Your mileage may vary: Case study of a robotic telepresence pilot roll-out for a hybrid knowledge work organisation

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ABSTRACT

Organisations wishing to maintain employee satisfaction for hybrid collaboration need to explore flexible solutions that provide value for both remote and on-site employees. In this case study, we report on the roll-out of a telepresence robot pilot at Microsoft Research Cambridge UK to test whether robots would provide enjoyable planned and unplanned encounters between remote and on-site employees. We describe the work that was undertaken to prepare for the roll-out, including the Occupational Health and Safety assessment, systems for safety and security, and the information for employees on safe and effective use practices. The pilot ended after three months, and robot use has been discontinued after weighing the opportunities against low adoption and other challenges. We discuss the pros and cons within this organisational setting, and make suggestions for future work and roll-outs.

CCS CONCEPTS

• **Human-centered computing → Collaborative and social computing devices**.

KEYWORDS

mobile robotic telepresence, hybrid work, hybrid office, videoconferencing

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1 INTRODUCTION

In light of the shift to remote and hybrid work that followed the COVID-19 pandemic, Microsoft Research Cambridge UK (the "lab" hereafter) ran a pilot roll-out of Mobile Robotic telePresence (MRP), a videoconferencing system on a remotely controlled mobile robotic device, to explore whether this technology would improve connections between remote and on-site employees. MRP has potential benefits for hybrid work, but the pilot found low uptake from employees and other challenges, among them security concerns, and the lab decided to discontinue use once the pilot ended. In this paper we report on the practical details of making the robots available for office use, sharing an overview of what was involved, and discuss the opportunities and challenges within this organisational setting. In doing this we frame MRP as a technology that must be understood within the context of social and institutional organization(s), with an emphasis on telepresence in practice.

Many workers in the knowledge industries show strong preference for flexible and remote work [3, 4], but it is not without limitations. A particular drawback of remote work, as we saw during COVID-19, was the loss of spontaneous and serendipitous interactions around the office (e.g., in the hallway, before and after formal meetings, by the watercooler) [2, 13, 16, 17]. Such interactions are important for the employees' well-being and social needs, and are also important for the work itself. Unplanned talk, sparked by physical proximity, creates trust and morale, and is often where work-related information is shared and where decisions are made [16, 24]. An office, as a space where employees come together to interact and not just "work", should cater to that function even in the hybrid mode to ensure that remote employees are not disadvantaged by the lack of in-person contact.

MRP could support this, as it allows a remote user to move autonomously around an office [1]. Previous studies report that users have found it useful for informal interactions [14], and that it helps remote users feel and be perceived by their colleagues as more present and more committed to their work [1, 12, 30]. As such, the lab sought to explore the possibilities of MRP for supporting an engaging hybrid place of remote and on-site employee connection. Although there have been studies on MRP robots in offices, those have mostly been of temporary use of the technology for the purposes of reporting on the users' experiences [12]. There have not, to our knowledge, been reports on what is involved in fully implementing a real-world MRP technology roll-out in a knowledge work organisation to directly support day-to-day hybrid work.

In presenting this case study, we wish to bring attention to the subject of hybrid work and workspaces with reference to a practical example. In this post-pandemic era, organisations need to think

[1] *Remote user* refers to the person operating the robot from a remote location, and *on-site users* refers to people in the same location as the robot (the office) who may or may not be directly interacting with the robot [22].

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more intentionally about the design of organisational spaces, to make them worthwhile places for employees to come in and work. We report on our pilot robot roll-out, to demonstrate the issues involved and highlight the importance of practical considerations in an actual field deployment. We also report on the employees' responses, to highlight the importance of understanding the real problems to be solved. We thus want to stress that providing effective hybrid solutions is a difficult undertaking. It will require a nuanced understanding of users' needs and more careful thinking about how we design spaces and systems for communication and collaboration.

2 THE ROBOTS

The lab purchased five Double 3 MRP robots [23], with the intention of having one for each floor of its building. The robots consist of a 9.7 inch touch screen, equipped with a microphone, camera and speakers, attached on a pole (of remotely adjustable height) which is then attached on a gyroscopically-stabilised two-wheeled base. Each robot comes with a docking station, which is plugged into an electrical socket and allows a docked robot to charge (figure 1).

Figure 1: A Double 3 MRP robot parked in its dock

Before we continue, we also note that although the lab discontinued use, this case study is not intended as a critique of the Double 3 robots or the company. Instead our case study highlights the importance of considering a wide set of organizational, social, and technological factors which may play a part in the success or otherwise of a field deployment. In that way our study attempts to promote a change in the unit of analysis away from the device itself towards the device's organizational, social, situated embedding. We believe that MRP technology has many use cases, but even when these seem clear, whether it works in practice for a particular organisation at a particular point in time is a matter of various practical circumstances which researchers should work to uncover and document.

3 OVERVIEW OF ROLL-OUT PROCESS

Table 1 provides an overview of the different tasks that had to be completed. As shown in the table, this work took several weeks and involved collaborating with many other teams, as well as with the users. However, the for the most part these tasks were done in an overlapping manner. While we waited for Occupational Health and Safety (OH&S) to draft the risk assessment report, we were in contact with them about potential risks and working to fix them, such as looking for accessibility solutions (Section 4.2), and writing instructions for safe use (Section 4.3).

4 PREPARATION FOR THE ROLL-OUT

This section outlines the work that was done prior to the roll-out. Despite much preparation, the process turned out to be iterative based on our changing understandings of issues over the course of the pilot.

4.1 Occupational Health and Safety

Before making the MRP robots available to the employees, we held an OH&S assessment. The external OH&S team had not dealt with these robots or anything similar before, so they asked for any information or reports we could share from similar cases. We sent them photos and videos of the Double 3 robots, and links to the product's specifications. However, we were not able to find any reports or case studies describing the health and safety assessment of robots in office spaces.

As such, they followed standard practice and proposed an on-site assessment. However, since the first opportunity for a site visit was to be after the pilot was due to start, we invited them to experience the robots as remote users. During their remote "visit", we showed them how to use the robots, and they tested how they moved, avoided collisions, and other issues. The inspectors were able to see each other as robots in the office, so they saw both the perspective of a remote user and how the robot might appear to on-site users. As a result, the site visit was not needed. Apart from some follow-up questions, they had all the necessary information to draft the assessment report.

In their assessment, OH&S rated all potential hazards as low risk - meaning that they have very low likelihood of occurring and/or posed slight or negligible risk of injury. The specific issues that were brought up during the process were about accessibility, safety and equitable use, and security. In the following subsections we show how we worked with IT, and Facilities Maintenance to address these.

4.2 Accessibility

The Double 3 robots are almost silent when the remote user is driving without speaking, so a blind or low-vision person may not know that such a robot is in their vicinity. The robot would need to indicate its presence using sound. We asked Double if they provided such accessibility applications, but they did not. Instead, we came up with the simple solution of equipping the robots with cat bells (Figure 2). We taped the bells on the robots' wheels, so that they moved and chimed with every wheel rotation. The sound was sufficiently noticeable without being distracting. A blind employee at the office reported that, once we explained to her the significance

Table 1: Tasks required for the roll-out

Task	Time frame	Other teams involved	Section
Risk Assessment	5 weeks	OH&S, IT, Facilities Maintenance	4.1
Accessibility	2 weeks	Users	4.2
Safety	2 weeks	IT, Facilities Maintenance	4.3
Security	3 week	IT	4.4
Robot Placement	Iterative throughout the process	Users, Facilities Maintenance	4.5
User Guidelines Creation	4 weeks	Office Outreach	4.6
User recruitment	5 weeks	Office Outreach, Facilities, Business Admins	5

of the sound, she was able hear it and know when a robot was in use near her. Moreover, sighted, on-site users have found it useful to be able to hear when a robot is approaching, as they had also previously found the stealthy movement of the robot unsettling. We did not have the opportunity to assess accessibility for other needs.

Figure 2: Cat bells were attached to the robots' wheels

4.3 Safety and equitable use

The Double robots are equipped with sensors that scan their 3D environment and avoid obstacles. When an obstacle is in their way they automatically adjust their path around it. Their speed is also restricted to 1.8mph, which is slower than the average walking speed. This makes it nearly impossible to have collisions. When the robots run out of battery whilst in use, their brakes automatically activate and they park in place.

However,the robots need to be docked between uses to recharge and be available to the next user, and so that they are not blocking the hallways. To address this, we posted instructions on the back of each robot asking on-site employees to move un-piloted robots out of the way and contact Facilities. This included information on how to pick up and move the robots without damaging them (Figure 3). We asked the on-site Facilities team to check on the robots as part of their regular office rounds and move any found or reported robots back into their docking stations. In addition, our onboarding and instructional materials reminded remote employees to always dock the robots after use (see section 4.6).

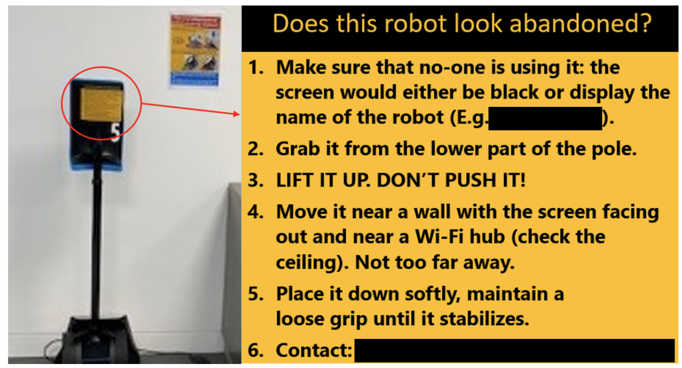

Figure 3: Instructions posted on the back of the robots, for on-site employees encountering abandoned robots in the office

4.4 Security

To manage the devices, we opted for Double's additional subscription service, Fleet Management, which allowed us to control who has access to the robots, see call logs and quality reports, and create visitor access passes. Access to these services, along with driving and AV streaming, is protected via standard web encryption.

To ensure that only lab employees had access to the robots, we used an internal security group. To gain access to the robots, new users were instructed to join this group through a link. The group only permitted users who were registered as lab employees to be added to it, and automatically removed members who lost that status. When a new member was added to the group, we sent them an invitation to sign up to the Double portal, and when a member was deleted we removed their access.

Even with encryption and our additional security group process, all MRP robots have some security risk for organisations that have strict security protocols. Using external web services represents some risk, although this can be assessed as reasonable through review processes. However, MRP represents a special case of risk for organisations that also have strict security and confidentiality protocols traditionally protected by building access. By design, MRP enables a remote user to have mobile access to a building without passing through physical security systems. Since there is no direct way to control who is at the remote endpoint in real time, or, in the worst case, a device with robot access credentials is misplaced, stolen, or compromised, some organisations may consider MRP to be an inherent security risk. Even if the risk of a security breach is low, the repercussions could be very serious. As a research lab for a global technology company, and given the low adoption, after the pilot it was decided that use should be discontinued until processes for enhanced security can be developed.

4.5 Robot placement

The physical placement of the robots and their docks in the building was an ongoing challenge. For safety reasons, robots must not reduce or block access to fire exit pathways, pose a potential tripping hazard, or have cables that run through a pathway. We tried to place the docks near where people intended to use them so as to reduce time spent driving to and from the dock. Moreover it made sense to place them in areas with good Wi-Fi connection to ensure that remote users did not encounter connectivity problems when they log in. We also needed the area to have enough free space for the robot to be easily driven in and out of its dock. Finally, we tried to avoid placing them near open plan desks to avoid distracting the people who were working there.

There were not many places in the lab's building to satisfy all these requirements. Most areas that were away from desks were fire exit pathways which could not be blocked. In non-pathway common areas, such as collaboration spaces and kitchens, there were not always sockets behind walls and using a nearby floor socket would lead in exposed cables causing a tripping hazard. There also were not many empty walls against which a robot could stand without being awkwardly placed between furniture and other equipment. In some cases, we had to make compromises with regards to ideal placement, prioritizing safety over convenience (Figure 4).

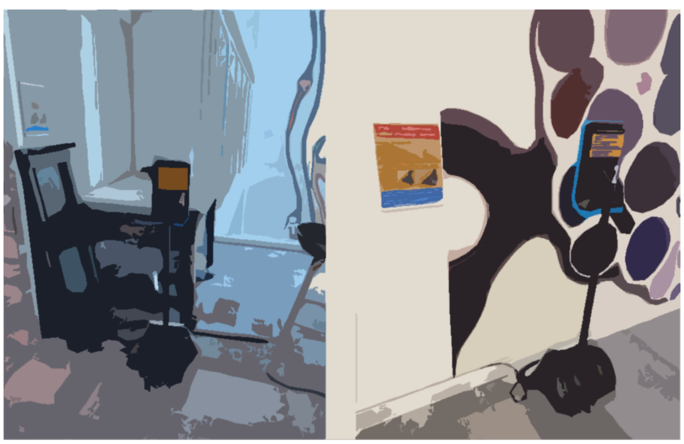

Figure 4: Robot docking locations in different areas of the building

4.6 Information on use

In addition to the instructions on the backs of the robots (Section 4.3), we used a SharePoint site to provide more information- instructions, bookings calendar, maps of the building, locations of the robots, and contact details. We created written instructions on how to use the robots, accompanied by images of the interface. These covered how to log in to the robot, exit the dock, drive the robot, adjust the robot's height and volume, zoom, park in place and how to dock the robot. We also made posters that were placed near the docking stations, asking on-site employees not to block the docking stations and repeating information on how to handle the robots and who to contact for help. Finally, we also created a short video (around 5 minutes) with instructions on effective use. This covered some of the social implications of using a robot that have been flagged by existing literature (e.g., how the perspectives of the on-site and remote users differ and that on-site users should not treat the remote user as an object) [1, 5, 14, 21, 30]. The video also provided some suggestions for effective use (e.g., taking turns in talk, asking for help), and asked employees to always dock the robots between uses.

5 RESPONSE TO THE LAUNCH

To attract employees to the pilot we advertised the launch of the robots via email, word of mouth, posters and short presentations to teams, where we emphasised the benefits of the robots (autonomy, mobility, possibility for unplanned interaction). This was done with the help of the Business Admins of the lab as whole and those of specific teams.

Despite that, interest in the robots was low. In the first week of recruitment, three individuals and one team of four responded to the email and asked to try the robots. Another person reached out the following week on behalf of his colleagues who are based in other offices and four more employees joined in the weeks that followed (15 new users in total). Of those, five did not actually use the robots, two used them once, and four used them a few times each but eventually stopped. The team of four used them for their regular weekly meetings, but this is mostly because they were also using the robots as a tool for their research (unrelated to telepresence). In addition to those employees, there was some use by one-off visitors, as well as by our team who had been using them occasionally to remotely attend social events, workshops and meetings.

With regards to not signing up, employees informally surveyed around the office reported that they did not have a reason to use the robots. One on-site employee explained that the users' status on Microsoft Teams could let them know if their colleagues were at their desks, and available to be interrupted. If they were not online it meant they would be at a part of the lab where the robot couldn't go anyway. As such they did not see a reason to roam around the office remotely. Some also thought the sign-up process was too complicated. As one said, "If I was on Teams remotely and there was a button that said 'would you like to join on a robot?' I'd be more likely to click that and have a go, rather needing to dig out that e-mail that tells me how I can log into it." Two people also said that they would feel embarrassed to be seen using the robot incorrectly.

With regards to low use by those who had signed up, fully remote employees, who wanted to use the robots for social presence in the office, reported that they found problems with audio and video quality the first time they used the robots, which discouraged them from using them further. One such user said, "I've not used the telepresence robots more after those few initial attempts. The audio filtering issues basically made them unusable for me, I'm afraid to say; I frequently had to ask people to repeat themselves. It just wasn't worth it." Both fully remote and partly remote employees who had signed up also claimed they did not have many opportunities to use the robots, such as social gatherings or meetings that required movement. Further some partly remote employees said that they did not have the time to drive the robot between meetings, and did not want to spend more time online than needed during on days when they work from home. In addition, Double robots use their own video-calling system that does not connect to Microsoft Teams meetings, which was, naturally, the video meeting technology in use by the lab's employees. As such, for many meetings, the remote robot users had to also run a parallel Teams meeting to see shared screens and other resources (such as parallel chat, rosters, notes, transcription etc.). This was also deemed to be inefficient and awkward.

6 DISCUSSION

6.1 Effort vs. value

Both adopters and non-adopters talked about not seeing the value of the technology and about how they expected it to require effort to use. This reflects one of the reasons pointed out by Grudin in his analysis of the failures of systems for collaborative work; the disparity between the work required to make a system function (and who has to do that work) and its benefits (and who receives them) [8].

The MRP roll-out team did significant preparatory work to run the pilot, but that work was not visible to the potential users and therefore not part of their decisions. Rather, employees may have seen their potential effort in signing up, as well as the effort of having to use yet another interface for their work. Further, those who already had some exposure to the MRP robots, may have expected docking, driving, requesting help, and finding workarounds for shortcomings, to require too much effort as well.

With regards to the value, we expected that the ability to move in space and have a physical embodied presence would be seen as important benefits. We hoped that remote employees would like the opportunity to be part of the office life outside of planned meetings and would also see value in being able to take more interactive part in activities that benefit from movements, such as prototyping artefacts. We also thought that on-site employees might like coming to the office more if they have the chance to "see" their remote colleagues on the robots. In reality, even if some employees considered those benefits, they might not have been important enough weighed against the effort of using the robots.

Three fully remote employees signed up and tried the robots, but eventually gave up on using them. Their reasons for signing up were to connect with their colleagues in more informal, social ways, but they found a lack of opportunities for these kinds of uses. Combined with the limited usefulness of the robots for meetings (as they would need to used Teams alongside it), that reduced viability for both planned and unplanned use. A team of employees who worked partly from the office and partly from home reported that their days spent at the office covered their need to socialise with colleagues and they preferred to keep their days at home free from meetings in order to focus on work. As such they would not opt to use the robot when working from home and they would not come into the office in order to see their colleagues on the robot (they would rather stay at home and have a quick Teams call, or come into the office to see colleagues in-person).

Whilst more comprehensive data is needed, this initial look into the reasons for not using the robots might suggest that the needs of fully remote employees differ from those of employees who work in flexible hybrid modes, and therefore so does how much they might value the affordances of the MRP robots. Fully remote employees may still want to connect in more informal ways and may be more motivated to try new technologies, but may also not be willing put up with systems that require high effort on their part. They might also benefit from the right support from on-site employees, such as being invited to casual meetings where the set up effort is shared and where mobility can be utilised. Employees working on-site, however, may have less need for such technologies and a lower threshold for dealing with the effort required to use them. Of course, the needs and barriers of both groups should be examined more carefully.

That said, the question of value has been brought up in previous cases of communication technologies which are now in mainstream use. For instance, when Instant Messaging (IM) was initially introduced in organisations, people reported that they could just email or call if they needed to communicate [6, 9–11, 19]. Videoconferencing, of course, has a very long history of failed adoption [20]. When introduced in companies, even people who liked videotelephony initially did not continue it use it as they were uncomfortable being on camera and preferred in-person experiences and the informal interactions before and after meetings to the mediated version [7]. As such, we should not be too quick to dismiss the long-term value of MRP technology.

What that value is, however, must be considered a joint product of the technology and its place within an organisation. More needs to be done to understand how the particular practices of specific organizations influence MRP robot adoption (and use). Our case covers just one organization, but other organizations will have different friction points that will skew the effort vs. value argument differently. Hybrid and remote work were common for lab employees even before the pandemic, and many teams within the organisation had already been physically distributed even across different time zones. The employees also have access to many tools for hybrid work, such as digital whiteboards and well equipped meeting rooms. Therefore, they may be more fluent in collaborating remotely than we might expect and may have learnt strategies for communicating effectively without needing physical presence, thus reducing the benefit of the MRP robots in this instance.

6.2 Critical mass

Starting with or quickly reaching a critical mass of users is, of course, crucial to adoption of technologies for communication, as is the subsequent growth of the userbase through network effects. The hope is that a group of interested users who first see the benefits of a technology are willing to accept the costs of use, and later demonstrate its benefits to others [15]. In the case of IM, Herbsleb et al. [11] initially saw low adoption when they introduced a system to distributed teams within an organisation. They had provided each user with one hour of training, as well as documentation for their system, including an online user manual and a 1-page quick reference card. Still, only 10% of trained users maintained regular use after two months. One of the reasons, among software problems and privacy concerns, was that by training individuals rather than teams they did not show people how to collaborate meaningfully with the tool. Indeed, where it was adopted, it was a by all or substantial part of a team. People did not individually find each other and chat, but used it if it was a part of their team's practices. So, in a second phase, they trained teams together (and fixed certain system issues), which then lead to more use (20-35%). Of course, the critical mass of users varies with each technology and its benefits. For something like MRP, it may be assumed that only the remote user needs to see the benefits. However it is a medium for interactions, and therefore both the remote and on-site parties need to collaborate to make it work, as well as all peripheral members such as bystanders and building management. While there may be niche cases were an individual succeeds in using it for long-term, regular, remote work, if there isn't a culture of using MRP robots in an office, a person may log in and find no-one on the other end willing to interact with and support them, nor any activities to do. As such they would not find any value in using this technology. For MRP technology to become a mainstream part of a hybrid office, usage will need normalization and support by the social and technical infrastructure.

6.3 The non-use perspective

Positive use is only one way of relating to technology; it can be narrow and mistakenly assumed as a natural fact, especially by those who research or develop technology [25, 26]. Non-users' perspectives can teach just as much as those of users. Satchell and Dourish [25] present types of non-users with different motivations, such as active resistance, disenchantment, disenfranchisement and disinterest. Our assumption was that non-users would be in the minority among employees of a global technology company. However, in talking about effort, some employees said that they did not have the time to look into it. This is not quite as severe as disenfranchisement, but shows that there is a cost to using the robots that some users could not afford within their work style. Disenchantment perhaps was also present, in that employees who work within the industry might perhaps be more skeptical about the robots working as well as advertised. For instance, a recruitment team who signed up knew very little about the robots and were initially very enthusiastic – more so than employees from more engineering and science groups. There might also be disenchantment with work itself, i.e. employees not wanting to spend extra time with work-related social interactions. Finally, there was active resistance from one person working in Facilities Maintenance. They did not believe that the technology could make their job easier, and also spoke to us openly about their belief that that replacing the work they do with robots would endanger their job in the long term, whilst also making it more troublesome in the short term. It seems that there might have been a wider variety of reasons for non-use than we expected, which is worth exploring more in the future. As Tabrizi et al. [29] point out bringing new technology into an organisation is not just about the technology. It should be guided by the needs of the organisation and centre on the pre-existing knowledge held by those who will use it.

7 CONCLUSIONS

In this case study we describe a pilot implementation of an MRP technology in a knowledge work organisation, for the purpose of testing improved support for hybrid work. We report on the often taken for granted preparation work that was undertaken in order to be able to provide the robots to employees, as well as how employees responded to this initiative.

With regards to the preparation work, we show that it involved collaborative effort from different teams over several weeks. The Occupational Health and Safety risk assessment pointed to many areas that we had to consider, such as safety, security and accessibility. We created a lot of information material on safe and effective use, and put systems in place with the IT and Facilities teams to ensure safety and security. Still given that it is an external service, security could not be guaranteed to satisfactory degree for the organisation.

In this process we also came across many issues of space. As outlined in section 4.5, there simply weren't any ideal locations to 'park' the robots. Their movement was also limited by doors, stairs and Wi-Fi access and there was a concern about disturbing people who were working. Future design of spaces for hybrid interactions would have to carefully consider how MRP or other telepresence technologies fit into work spaces, so that they are functional, do not limit the space of the people in them, as well as how they fit with organisational requirements.

The low adoption of the technology also pointed to a need to better test our assumptions about the benefits of a system and the needs of the potential users. In this case, it seems likely that the effort of using the robots outweighed the benefits. Employees claimed not to perceive any value in them. However, given that people did not actually use them us much, this is hard to say with any certainty. The benefits of autonomous, mobile presence in an office, and the ability to have informal social encounters might have be seen as valuable if the system was easy to use and better integrated in people's workflows. Of course, this understanding is only from a brief informal survey and more rigorous study is needed. Also, whilst we surveyed non-adopters around the office, and asked remote users why they discontinued use, we were not able to get insight into fully remote non-adopters as they were not easy to reach.

Effective implementation of new technology in organisations has been found to be most successful when the workforce is included in the process [18, 27], and this pilot was no exception. In particular, the lesson from this case study is not that less-than-total adoption in an of itself was the reason for discontinuing the program, and represented a problem to be solved, but rather that there needed to be clear prioritisation of sets of population needs within an organisation. A further lesson was that non-users may teach us about gaps in assumptions about people's needs. With regards to implementation, future deployments should aim to reduce effort required to use a system, identify specifically how it can be integrated into employees' collaborative and communicative routines, and consider hybrid implementation in the design of spaces. While this attempt to establish MRP in this workplace was not successful, the technology might be more useful, easier to implement, and more likely to be used in other settings, such as schools, museums or offices of smaller organisations, so we hope that the work we present here helps others be more prepared in what to expect.

Of course, the catch-22 of technology adoption is that it requires investment without established value, but that value cannot be established without investment. And, in the field, even well-supported hypotheses about value are tested by a range of complex interrelations. Nevertheless, rather than focusing on the negative outcome that this pilot did not establish the value of robots, the lab believes that the exploration itself was of value. The right choices for hybrid work are uncertain, and are likely to be for some time. For organisations to thrive in a context of uncertainty, developing a culture of experimentation is crucial. As Sondheim [28] teaches, "The choice may have been mistaken; the choosing was not. You have to move on."

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