-recorded all the talks because we know there might be internet issues in the training session. When [she] gave her presentation, we played her pre-recorded video. When it came to the Q&A, we used WeChat audio chat and amplified via speaker. We hold the phone to let her listen to the question. We turned it (Beam) off. - O1

"[The Beams] did not work well during the workshop i attended and set us back in the schedule." - C79

The other attendee stayed connected for several hours while he watched presentations through the Beam. This person gave a presentation through his Beam. He verbally described his slides while a local person advanced them on a separate computer connected to a projector.

For both workshops, remote attendees were noticeably not able to participate in shared lunches as part of one of the workshop's activities or dinner or drinks afterwards.

"Honestly the whole downside of the event was that I couldn't go for a beer afterwards… I obviously missed out on the social aspects of it. That is a big benefit of attending the conference right! But even then during the lunch time you know I was just chatting and coffee breaks I was chatting with people." – W1

Ad-Hoc Usage

One person had a last minute family emergency and could not travel to CSCW to present her paper. A colleague showed her slides from the speaker podium and the presenter gave the talk remotely through a Beam—with the permission of the General Chairs. This was experimental given that normally you have to be present at a conference in person to have your work published. This setup worked well and the presenter was able to complete her talk and answer questions through the Beam. This suggests the potential for offering remote presentation possibilities for restricted cases (e.g., accessibility needs).

We had an additional two people participate as panelists during two different panel sessions at CSCW where their Beam was placed on the panel stage in front of a table. The goal was to allow them to engage in discussions as part of the panel. While it was beneficial to incorporate them into the sessions from their remote locations, they appeared to be somewhat overlooked during the session and were not able to engage in discussions very well. This suggests that more advanced planning is needed to develop better strategies for having remote attendees as panelists in order to increase their participation.

For the remainder of the results, we explore the deeper socio-technical benefits and challenges that emerged for remote attendees.

PERSONALIZATION

Personalization was valued by our participants and helped create a sense of ownership and identity within the telepresence robot. They generally felt that the personalization items helped others to recognize them.

"I don't know that I got a sense that it was me, but I think that actually having the name tag on it when I arrived and having the T-shirt on the top did give me a sense of ownership over it. I wouldn't call it at the level of a surrogate or embodying that thing but certainly the feeling of a little bit of ownership." – S3

In the closing survey, we asked local attendees to rate their agreement with the statement, "I was able to identify and associate the remote people with their Beam at the conference" on a 7-point scale (from 1-Strongly Disagree to 7-Strongly Agree). The mean score was 4.1 ± 1.8 (median=4).

Those who did not personalize their items either did not pay much attention to the balloon we attached, felt they were fine as default items, or wished they had sent their own item that was more serious in nature.

"I wish I had sent/asked in advanced for a more personal and maybe more 'serious' and not disposable object but I didn't get around that, the balloon was good enough as far as bringing some color and personalization although it might have played into whatever enabled the sometime condescending/paternalistic/not taking seriously approach that I have felt from some attendant I interacted with." – D1

With the shared Beams, we had to ensure that each Beam had the proper personalization items on before the remote attendee connected. This involved changing items during breaks. In only one case was there ever an accidental situation where a Beam was not properly personalized for the remote attendee. The participant's response to the situation illustrates that it was the personalization items that created a sense of ownership or possession to the Beam, and not the Beam itself. Thus, Beams could be interchanged amongst people, providing that the visual markings depicting personalization (or ownership) were accurate. We caution, however, that only one participant faced this experience in order to comment on it.

"I beamed into the one that was on the schedule that was Beam #6 and that ended up being [another person's] Beam and there was also that feeling that I was in someone else's Beam. Not that I'm in that person's body, but someone else's possession… I could see other people are more sensitive to that type of thing but I'm pretty share and share alike as a personality so I don't really feel that bad about it." – S3

While we had hoped to provide people with a way to personalize their Beam to reflect their identity in some way, participants appropriated the idea in a way that made it a method to brand a Beam for a particular institution or geographic location. Thus, personalization was less about an individual's identity *per se*.

"At first when you told us to get the identity, what I thought I'd do was have a bandana with our university logo and a [country] flag…. I thought it might not be enough time. So I looked in Amazon and I wanted something with the university identity or [country's identity]. So I picked something from [my country]." – D3

We did not guarantee to participants that they would receive their items back as this would have been more logistically challenging. As such, personalization items tended to be throw-away or inexpensive items.

"The nice thing is the scarf was free, they were handing it out in a recruitment event."- D4.1

Some remote attendees had a person from their institution who was present at the conference and could take their items back home with them. This prompted one participant to wonder if their research group would reuse the items for future telepresence attendance to create a longer-term institutional identity across conferences that they would remotely attend.

We offered a basic level of personalization and, naturally, people wanted more options. For example, some people wanted to fully clothe their Beam or be able to change clothing items. Those people who shared a Beam within their institution and had one set of personalization items for the entire group. This created mixed reactions. Some felt that it was beneficial to have the Beam personalization associate them with their institution. Others were concerned that the items did not reflect their own personality or style of attire, or that the items were not of a professional nature.

"Our robot was more like a boy. The hat and scarf, it was more like a boy. Maybe I would more girlish, feminine things" – D5.3

Even though participants sent us their items and we provided a full-length mirror for them to look at themselves before leaving the Beam control room, participants commented that they still did not have a good sense of how they really looked in their Beam with the personalization items. The most effective way of understanding how one looked was to have friends at the conference send pictures to the remote attendee.

SHARING AND COORDINATION

As mentioned, three remote attendees shared Beams throughout the conference where they connected in for pre-selected sessions. Beams were also shared opportunistically in other ways that we had not previously imagined; this illustrates the creative ways in which remote attendees may appropriate Beams in ways that match a broader set of needs for remote attendance.

One remote attendee used his Beam to connect into CSCW while teaching his undergraduate class. He situated himself in the middle of the camera's view and the rest of the class was seen in the background. They attended a CSCW session on education.

"It certainly feels like I'm less of a head and more of a portal. And people are seeing into my world…I got a webcam, not just the laptop, and kind of propped it up so we could get a wider view of the class. So people could see we were the class. I also reminded people that if you don't want to be seen then don't sit in this general area. Sit on the sides…. We did have one student who sat in that area because they didn't want to be seen." - S3

As described, two research groups shared their Beams amongst graduate students. This was seen as being highly beneficial by the students as attending the conference in person was not something that was financially possible. They all decided to use the Beam at one point or another during CSCW because they saw the value in attending the conference for part of the time, albeit from their remote location. The fact that they were sharing a Beam also made it less stressful for some since they did not feel obligated to be at the conference the entire time.

"I have a job and meetings and so I couldn't have been present for the entire time. It was nice I did my part and I knew other people were getting the Beam experience. It was very nice having multiple use the Beam." – D5.5

Despite the positives, participants from this group described several challenges to this type of sharing. First, it was clear that it was more difficult to identify the person in the Beam at a particular time since everyone had the same identity items. This made it easy for us as organizers since we did not have to change the personalization items. It also meant that local attendees from the same institution could easily recognize their Beam regardless of who was in it. Yet this benefit was to the detriment of the remote attendees if they wanted to fully present *themselves* at the conference and not necessarily their institution.

Second, coordination issues emerged around who would get to use the Beam at various points in time and whether or not the Beam would be ready when 'your turn' came. Some people were not able to attend all of the sessions that they wanted to. Some faced issues in getting 'bumped' out of their Beam because the next person wanted to use it and they were not ready to leave.

"It was good because maybe some prefer morning times, some prefer evening times. Always there was someone on the Beam. As a lab we didn't miss anything. But as a person… personally I miss many, like there was an award session, so I missed that. And I really wanted that…I would have liked to see how the Beam could see the posters or whether I could be able to read the posters." – D5.3

Third, sharing a Beam sometimes meant being restricted in terms of where you connected from, e.g., being forced to connect from a shared research lab location rather than one's home. Conceivably one could connect from anywhere, however, it was sometimes easier to be in the same location as others who were sharing the Beam. In this way, the shared location was both a drawback and a benefit. For example, it allowed remote attendees to setup a single laptop with the Beam software and easily know when the next person was ready to connect since they could ask them in person. They could also use the Beam at the same time to see the same session talks.

When asked if survey respondents noticed that Beams were being shared vs. dedicated, 160 survey respondents said they did not notice, while 33 said they did. This suggests

that the sharing of Beams was relatively unnoticeable to local attendees and did not affect their experience. 46 respondents suggested that future CSCW conferences use a mixture of shared and dedicated robots, 20 suggested only dedicated robots, and 109 did not have an opinion.

SOCIAL CHECKUP AND TECHNICAL HELP

All remote attendees joined the backchannel at one point or another along with five support staff and one local attendee (the faculty supervisor for one of the shared institution Beams). Attendees made a total of 267 posts with an average of 22.8 +/- 26.1 posts each (median=16, min=1, max=104). Support staff made a total of 168 posts with an average of 44.6 +/- 37.2 posts each (median=39, min=11, max=105). The local attendee made 18 posts. All posts occurred during the main conference talks or breaks with the exception of only five that occurred during the demo reception.

Table 2: The types of posts made in the backchannel.

Type of Post	Count	% of Posts (n=619)
Technical Comments	190	30.7%
Social Comments	181	29.2%
Social Questions	55	8.9%
Social Answers	47	7.6%
Technical Questions	47	7.6%
Technical Answers	43	6.9%
Skype Notifications	31	5.0%
Greetings	25	4.0%

Table 3: The sender and intended receiver of posts.

Sender	Intended Recipient	Count	% of Posts
Remote attendee	Support staff	194	42.8%
Remote attendee	Remote attendee	53	11.7%
Remote attendee	All remote attendees	10	2.2%
Remote attendee	Everyone	0	0%
Support Staff	Remote attendee	129	28.5%
Support staff	All remote attendees	24	5.3%
Support staff	Local attendee	10	2.2%
Support staff	Everyone	8	1.8%
Support staff	Local attendee	7	1.5%
Local attendee	Remote attendee	11	2.4%
Local attendee	Support staff	7	1.5%

Our coding revealed that the backchannel afforded remote attendees with an opportunity to gain both technical and social help. Table 2 shows the types of posts made in the backchannel. Overall, 280 posts (45.2%) were about technical topics, such as questions about the Beams' features, comments on the telepresence setup, questions about Wi-Fi, etc. A very similar amount, 283 posts (45.7%), were about social topics such as social etiquette, social norms, locations to park in rooms, etc. Thus, posts were relatively balanced between technical and social topics.

Table 3 shows details on the sender of each post and the person we coded as the (most likely) desired recipient based on the tone of the post, its contents, or if anybody's name was mentioned explicitly. Posts between remote attendees represented only 13.9% of all posts. Posts between remote attendees and support staff accounted for 76.6% of all posts. Thus, the backchannel was dominated by conversations between staff and remote attendees.

Our observations throughout the conference showed that, somewhat surprisingly, the backchannel became a means for remote attendees to get social information from someone physically present at the conference. Because support staff were physically present in many of the sessions that the remote attendees were present in (for observation purposes), remote attendees would frequently ask questions of them in the backchannel. For example, they would ask about their positioning in the room, whether there was a better viewing location that was empty, if it was socially a good time to leave, if they were too loud, etc. In this way, support staff became local proxies for the remote attendees by providing them with information that was difficult to ascertain through the Beam. This could be done discreetly through the backchannel, rather than talking aloud in the conference sessions.

"The backchannel was essential for [getting help]… I was trying to move to a new place in the session I could ask people there. I wanted to move in front of the speaker between talks and I wasn't sure if it was a good idea to do. Other people were in the room to ask." – D3

One of the institutions that shared a Beam had, on their own accord, assigned a "Beam Buddy" for each time that a student was remotely connecting into the conference. This person was local at the conference and stayed with the remote attendee. In a similar fashion to support staff, the Beam Buddy acted as 'eyes on the ground' at the conference to share additional contextual information with the remote attendee. This group also created their own separate backchannel as means to coordinate the sharing of their Beam.

"We had a Beam buddy on the other side to help… in the spreadsheet there was another column listing the Beam buddy. They'd say someone else is coming to take care of you. Then the other person came. They could also help. For one of the coffee breaks, [my supervisor] was helping us. It was more than navigating, it was helping us talk to people, introducing us." – D5.3

As stated, conversations between remote attendees were less frequent. In these cases, remote attendees would share tips with one another about, for example, how to adjust

sound or where to position themselves in the room. We hypothesize that there were far fewer posts between remote attendees since most of them were relatively new to using a Beam, as compared to the support staff; thus, support staff were more able to provide help and suggestions. Moreover, most of the remote attendees did not have an established social relationship prior to the conference.

Somewhat surprisingly, none of the posts in the backchannel talked about the contents of the paper presentations. Conceivably, the backchannel could have been used as a forum for remote attendees to discuss the contents of talks, yet they did not.

The backchannel was not always a positive experience for remote attendees. Sometimes it became distracting because new posts created an audio alert on the remote attendees' computers, even when the post may not be directed towards them.

COMMITMENT

We learned that fully committing to attending a conference or portions of it from a remote location can be challenging. We had several people who did not show up as remote attendees or cancelled before the conference started. Others were not able to commit to attending the driver training or orientation of the hotel. Once CSCW began, remote attendees faced varying levels of commitment issues to attending the conference. This was even the case for participants who only intended to come for one or two sessions. Those who felt they were successful at 'being at' the conference had done some preplanning work before the conference in order to be ready. This included looking at the program to select which sessions they were going to. One participant even talked with her family and co-workers to let them know that she was going to be 'away at a conference' that week.

"I kind of warned people I'm going to be at the conference this week… we don't have classes yet this week. So I didn't have to teach or anything. Otherwise I would have had to make arrangements. "- D3

For others, pre-planning for the conference was not something they thought of, though in retrospect they realized it would have been a good idea. Instead, participation at the conference could easily become of secondary importance when compared to the activities happening at one's actual location. This included family happenings, last-minute work meetings, casual interactions with co-workers, etc. The challenge is that family or co-workers see the remote attendee present either at home or work and somewhat assume a sense of availability.

"I was more obligated to attend to my real life meetings…Beam activities were secondary and my real life was more important since there were people here whom needed a response."- D4.1

One person talked about it being difficult to commit to sitting in front of her computer for long portions of time at the conference. This created less exercise for her than she normally received during a typical workday.

As mentioned, being able to share a Beam was one way that participants were able to commit to smaller portions of the conference and not feel guilty about a lack of attendance.

DISCUSSION

The goal of our study was to explore how remote attendees participated in conference paper sessions, breaks, workshops, and receptions using telepresence robots. Compared to past efforts in studying telepresence attendance at academic conferences, notably at Ubicomp/ISWC 2014 [19], we explored a broader set of participation across conference events and an increased numbers of participants. We also explored a differing telepresence setup, which included the use of both dedicated *and* shared telepresence robots. Together, these differences allowed us to explore a broader set of circumstances.

We found similar challenges for remote attendees at CSCW 2016 when compared to Ubicomp/ISWC 2014 [19]. In this way, our work validates prior study results with increased numbers of participants and conference activities (e.g., receptions, breaks). Similarities included difficulties navigating in tight spaces; difficulties seeing presentation slides unless one was parked near the front of the room; challenges using eye contact and body language when communicating during breaks; a lack feedback of audio levels; additional social attention because of the novelty of the Beams; and, privacy issues from local attendees being able to see into remote attendees' homes. Second, we found important differences with past research that were elucidated by having broader remote participation at CSCW. The remainder of our discussion focuses in on these findings and their implications for future telepresence attendance at academic conferences along with corresponding design implications.

Personalization

Past efforts to personalize telepresence robots at an academic conference saw little uptake (2 of 7 remote attendees chose to personalize their robot [19]). We made personalization a requirement at CSCW and, for those who did not choose to personalize, we added a default personalization (colored balloon). This largely worked well, yet the setup also created challenges. Personalization was done through physical objects as opposed to digital ones. This made them highly noticeable but increased work for remote attendees and support staff, given the number of remote attendees. Items need to be purchased and shipped by the attendees, and then pre-collected, stored, and managed throughout the conference by the support staff. Remote attendees wanted more options, especially when it came to using shared Beams such that each user could tailor the robot to their own needs.

If telepresence efforts are to scale to include larger numbers of remote attendees, the use of physical objects for personalization may not scale, unless items are made to be more generic across participants. On the other hand, some form of digital augmentation to telepresence robots may offer a compromise. Here we see the need for personalization to move 'off the screen' to places attached to the robot to increase visibility. Yet one must also be cautious with digital approaches. With digital personalization, there is risk that a person may try to change their personalization often since it easy to do so. In actual fact, personalization that changes less over time may be easier for local attendees to identify with at the conference.

Appropriation

We had imagined that telepresence attendance would follow a model of participation that we had established as the telepresence organizers. However, it was evident very quickly that telepresence attendance was much more about appropriation and allowing the remote attendees to decide how to best make use of the opportunity that Beams afforded them. Remote attendance was not a *per person* activity like we expected. Clearly social norms are developing and the model for remote attendance is not like the model for local attendance. In the local case, a person registers and attends the conference as him or herself. There is no other type of attendance. Yet remotely, there is a whole host of ways to utilize one's "attendance."

The implication is that telepresence attendance should be considered a flexible option to support a multitude of different situations. This suggests that a 'one size fits all' model is not good enough when it comes to the design of telepresence robots. Differing attendance models may require different types of robots. For example, two people attending the conference through a single telepresence robot may be more apt to want to choose a 'two-headed' telepresence robot than one with a single display. A person using a telepresence robot as part of a class may want a wider screen to show the entire class, or the ability to visually obscure people who do not want to be on camera. These are but several sample design ideas. Other design solutions may similarly map to the changing needs of the remote attendees and their appropriation of the robot. Appropriation will also certainly bring unique challenges to conference management where it may be difficult to anticipate one's usage ahead of time.

Social and Technical Support

Our backchannel provided remote attendees with a means to gain both social and technical support at the conference. Compared to McCarthy and boyd's study of a backchannel at CSCW 2004 [17], which focused almost exclusively on discussions about talk contents, our backchannel never focused on presentation content. Instead, it was most often about solving issues with the Beams and deciding how to behave and act in the conference environment. While beneficial, one caveat with this approach relates to who is providing the social advice on what one ought to do in a Beam. A large portion of our conversations in the backchannel were between support staff and remote attendees. Thus, support staff could play a large role in suggesting behaviors to remote attendees. However, this may not always be desirable and it has the potential to leave the suggestion of social norms in the hands of a few, rather than being organic in the hands of many.

What was surprisingly successful about the backchannel were instances where support staff and local attendees were able to provide 'eyes on the ground' to the remote attendees. This suggests that future design work for telepresence attendance should explore additional ways for remote attendees to communicate with local attendees.

Commitment

Lastly, commitment was perhaps one of the largest challenges for CSCW telepresence, from both an organizing perspective and an attendee's perspective. Past research of remote attendance at Ubicomp/ISWC 2014 did not report any commitment issues [19]. This clearly points to the need for ideas to support a certain level of commitment to attendance. This might rely on a specific registration cost to ensure one is committed to attend (also suggested in [19]). It could also mean added support around methods to help one pre-plan their conference attendance much the way a person might when attending in person, e.g., selecting talks to see ahead of time.

CONCLUSION

We conducted a study of telepresence attendance at the CSCW 2016 conference using telepresence robots. Remote attendees participated in workshops, the demo and poster reception, and conference talk sessions. Our telepresence setup expanded out the number of attendees from past efforts (e.g., Ubicomp/ISWC 2014) and explored dedicated *vs.* shared robots and telepresence robot personalization. Our results show that shared robots provide a compelling way for remote attendees to attend an academic conference; in fact, sharing can be expanded out in a variety of different ways based on user appropriation of a telepresence robot. Personalization of robots is valued, yet can be challenging when robots are shared amongst multiple attendees. Social and technical support through a backchannel is beneficial, especially when it can provide local contextual information. Commitment is a deterrent to successful remote attendance, which suggests strategies for pre-planning one's attendance. Moving forward, we feel it is valuable for researchers to continue to explore telepresence attendance at academic conferences, with particular value in understanding the scalability of such attendance across larger conferences and venues.

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