Embodied Social Proxy: Connecting Hub-and-Satellite Teams

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ABSTRACT
Current business conditions have given rise to a particular kind of distributed team that is mostly collocated except for one remote member. These "hub-and-satellite" teams face the challenge of leaving the satellite colleague out-of-sight and out-of-mind. We developed a telepresence device, called an Embodied Social Proxy (ESP), which represents the satellite worker in collaborations with hub colleagues. ESP serves as a consistent video conferencing terminal for the satellite that can be moved to wherever meetings occur. Our studies of teams using ESP in their daily work show that its continuous physical presence improved the interpersonal connections between hub and satellite colleagues.

Categories and Subject Descriptors
H.4.3. Information systems and applications: Communication applications: *Computer conferencing, teleconferencing, and videoconferencing*.

General Terms
Design, Human Factors.

Keywords
Distributed collaboration, embodied video conferencing, telepresence.

HUB-AND-SATELLITE TEAMS
Integrating remote workers into distributed teams is a key challenge for many organizations, especially as they add remote sites to attract and maintain talent around the world. As companies transition from collocated employees at a centralized site to distributed work among newly added sites, teams may need to interact with individuals or small groups of remote colleagues at a different location. Asymmetrically distributed teams can also result from other business trends, such as out-sourcing, hiring or retaining someone who needs to live in a different location, or consultants that remotely join a team for a time interval. This asymmetrical distribution brings a focus on the challenges of integrating these remote *satellite* workers with the center of gravity of collocated workers at the *hub*.

The fundamental asymmetry of these teams presents challenges that are distinct from other topologies of distributed teams (e.g., two sites collaborating with each other, individuals all distributed from each other). Collocated teammates reap the benefits of face-to-face communication, continuous awareness of others' availability and work activity, and readily initiated ad hoc conversations [3]. Teams that are evenly distributed between two or more sites have a social context at each site. The solitary remote satellite worker, however, is a secondary participant in meetings, unable to participate in hallway conversations, and, in short, out-of-sight and out-of-mind. The satellite worker experiences the technical limitations of remote collaboration technologies (e.g., audio, video, awareness), and the social effects of being separated from the team's center of gravity.

We developed the Embodied Social Proxy (ESP) concept to address these deficits by giving the satellite worker a physical embodiment in the workspace of the hub team. An ESP is a videoconferencing terminal dedicated to a specific satellite worker during meetings (Figure 1) and provides awareness information about their availability and work activity between meetings. ESP is small enough to be moved among meeting sites but large enough to show the satellite worker at roughly human-scale.

RELATED RESEARCH
While there has been much CSCW research to explore video-mediated support for distributed work, prior work has not focused on the particular needs of hub-and-satellite teams. Media space systems [1] have used high-fidelity video and audio connections to connect physical spaces (e.g., offices, lounge areas). Some media spaces even explored physical representations of others' presence information [4]. The Hydra system [6] used a media space to support fully distributed videoconferencing meetings by embodying each participant into a separate desktop terminal. This separation enabled users to naturally refer to the different participants through gaze and orientation.

Figure 1: A meeting where one remote satellite worker is represented by an Embodied Social Proxy.

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Portable videoconferencing embodiments [8] enabled carrying a laptop-based video terminal into a variety of meeting environments where it could be set up on a table to interact with colleagues in a meeting. Robotic embodiments [2, 5] enabled a remote user to autonomously move about and engage with people in a variety of locations.

ESP lies at the intersection of media space video conferencing terminals and robotic telepresence units. While we wanted to enable the video terminal to move around to wherever meetings occur, we aimed for a prototype that would afford viable implementation and deployment of a number of units in our company. We wanted to enable studying and understanding long-term deployment issues and the impact of ESP on the social dynamics of the team. We also focused on the distinct needs of asymmetrically distributed hub-and-satellite teams.

DESIGN AND DEPLOYMENT

We initially designed ESP to meet our own need to integrate two satellite members into our research team. We used iterative- and under-design methodologies to evolve from a minimal solution – a laptop with a webcam – to a design that met our daily needs. The final design (shown in the video) included a 20" LCD screen, a webcam, a mechanical pan-tilt-zoom network camera, a fisheye network camera, and an echo-cancelling speaker/microphone all mounted on a cart (Figure 1) along with a CPU, uninterruptible power supply and networking hardware. Videoconferencing could be initiated and terminated by either the hub or the satellite. While in videoconference mode, the satellite's video filled the screen and the satellite saw multiple video feeds; otherwise the screen showed the satellite's calendar, current and historical IM availability, and connectivity information.

These two ESP units have been in daily use for over nine months. Beyond the characteristics of the device itself, there were two notable aspects of ESP usage. First, we relied on "handlers" at the hub site to move the carts around and ensure that ESP was working properly. Second, giving ESP a "home" location between meetings turned out to be very important for encouraging more interactions with the satellites. We eventually dedicated an office to the two ESP units, where many small meetings occurred.

We considered these two ESP units to be useful and generally successful at meeting our goals. We contracted an external researcher to study our research team's use of these two ESP units, using one-on-one interviews, direct observations of meetings where one or both ESPs were used, and a diary of daily ESP usage kept by the two satellite workers. This study showed that ESP helped the satellite workers to be effective meeting contributors.

We built four more ESPs for four different hub-and-satellite product teams in our company. Besides enabling us to deploy ESP outside of our own research group, we were able to explore how different dimensions in the product teams affected their use of ESP. The satellites varied in their seniority, time working with the team, travel frequency to the hub location, home locations, and time zone differences. The teams varied in the activities they performed, their working cycles and needs for communication. These variations allowed us to contrast multiple dimensions that affected the usage of ESP and the team's interactions. We found that beyond just helping in meetings, ESP helped form social ties between the hub and satellite workers. Details on these studies are covered elsewhere [7].

CONCLUSIONS

Based on our experiences with ESP, we found evidence of how ESP improved in-meeting interaction between hubs and satellites and, perhaps more importantly, facilitated the social integration of the satellite into the hub team. ESP provided a way to include the satellite in some of the social connection that typically happened face-to-face at the hub (e.g., chatting before starting the meeting, saying "hi" in the hallways, or joking about the ESPs). We note that the asymmetrical distribution of the teams was at the root of the challenges of socially integrating the satellite. Since the hub colleagues could easily leverage the richness of face-to-face interaction, using less rich electronic media to connect with the satellite put them at a disadvantage. The inherent asymmetry of the hub and satellite gave rise to the need for a telepresence device to provide an effective way to maintain interpersonal connection. We plan to continue to use ESP to explore how it can support distributed work over the long term and in different team situations (such as satellite new hires joining the team).

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