Charting the Path: Requirements and Constraints for Technology-Supported Walking Meetings

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Traditional meetings involve extensive sitting, which negatively impacts the health of attendees. Understanding how technology can facilitate integrating physical activity into the workplace, such as in walking meetings, is vital to improving workplace wellbeing. To that end, we applied a mixed-method approach to explore requirements and opportunities for walking meetings. We conducted an online questionnaire and a series of interviews with early adopters of walking meetings and created design fictions based on their feedback. We evaluated the design fictions with a second questionnaire and garnered additional feedback from the original early adopters. Based on our findings, we derived four dimensions associated with walking meetings: *practical*, *environmental*, *social*, and *cognitive* facets. We define attributes, challenges, and opportunities within these dimensions which are important for designing systems that support walking meetings. Our work identifies key considerations for developing systems that integrate physical activity into communication activities.

CCS Concepts: • **Human-centered computing → Collaborative and social computing**; *Human computer interaction (HCI)*.

Additional Key Words and Phrases: Walking Meetings, Office Workers, Physical Activity, Synchronous Work, Remote Work, CSCW

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1 INTRODUCTION

Walking while thinking and conversing is deeply embedded in our society. Scholars in ancient Greece would walk together as they discussed and learned on the move [66]. Today, however, walking has fallen out of favour in the workplace. When we meet to discuss work matters, we almost always sit indoors.

We have optimised the modern workplace towards minimising movement and physical activity with the aim of making work easier [34]. Over time, we have developed increasingly sophisticated digital methods of accomplishing nearly every work-related task. As a result, over two-thirds of the workday is spent seated [21], which is a significant risk for public health [13]. Regularly sitting for long periods of time can increase the risk of cardiovascular disease [30], diabetes [82], and

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all-cause mortality [59]. Even in countries with highly regarded workplace wellbeing policies, such as Germany, workers still express a need for better managing their wellbeing [14]. Consequently, it remains an open question as to how to transform future workspaces to integrate intentional physical activity throughout the day.

Recent years have seen indications of increasing mobility in the workplace by introducing, inter alia, standing desks [79] or physical activity programs [32]. Walking meetings are one promising method of increasing physical activity at work. Unlike many other potential interventions, walking meetings do not interrupt the workday. Rather, they are an opportunity to integrate movement into the regular workflow and to get exercise while being productive at the same time.

However, for many individuals, walking meetings are only seen as a viable replacement for specific categories of meetings. Early brainstorming and ideation sessions or informal meetings where minimal note-taking is required are commonly viewed as meetings that are appropriate for walking meetings [27]. While the benefits of walking meetings are apparent and technologies exist that could be used for meetings in motion (e.g. recording devices), the usage is low, which hints at ineffective solutions and insufficient knowledge of user needs. Hence, there is a need to build constructive knowledge [58] and understand the constraints and requirements in designing technologies that support walking meetings. We contribute a strong basis of understanding the user requirements that are largely technology-independent before imposing solutions, which can then inform future implementations.

To this end, this paper explores the requirement space of walking meetings to understand how future technologies can effectively support different types of meetings in motion. We conducted an online questionnaire with potential users and a set of interviews with early adopters, based on which we created four design fictions of future walking meetings. These fictions address the four quadrants of the Computer-Supported Collaborative Work (CSCW) space-time matrix [38]. We used the fictions to elicit feedback about them from potential users (in an online questionnaire) and early adopters (in follow-up interviews).

By engaging with both early adopters and potential users in a multi-stage mixed-method study, we aim to address the research question: "What are the requirements and constraints for designing technologies that empower users to integrate movement into meetings in motion?"

This paper is intended to benefit HCI researchers, technology designers, or *knowledge workers* aiming to increase movement in the workplace by contributing a broad understanding of factors involved in designing technology to support walking meetings. In particular, we contribute: (1) A set of interviews with early adopters of walking meetings that identify key challenges in supporting meetings in motion; (2) four design fictions of future walking meetings, evaluated in an online questionnaire and a set of interviews; (3) a requirement space for walking meetings and (4) considerations for future systems that support walking meetings.

2 RELATED WORK

In this section, we review past findings that provide context for our research. First, we discuss notions of meetings situated in time and space; we then report on past works highlighting technology that supports collaboration and connectedness. Next, we explore past interventions in fostering physical activity at work. Finally, we review past literature on walking meetings and uses of design fictions in HCI.

2.1 Meetings across Space and Time

Where (e.g. in the virtual space or in the real world), when (synchronously or asynchronously) and how (e.g. statically or in motion) people work affects not only their work experience but also might impact design considerations for technologies in the work context. This is reflected

by work in CSCW that focuses on building an understanding about such elements of the work experience. For instance, Johansen's space-time matrix [38] is a commonly used framework in the CSCW community. The matrix decomposes cooperative systems by space (co-located or remote) and time (synchronous or asynchronous). An extended framework, the Model of Coordinated Action was proposed with additional dimensions of Scale, Communities of Practice, Nascence, Planned Permanence, and Turnover [42]. This framework has expanded applicability, but since our work particularly addresses meetings in motion, the space and time dimensions are of greatest importance for this paper. As recurring meetings become an increasingly significant part of work life, Niemantsverdriet and Erickson [54] suggested that future technologies for meeting support should offer alternative means in which meeting are organised and enacted. In line with this, CSCW research also has an established appreciation for the importance of mobility at work. Bellotti and Bly [5] recognised opportunities and challenges produced by mobility at work. On the one hand, not working on assigned workstations made collaboration more complex. On the other hand, mobility was necessary for creativity and facilitated social processes at the workplace. Early distributed meeting systems also used (simulated) mobility as a key design consideration [53]. Later work by Ciolfi et al. [20] highlighted the importance of location and consciously choosing the place of work for meaningful collaboration. Our work aims to further chart the importance of mobility and activity in meetings and explore how technology-supported meetings in motion can contribute to an improved meeting culture.

On a similar note, Dahlbom and Ljungberg [23] discussed the notion of mobile informatics and reflected on the impact of work becoming more mobile. They also discussed mobility in information technology in terms of wandering, travelling, and visiting. To illustrate, if a person uses their mobile phone to make a note while participating in a Zoom meeting, this person is wandering with the means of technology. If a person is replying to a work email while being on the bus on their way to a lecture they are supposed to hold, they are travelling. If a person is participating in a conference for work, either in person or via a designated platform (e.g. Zoom), this person is visiting. Interestingly, Dahlbom and Ljungberg [23] highlighted that they observed that people often tend to adapt the mobile context of use to a stationary use context. In contrast, we want to explore how we might support physical "wandering" with the means of mobile technology. However, in the broadest sense, our main motivation is similar to the ones introduced by Dahlbom and Ljungberg [23], namely how we can support mobility (in our case meetings in motion) at the workplace by means of interactive technology.

Two decades ago, Luff and Heath [45] discussed the static nature of collaboration technology that often restricted the movement of its users. Technology support during mobility has since increased, but there is still a need to explore how technology could support meetings in motion. Luff and Heath [45] explored a variety of workplace activities and studied the mobility of artefacts on the micro-level (e.g. mobility of medical documents). They found that the mobility of objects is essential to foster communication and support collaboration. Furthermore, they called for a more in-depth exploration of objects-in-interaction. Our aim is to address this call in the context of meetings in motion. We strive to build an understanding about the requirements for designing objects-in-interaction for meetings in motion.

In his PhD thesis, Wiberg [80] explored user needs in the context of mobile meetings and dispersed interaction support. He considered both physical and virtual meeting support. His results emphasised considering spaces beyond classic meeting rooms when studying collaboration in the work context. Similarly to Wiberg [80], we focus on in-person and virtual meeting scenarios, and we also follow his call to go beyond meeting rooms when studying meetings in motion. RoamWare [81] was designed to support "mobile meetings" [6]. Mobile meetings are somewhat

more informal, spontaneous meetings, often outside of regular meeting rooms, without a pre-arranged agenda. Technology use often divides attention, meaning that people stop communicating and collaborating with each other when they use their technologies. Consequently, RoamWare aims to integrate seamlessly into the mobile meeting context while, among other things, collecting meeting participant IDs and taking notes. In our work, we aim to learn more about the requirement space to design technologies that seamlessly support meetings in motion.

2.2 Technology to Foster Connectedness and Collaboration

With modern communication technologies and the prevalence of partially remote friends, family- or team members, the lines between the space and time dimensions can be blurred. Indeed, much research has focused on making remote communication feel less distant. In a leisure context, Experiences2Go [36] uses mobile video to enable remote family members to observe and participate in activities with loved ones, and Tang et al. [75] used physical artefacts to enhance video communication at home. Along these lines, outside of the workplace, researchers have made efforts to increase remote audience participation in social events using interactive crowdsourced live streaming systems [74].

In the work context, the increasing frequency of remote collaboration has driven research in increasing engagement for remote team members. Shami and colleagues [65] explored avatars with gestures to better include remote team members. Mixed reality (MR) is a promising tool for remote communication, enabling remote teammates to enter shared virtual spaces. Müller et al. [52] explored MR for remote collaboration and established a concept of shared virtual landmarks to ensure common reference points for remote members. While these previous studies provide an extensive understanding of collaboration, it still remains an open question how physical activity and movement during meetings can affect communication.

Researchers have also worked to automate aspects of meetings, such as continued idea generation through intelligently presented relevant photographs during brainstorming [78] and automatic generation of "action items" based on meeting transcripts [48] to support collaboration. McGregor and colleagues [48] found that meeting conversations are a difficult challenge for speech-based agents. The prospect of an artificial intelligent meeting assistant is promising and could be applicable to meetings in motion but requires further development.

2.3 Physical Activity at Work

The potential benefits of walking have been extensively researched in the public health domain. Walking has a positive effect on both physical and mental health. Walking improves cardiovascular capacity and leads to greater endurance [50]. Consequently, walking reduces diseases, blood pressure, and weight [17]. A recent scoping review by Kelly et al. [39] explored the interplay between walking and mental health. They found prevention and treatment effects for depression and anxiety. Furthermore, their results indicated emerging positive effects for mental health outcomes such as stress, self-esteem and wellbeing. Walking also improves mood and happiness [77] and being outside has additional benefits, as nature experiences contribute to stress reduction [35].

In addition to the physical and mental health benefits, walking can also positively contribute to productive goals. Perceived seminar and discussion quality was improved when seminars were conducted while walking outdoors [15] and walking improves creativity [57].

On another note, previous work extensively discussed the negative effects of uninterrupted sedentary behaviour, e.g. [76, 82]. Despite the manifold benefits of walking and decreasing sedentary behaviour, the majority of people are not moving enough [22]. For instance, workers spend an average 71% of their day sitting [21]. Public health research has identified key barriers and facilitators

to reducing sedentary behaviour at work. Habitual sitting was the key barrier while standing or walking meetings were the most supported facilitators [55].

Companies invest significant amounts of money in workplace health promotion. Methods of increasing physical activity at work often include taking more breaks from productive activities [16, 41, 46]. On a similar note, Moradi and Wiberg [49] studied mobility inside workplaces. They introduced a conceptual framework that encompassed five categories that influenced patterns of movement in the workplace, such as spatial possibility and social relations. Based on their insights, they designed the NEAT-Lamp and the Talking Tree. The NEAT-Lamp is a lamp with an intentionally unobtrusive design. It is placed on a work desk and automatically switches on if a person was sitting for 25 minutes. As soon as the person leaves their position, the lamp automatically switches off. The Talking Tree is an ambient display that visualises the amount of movement in a designated area by changing the colour of its leaves. Moradi and Wiberg [49] emphasised that local movement is a socially embedded practice. In line with their work, we aim to consider the social aspects relevant to work environments when studying meetings in motion.

A recent systematic literature review [85] showed that physical environments in and around the workplace, such as treadmill desks, can support increased physical activity levels and decreased sedentary behaviour. Yet, to date, the majority of workplaces focus on increasing productivity while decreasing physical activity [34]. Hence, we can achieve even more efficient results by integrating physical activity into the workday and enabling working-in-motion. To this end, this work explores how systems that support engaging in physical activity while working can be designed to actively support workers.

2.4 Walking Meetings in HCI

Despite the promises of walking and physical activity in general, relevant work in the HCI community regarding the role of technology in walking meetings has been relatively sparse. While communicating with others during a walk in a virtual environment was explored relatively early in CSCW literature [84], co-located walking meetings received less attention. Research by Ahtinen et al. [1–3] used the persuasive technology paradigm. For instance, Ahtinen et al. [2] introduced the walking metro mobile application concept. Based on a prototype and two user studies, they derived design implications for "persuasive mobile walking meetings". They identified three categories of design implications: making the concept of walking meetings more acceptable, providing non-interrupting guidance, and implementing instructions, discreet persuasion and stimulation. Along the same lines, Brainwolk [1, 3] was designed with the intention to persuade people to conduct meetings while walking outdoors. The app provides information about the opportunities of walking outdoors. Furthermore, the initial form of the app includes checkpoints users can set as their targets as well as gamified elements such as points for reaching a checkpoint. Based on a first user study, Brainwolk was revised and Brainwolk 2.0 was developed. One of the main changes in Brainwolk 2.0 was that it used less gamification elements and more subtle persuasion (e.g. persuasion to participate in walking meetings instead of persuasive principles during the walking meeting). Brainwolk [1, 3] focuses on the creative part of work (e.g. brainstorming sessions), emphasises that walking meetings should ideally be conducted in nature, and was designed based on persuasive walking meeting implications.

In their work, Ahtinen et al. [1–3] mainly focused on encouraging users to conduct walking meetings and provided support through route guidance. Rather than focusing on persuading users, our work looks at understanding current and potential participants of meetings in motion with the design principle of supporting reflection in mind. In line with Oulasvirta and Hornbaek [58], we are aiming to build constructive knowledge by charting the requirements for future products that empower users in their decision to conduct meetings in motion. This approach avoids the ethical

and practical pitfalls associated with persuasion [63, 67, 68] and instead empowers users to make informed decisions about their meeting behaviours in the spirit of fostering reflection [12].

Another group [24] has explored infrastructure support for walking meetings through a marked meeting path on a university campus. They also investigated additional infrastructure support in the form of "Hubs" to facilitate periodic note-taking and presentation of visuals during walking meetings [26]. Further, Damen and colleagues abstracted drivers and barriers for walking meetings from experiences conducting meetings on their marked walking path [27]. The drivers and barriers paper uncovered valuable qualitative insights on walking meetings related to their "WorkWalk" infrastructure. While Damen et al. addressed a research question specifically relating to the intricacies of their walking meeting infrastructure, a holistic understanding of the requirements and constraints for walking meetings in general is still needed.

There is an unexplored opportunity to harness technology to support users in overcoming some limitations inherent to meetings in motion. For example, the lack of ability to take notes and use visuals is mentioned by users in multiple studies as a drawback of the walking meeting format [1, 26, 27].

The term "walking meeting" has been commonly used in literature without consideration for the inclusivity of the term. The purpose of a walking meeting is for two or more colleagues to communicate and collaborate while in motion. This practice integrates physical activity into the workday, shifts relationship and conversational dynamics, and provides stimulation for creative thought. Walking, as a specific function, is not as crucial to the practice as is being in motion together. For consistency with established literature in HCI [1–3, 24, 27], we will use the term "walking meeting" throughout this paper to refer to any meeting in motion. Accessibility issues with the term and concept are discussed in Section 7.4.

2.5 Design Fictions

Design fictions are an increasingly common way to elicit reactions regarding potential technological futures. The origin of the term "design fiction" is often attributed to Julian Bleecker [8], or Bruce Sterling [69]. Although there have been multiple attempts to define the term [4], it can generally be thought of as the use of narrative and world building to create context for readers to envision the use of future technologies.

In HCI, design fictions have been the subject of numerous publications [9, 10, 40, 43, 44, 56, 61, 71]. However, how best to evaluate design fictions is often a source of debate. Baumer and colleagues [4] recommend that evaluation methods be directly related to the expected knowledge gain from the fictional scenarios. Specifically, presenting the scenarios to potential user groups was a key recommendation which we put into practice for this work.

In this work, we use design fictions as a means to explore the hypothetical implications of introducing technology which supports meetings in motion. Design fictions are suitable for the task as studying the personal and social consequences of meetings in motion in real-life meetings would disrupt the content of the meetings. Further, it enables us to include those users who do not participate in such meetings at present in the study. Our work is inspired by past design fictions, which specifically explored the social consequences of emergent technologies. HawkEye [56] effectively explored how social structures are affected by the design of technology for dementia care. Wu et al. [83] employed a design fiction to investigate how different stakeholders involved in the shipping industry were able to discuss technology-related ethics dilemmas. These examples informed our work by showing how design fictions enable exploring a topic with a potentially high social impact such as introducing meetings in motion in an organisation.

2.6 Summary

There is strong evidence in the literature to suggest that users who perform primarily sedentary work could benefit from incorporating physical activity into the workday. Movement improves not only physical health, but also creative thought processes and social dynamics. However, there is a lack of widely used technologies to support movement at work, particularly in relation to walking meetings. Walking meetings are a prime opportunity to accomplish productive collaborative tasks while in motion. While the CSCW community has embraced mobility as a key element of cooperative work and some inquiries into designing systems from walking meetings were conducted, there is an emergent need for an in-depth understanding of the walking meeting requirement space. Consequently, the goal of this paper is to establish a detailed understanding of the design constraints and user requirements connected to walking meetings to inform future systems designers.

3 METHOD

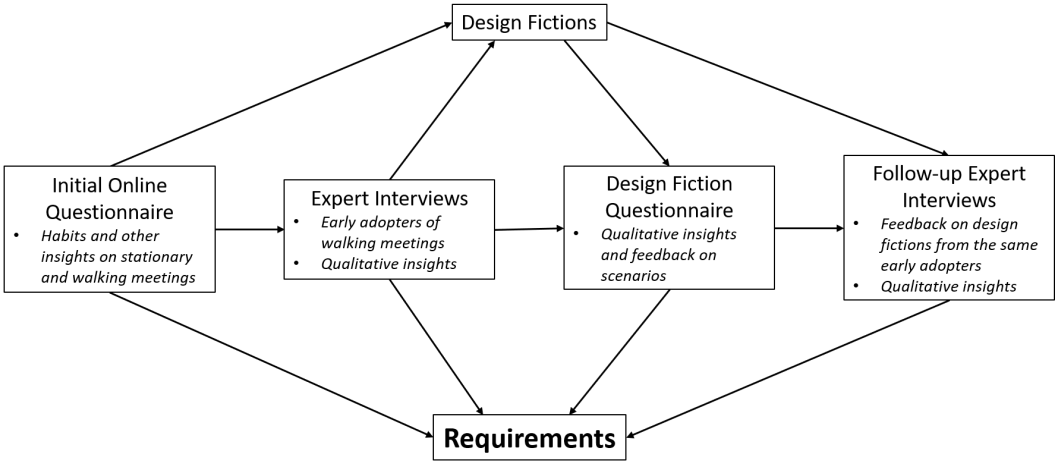


Fig. 1. Overview of mixed-methods approach to generating the set of requirements for walking meetings.

In our study, we inquire how walking meetings are already enacted by early adopters and seek input from potential users. To this end, we used a mixed-methods approach to generate insights and feedback from multiple sources. We conducted an initial online questionnaire to generate data on walking meetings from participants with a range of experience. Following this, we conducted initial interviews with early adopters of walking meetings to gather deeper qualitative insights on walking meetings and seminars. We created four design fictions based on combined insights from the questionnaire and interviews. To evaluate the design fictions we conducted a second online questionnaire and carried out follow-up interviews with the participants from the initial early adopter interviews. Finally, we created a requirement space for walking while working based on the combined findings from all stages.

We aimed to chart a requirement space for walking meetings that encompasses the needs of people with a variety of different experiences. Hence, we chose this set of methods because it allowed us to combine in-depth insights from early adopters with findings from a broader sample with different levels of walking meeting experience. Figure 1 presents an overview of the set of methods we applied and how the stages are related.

For the purpose of clarity, the evaluations before and after generating the design fictions will be presented separately. Section 4 describes Study 1, which includes the methods and results for initial questionnaire and initial early adopter interviews. Study 2 (Section 6) contains the methods and results for the design fiction evaluation questionnaire and follow-up interviews.

4 STUDY 1: INITIAL QUESTIONNAIRE AND EARLY ADOPTER INTERVIEWS

We conducted an online questionnaire asking people about their current meeting habits and preferences, technology use in meetings, and technology use in walking meetings.

Following this, we conducted interviews with early adopters of walking meetings to generate in-depth insights about the requirements of holding successful walking meetings. Early adopters have been leveraged extensively in HCI research to gain insights from individuals who have experience with technologies or practices in their daily life [47, 70, 86]. Early adopters provide unique viewpoints based on their experiences, which can be drivers for future design. We reached out to individuals who currently practice walking meetings or other forms of walking while working on a regular basis.

Due to the ongoing COVID-19 pandemic we conducted all interviews via Zoom. Each interview was a one-on-one session with a single researcher and lasted approximately 45 minutes.

4.1 Participants

Our initial evaluation was a combination of quantitative (online questionnaire) and qualitative (interviews) methods. We therefore had two separate recruitment strategies.

The participants for our online questionnaire were recruited through the crowdsourcing website Amazon Mechanical Turk (MTurk). We recruited $N = 91$ participants, aged 22-68, M = 33.1, SD = 9.5. 33 participants were female and 58 were male. The participants resided in the European Union or the United States and worked in a wide range of professions including: engineering, management, IT, healthcare, academia, students, law, marketing, trades, restaurants, delivery, teaching, and finance. The compensation was based on an hourly rate of 10 USD /hour, resulting in $0.50 per participant. It was required that the participants had a record of completing Human Intelligence Tasks (HITs) with an acceptance rate of at least 95%. HITs are single tasks such as "Identify the object in the picture". These selection criteria are in line with previous work in HCI [29].

For the interviews, we recruited N = 6 participants (3 female, 2 male, 1 undefined) from 5 European countries via snowball sampling. All of the participants are knowledge workers, primarily in research fields, who were known to have prior experience with walking meetings either through personal contacts or their published information. We asked the participants in advance whether they considered themselves to be experienced with walking meetings, so all of the interviewees were self-assessed as experienced. Table 1 shows an overview of the participants for the initial interviews.

Table 1. Overview of the early adopter interview participants.

PID	Age	Gender	Profession	Location	Field
P1	34	Female	Researcher	Italy	Computer Science
P2	31	Male	Researcher	Germany	Psychology
P3	28	Female	Senior Researcher	Germany	Psychology
P4	37	Female	Postdoc Researcher	Denmark	Anthropology
P5	61	Undefined	Professor	Netherlands	Philosophy
P6	55	Male	Research Manager	Austria	Physics

4.2 Questionnaire Content

The online questionnaire consisted of closed- and open-ended questions. We explored the perceptions and intricacies of walking meetings. We inquired if and how often participants engage in stationary meetings and walking meetings and which technologies they usually bring to these different types of meetings. Stationary meetings were included in the questionnaire because we were interested in understanding how habits and technologies could be transferred to walking meetings. We also asked about the number of meeting participants and their hierarchical composition. The complete questionnaire can be found in the supplementary material.

4.3 Interview Protocol

The interview protocol was structured as follows: In a first step, we obtained demographic data and information about daily work routines. We then inquired about walking meeting routines and motivations to hold such meetings. In the final part of the interview, we asked if the participants wished to add something or if they liked to elaborate further on aspects that have already been discussed. Since our participants were truly interested in the topic of walking meetings, this final, open block of the interview offered them an opportunity to elaborate on aspects of particular personal relevance to them.

4.4 Analysis

For the online questionnaire, we divided the survey responses based on participants' self-reported experience with walking meetings. The 91 respondents were split in to two groups: *Experienced* ($n = 49$) with some previous walking meeting experience, and *Not Experienced* ($n = 42$) with no prior experience. All questions relating to walking meetings were worded as "Why do you or would you..." so that *Not Experienced* respondents could provide their hypothetical perceptions while *Experienced* respondents could provide their personal motivations based on experience. The full set of questions and answers, along with scripts used to summarise and visualise the data is available in the supplementary material.

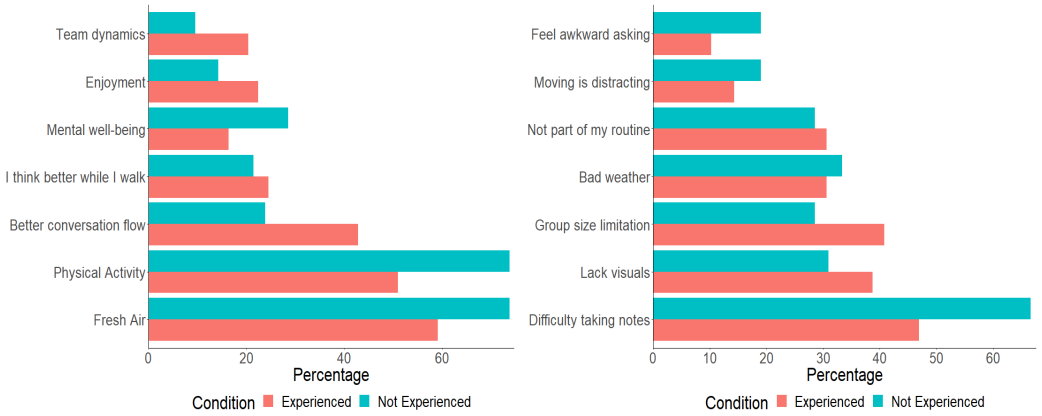
All interviews were recorded with consent and transcribed verbatim. The interview transcripts were then imported into Atlas.ti 8 analysis software. As a first step, three researchers coded a representative sample of 17% of the interview material using open coding. As a next step, a coding tree was established based on a discussion between the three researchers. Subsequently, the remaining transcripts were then coded individually by one of the three researchers. This procedure is in line with Blandford et al. [7]

Clarification of terms—we evaluated multiple data sets and generated *themes* which represent interesting information contained in the responses. We then clustered the themes into groups, which we call *dimensions*. The dimensions will be introduced and explained in Section 4.6.

4.5 Questionnaire Results

Participants indicated their motivations for participating in walking meetings (Figure 2a). A majority of the participants were motivated by "physical activity" and "fresh air". These health benefits are the most obvious reasons to participate in walking meetings. However, a relatively small proportion of respondents mentioned the potential cognitive benefits, such as conversation quality and thought processing. To inform our interview protocol, we statistically analysed the differences between those with and without prior experience in walking meetings. We used Welch's t-tests to compare the two participant groups (note the unequal sample sizes). P-values were Bonferroni-corrected. The group of participants who have prior walking meeting experience rated "better conversation flow" much higher than those with no experience. Participants who were familiar with walking

meetings were significantly more often motivated by physical activity to participate in walking meetings ($t(41) = 2.29$, $p < 0.05$). There were no more significant differences between the groups. A full analysis of all items is available in the supplementary material. While these quantitative results are only a indication of the design constraints involved in designing for walking meetings, they allowed us to identify key aspects to be addressed in the interview.



(a) Motivations for Walking Meetings.

(b) Reasons Not to do Walking Meetings.

Fig. 2. Motivations for and against walking meetings reported by novice and advanced walking meeting users. Each graph represents one question from the questionnaire, with answer options on the Y-axis.

The reasons for *not* participating in walking meetings are depicted in Figure 2b. A key result is that many respondents find "difficulty taking notes" to be a primary reason for avoiding walking meetings, which is consistent with other walking meeting literature [1, 27]. When the data are divided by walking meeting experience, the prominence of note-taking difficulties is more apparent in those who have not participated in a walking meeting. This could indicate that the issue of note-taking appears to be worse than it is in practice, or that those who participate in walking meetings have developed strategies to manage the issue.

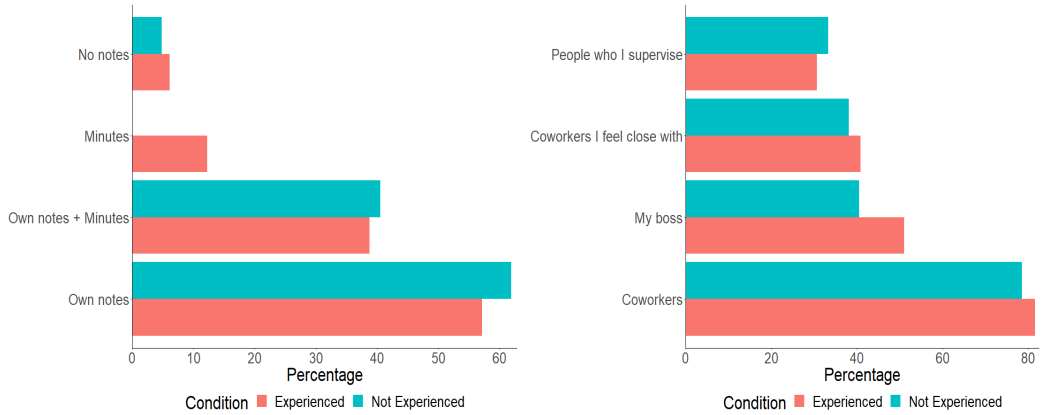
Regarding note-taking habits, Figure 3a, participants tended to choose options involving taking their own notes, rather than relying on others to record minutes. This may imply that users prefer to have some agency in generating notes. Participants with walking meeting experience were more likely to find meeting minutes acceptable, but this was still a notably small portion compared to answers including "own notes".

Participants also indicated who they would join on a walking meeting. As shown in Figure 3b, the differences between experienced and inexperienced participants was very small. In both cases, respondents were most likely to participate in walking meetings with coworkers on the same hierarchy level. This finding is consistent with Damen et al. [25], who reported that participants were less likely to initiate a meeting with someone of a different seniority level.

4.6 Interview Results

We generated numerous themes while analysing the interview transcripts. Through a series of discussions and strategic grouping of interview codes, we derived four dimensions that organise the themes and uncover important insights: (1) *Practical*, (2) *Environment*, (3) *Social*, and (4) *Cognitive*.

The *Practical* dimension encompasses insight on functional topics such as planning and note-taking. The *Environment* dimension includes findings related to nature, and the surroundings. The



(a) Note-taking habits in meetings.

(b) With whom participants would walk.

Fig. 3. Note-taking habits in meetings and with whom participants would do walking meetings. Each graph represents one question from the questionnaire, with answer options on the Y-axis.

Social dimension contains themes related to relationships and interpersonal dynamics. Finally, the *Cognitive* dimension describes findings about ideas, topics, and conversations.

Table 2 shows an overview of 11 important themes identified from the interviews organised within the four dimensions. The remainder of this section presents a detailed look at these themes.

4.6.1 Practical. Accessibility—Accessibility is an important but under-reported issue for walking communication. The interview participants identified accessibility challenges from multiple perspectives. One participant [P5] commented on a lack of inclusivity for individuals who use wheelchairs, particularly regarding routes in rural or wooded areas:

> *That's one of the limits of the walking seminar. It excludes people who either are in wheelchairs or for other reasons cannot walk. That's a limit.* [P5]

This "limit" is a serious inclusivity issue that should be taken into consideration when developing technologies to support integrating physical activity into the workplace.

There are also other, potentially more subtle, accessibility issues. One participant [P4] discussed fitness levels and potential monetary barriers, since they would often take a train to a park outside of the city for walking seminars.

Considering inclusivity in multiple forms is crucial to fostering a beneficial environment for all participants. There exists a major opportunity for future practitioners of "walking" meetings to create a more inclusive space.

Note-taking—All participants indicated that walking excludes note-taking because it is difficult to generate notes while walking, navigating, and remaining engaged in the conversation. One participant [P2] adapted by only using walking meetings for particular topics or types of discussions where notes were not important:

> *You don't take notes when you walk around, and that's the reason why I think it doesn't make any sense to talk about very complex stuff or stuff you should put down* [P2]

Another participant [P5] would pause at benches during their meetings to create an opportunity to take notes and rest:

> *I tell them at some point, "Now, we sit down, and I rest and you take notes."* [P5]

Table 2. A summary of the themes from the initial interviews organised into four dimensions.

Practical	
Accessibility	Physical and financial inclusivity are often overlooked, but are important challenges for walking meetings.
Note-taking	It is difficult to take notes while walking. Participants either need to take note breaks or avoid topics that require note-taking.
One-on-One Interactions	Walking meetings allow for deeper individual interactions, but require strategies to accommodate larger groups.
Planning	Walking meetings were often spontaneous and routes were mostly not planned, but navigation can be distracting.
Environment	
Focus and Distractions	Parks and nature can be good environments for focus, but city sidewalks are full of distractions.
Weather	Weather is an unavoidable consideration for outdoor meetings, but can be accommodated with proper preparation.
Social	
Hierarchy	Feelings of hierarchy diminish when participants walk together.
Signals Openness	Walking signals that you want an open and creative conversation.
Cognitive	
Delicate Topics	Walking together enables difficult and personal conversations.
Creative Discussions	Walking meetings are a good environment for creative discussions, including brainstorming, sharing future visions, and abstract topics.
Not for Concrete Decisions	Due to a lack of note-taking and document support, detail-oriented discussions tend to be inappropriate for walking meetings.

One-on-One Interactions—All of the participants conducted walking meetings one-on-one. On the one hand, direct and personal conversation creates opportunities for engaging discussions, which is a benefit of walking meetings. One participant commented that "*the advantage of the walking seminar is that people have one-to-one conversations*" [P5].

However, this can also be a limitation of walking meetings. It would be a significant logistical challenge for a large group of people to contribute to a single conversation. Two participants [P4, P5] had successful prior experiences hosting walking meetings with large groups. They both split the participants into pairs and essentially hosted parallel one-on-one meetings. Meetings using this strategy with up to 40 participants showed no noticeable change in effectiveness.

Planning—Most of the interview participants [P1, P2, P3, P5] mentioned that their walking meetings were usually unplanned. An attendee would spontaneously suggest that their scheduled meeting should become a walking meeting:

> *We would have a meeting, and he would say, "Okay, let's walk," so I never knew it would be a walking meeting.* [P3]

Others indicated that the meeting would be "*in response to the weather*" [P5]. Many of the participants expressed frustration with the fact that the meetings were not planned as walking meetings in advance, and suggested that advanced knowledge would be both useful and respectful.

Planning also extends to routes and navigation. Nearly all the participants [P1, P2, P3, P5] did not plan their routes in advance. One participant explicitly commented on the tension between navigation and conversation:

> *There is a tension between having your mind on where should we go next and having your mind on work. If you really want to work, you don't want to do trail finding.* [P5]

However, most participants reported that they would usually walk in parks with multiple paths where navigation was not crucial. They would walk in random directions or complete laps around the park to avoid the issue of route planning. Walking in laps creates tangible cues to indicate when a meeting should come to a close:

> *We would try to close our conversation while we're reaching the end of the route.* [P3]

4.6.2 Environment. Focus and Distractions—The participants had mixed opinions on distractions while walking outside. One participant [P1] mentioned that walking itself is distracting, especially if the conversation is not compelling. They would avoid conducting walking meetings with colleagues they knew to have trouble focusing or with topics they found boring:

> *Walking meetings would not be my choice with people who have problems to focus...walking and moving, it's a bit distracting overall. You need to find the talk compelling.* [P1]

However, some participants found that nature was a good environment for avoiding distractions and finding focus. One participant [P2] had negative experiences walking on sidewalks around the city, but found parks to be a suitable environment for engaging conversations:

> *A park is much better, because you can also sit down if it's necessary. You don't get distracted* [P2]

Weather—Weather is an unavoidable consideration when hosting a meeting outside. The participants often regarded walking meetings as an opportunity to enjoy the outdoors and were noticeably tolerant of inclement weather. One participant [P4] has experienced a complete range of temperatures and weather systems:

> *We decided to walk also in rain with rain gear. The only reason for us to cancel the walking seminar would be thunderstorms...We also walked in snow.* [P4]

The mention of "rain gear" in this comment is an important consideration. There is a colloquial saying attributed to author Alfred Wainwright that says "*There is no such thing as bad weather, only inappropriate clothing*". The participants we interviewed embody this saying, demonstrating that walking meetings can occur in any weather with proper preparation.

4.6.3 Social. Hierarchy—Three of the participants [P1, P2, P3] mostly conducted meetings with their respective supervisors, while two other participants [P4, P5, P6] were usually the supervisors themselves. Both categories of respondents reported that feelings of hierarchy diminished while walking together side-by-side.

> *While we were walking this was gone, because we're next to each other just walking. I think the hierarchy was not that present.* [P3]

One participant commented on the influence of hierarchy in note-taking with his employees:

> *I walk up and down or sometimes I just go outside to walk around...But I only take the phone with me, and I don't take any notes. If things are important, people (i.e. employees) should write me an e-mail afterwards.* [P6]

Signals Openness—Several interview participants noted that asking a colleague to go on a walking meeting sends a particular message about the intended nature of your conversation. One commented that a walking meeting signals that you want to have a creative conversation: "*Let's get*

creative and share some ideas" [P2]. Another noted that walking conversations were an opportunity to be more open with their thoughts:

> *Don't think about things so much and just say what comes in mind. Maybe it's also why more difficult things are easier just to say while walking.* [P3]

Participants also commented that the atmosphere while walking was more relaxed, leading to honest discussions:

> *I felt it was slightly more relaxed and frank as a conversation, honest and transparent in that sense.* [P1]

4.6.4 Cognitive. Delicate Topics—Multiple participants [P1, P2, P3] mentioned that they used walking meetings to discuss delicate or confidential topics. They noted the advantage of walking side-by-side, rather than face-to-face, for diffusing tension when discussing personal matters or having difficult conversations:

> *When we, for instance, discussed something more difficult...it was easier to talk about this when walking, I think, because you're next to each other, but you're not looking in the eye.* [P3]

Creative Discussions—We asked the participants about the topics they discussed during walking meetings. In many cases the participants reflected that their conversations tended towards strategic visions, brainstorming, and abstract topics. One participant said that often "*we were speaking about the future*" [P1], while another commented that "*it's usually about more strategic stuff or creative ideas*" [P2]. Another participant noted that walking meetings are a good opportunity to share creative thoughts and generate new ideas with a colleague:

> *It's easier to have conversations about more abstract topics or ... maybe brainstorming or what we should do next or how we should proceed with this and this problem.* [P3]

Not for Concrete Decisions—As a complement to the previous point on creative discussions, participants found walking meetings to be inappropriate for making concrete decisions. Conversations that required notes or references to external information were mentioned as topics that were not typically conducted as walking meetings:

> *I don't see walking meetings as a way to, again, take decisions about prototype, what to do next, how to change it, how to change the interface.* [P1]

This relates to the information on note-taking presented in the *Practical* dimension. The participants did not find it feasible to take notes while walking, which steers the conversation towards more abstract discussions rather than detail-oriented topics.

5 DESIGN FICTIONS

The initial questionnaire and interviews provide us with a thorough understanding of current practices and perceptions of walking meetings. In order to generate opinions and reactions about a potential future where walking meetings are commonly supported by technology, we created design fictions to conduct a second study phase. Design Fictions were chosen as a method because they enable creative exploration of possible technological futures before investing time into prototyping. Additionally, design fictions enabled us to elicit opinions from participants virtually without violating COVID-19 restrictions.

One design fiction was created for each of the four quadrants of the CSCW space-time matrix [38] based on the Study 1 themes. The first author created initial drafts which were reviewed and iterated upon by authors 3 and 4. As advised in Baumer et al. [4] and Lindley & Coulton [43], we focused on provoking the readers to envision themselves using the technology and to encourage reflection.

Each scenario was introduced with a *Setting* paragraph that provided character names, locations, and the basic functioning of the technologies followed by a *Narrative* approximately one page in length. The fictional narratives depicted one or more characters interacting with the technology in a meeting or seminar scenario. Each scenario was accompanied by a simple cartoon sketch of a single scene from the narrative.

The results of the initial questionnaire (Section 4.5) and the initial interviews (Section 4.6) were both used to guide the development of the design fictions. Particularly relevant themes written into the scenarios include: *note-taking, hierarchy flattening, openness and discussion of delicate topics, focus and distractions, one-on-one interactions, and creative thought processing while walking.*

Additional inspiration for the design fiction scenarios was also drawn from related work. Ahtinen [1–3] explored technology aided navigation with stopping points of interest, which was adapted in scenarios 3 and 4. We built upon these concepts along with Damen's hubs for displaying information [26], while adding additional functionality and futurism through augmented reality. Damen also showed that experienced walkers deviated from set walking routes [27], so we included free wandering in scenarios 1 and 2. Scenarios 3 and 4 depict lectures, rather than traditional meetings. This was motivated by two of our interview participants [P4 & P5] who mentioned their experiences with walking seminars. Lectures are a subset of meetings with a specific hierarchy, and virtual lectures are a common example of asynchronous information exchange. We decided to explore lectures as they were likely to provoke a discussion as they are associated with a set of established challenges, e.g. attention management [73].

Figure 4 shows a brief description of each design fiction in its respective quadrant. Full-length versions of the four fictions can be found in the supplementary material.

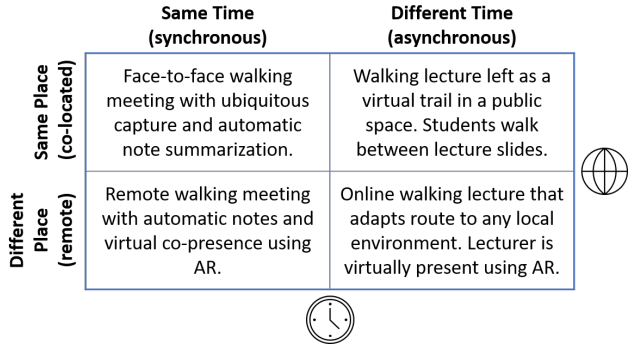


Fig. 4. CSCW Space-Time Matrix of the Four Design Fiction Scenarios.

Design fiction #1 [F1] depicted an in-person walking meeting in a park using a ubiquitous recording system that automatically generated personalised summaries based on active and passive input from the users. The characters used gestures to indicate when something important was said or when they wanted something deleted from the record. The system also tracked engagement in the conversation and highlighted segments in the summary where the users were particularly engaged. In this scenario there was a difference in seniority between the characters and a feeling of diminishing hierarchy was highlighted.

Design fiction #2 [F2] featured an employee working in Tokyo having a remote walking meeting with a colleague in London. The two characters each went to local parks to participate in the

meeting. They used augmented reality (AR) headsets that displayed realistic holograms of the meeting partners to one another, giving each the impression that they were walking alongside their partner during the conversation. In this scenario the colleagues discussed personal matters and deleted the confidential aspects of the discussion from the note summary.

In design fiction #3 [F3], a student was participating in a seminar that employed a novel approach to COVID-19 restrictions. The professor left a GPS-tagged trail in a local park that the students followed on their own time to complete the seminar and exercises. When the students reached the designated starting location, they donned a headset and began the virtual presentation. After each section there were interactive exercises for the students to complete, and then they would walk to a new location to begin the next section of the lesson.

Finally, design fiction #4 [F4] presented a student partaking in a massive open online course (MOOC). The course was being attended by students from across the globe and seminars could be initiated at any time. The professor created a path similar to the one presented in design fiction #3, except that it would automatically adapt to the local surroundings. The students used AR headsets to view the lectures, which featured three-dimensional representations of the professor and interactive visuals.

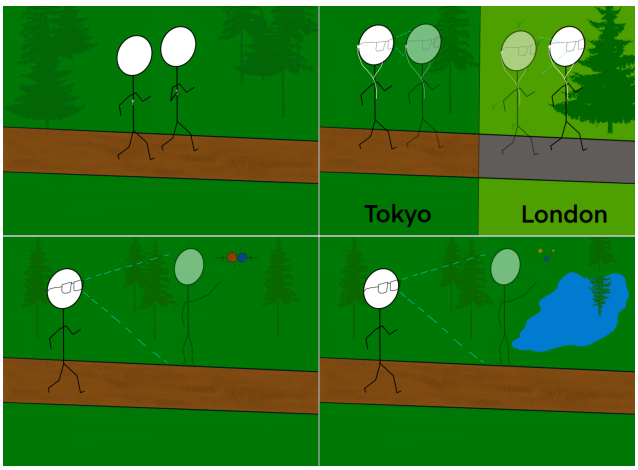


Fig. 5. The four cartoon sketches provided with the design fictions.

6 STUDY 2: FEEDBACK ON DESIGN FICTIONS

As a second major step of our inquiry, we collected feedback on the design fictions from a second online questionnaire and a set of follow-up interviews with the early adopters we initially interviewed. The design fictions served as a means to critically re-examine our assumptions in a dialogue with the walking meeting early adopters and a broader audience, in line with evaluation methods recommended by Baumer et al. [4]. The aim of Study 2 was to inquire how our fictional prototypes were perceived from people with a variety of different experience levels regarding walking meetings. The four design fictions served as prompts to stimulate reflection about the boundaries of the walking meetings requirement space.

6.1 Participants

Study 2 was a combination of an online survey with potential users and semi-structured follow-up interviews with the early adopters from Study 1. Thus, we used two different recruitment strategies.

We recruited $N = 4$ participants (2 female, 2 male) from our initial pool of early adopters. After the initial interviews all participants consented to being contacted again. The participant IDs stated in the results section reflect those in Table 1.

Further, we recruited a total of $n = 80$ participants (30 female, 50 male) via Amazon Mechanical Turk (MTurk). The participants age ranged from 21 to 66 ($M = 36,1$, $SD = 11.2$). Similar to the previous online questionnaire, compensation was based on the standard rate of 10 USD / hour. Thus, participants received $2 for their participation. Similar to our initial questionnaire, we required each participant to have a record of completing Human Intelligence Tasks (HITs) with an acceptance rate of at least 95%. This requirement is in line with previous work in HCI [29]. Responses from the questionnaire participants are labelled with a Q and a number to differentiate them from the interview participants.

6.1.1 Online Questionnaire. Each participant was presented with two out of four randomly selected design fictions (one in the meeting [F1, F2] and one in the seminar [F3, F4] context). The online questionnaire consisted of closed- and open-ended questions.

After a brief introduction to the study, we asked the participants for demographic data. They were then presented with one out of the two randomly selected design fictions. We asked the participants to take their time reading through the fictional scenario and looking at the sketch. We then inquired about experiential qualities of the fictional scenarios. To that end, we asked about emotions connected to the fictional scenario and potential positive and negative aspects. Further, we asked about social aspects (e.g. 'With whom would you like to participate in such a meeting and why?'). The last part of the questionnaire contained an open text-field providing the participants with an opportunity to express additional thoughts about the fictional scenario. This was followed by the presentation of the second design fiction. We then presented the aforementioned questions a second time.

6.1.2 Interview Protocol. We offered the participants the opportunity to read the design fictions before the interview. To that end, we sent a PDF that included the narratives and a sketch for each of the four design fictions via email. Reading the fictions in advance was optional, but all participants completed the task. All interviews were conducted via Zoom due to the COVID-19 pandemic.

After a brief introduction about the goal of the follow-up interview, we started with an open question inquiring about the overall impression of the fictional scenarios. This was followed by questions about emotional aspects connected to the fictional scenarios. We then inquired about social intricacies of the fictions. To conclude the interview we provided participants with the opportunity to add additional thoughts about the different design fictions and beyond.

6.2 Analysis

The open questions of the online questionnaire and the interviews were analysed as follows. In a first step, we prepared the data for analysis. The online questionnaire responses were clustered by question and condition (i.e. to which design fiction they were referring). All responses and participant demographics are included in the supplementary material. This also includes visualisations of the data collected. Text files containing all of the open ended responses to a single question and condition were imported into Atlas.ti 8 analysis software. The responses were coded verbatim.

Similar to the initial interviews, all interviews were recorded with consent and transcribed verbatim. The interview transcripts were then also imported into Atlas.ti 8 analysis software.

As a first step, two researchers each coded 50% of the material using open coding. An initial coding tree was then established based on a discussion between the two researchers [7]. The remaining material was coded by a single researcher, and a discussion session between three

researchers was conducted to finalise the coding tree. Three researchers then iteratively discussed themes identified in the material.

6.3 Results

We generated multiple themes from responses to the design fictions. We used the four dimensions (*Practical*, *Environment*, *Social*, and *Cognitive*) identified in Study 1 to organise these themes.

The questionnaire contained several sets of closed questions (e.g. PANAS) which did not produce any significant results. We will not include these results here for the sake of brevity, and instead focus on the themes we identified in the open questions. The full data set, along with R scripts to create visualisations, is included in the supplementary material.

Table 3 shows an overview of the 12 themes generated from the design fiction analysis organised into the four dimensions. The remainder of this section presents a detailed look at these insights.

Table 3. A summary of the themes from the design fiction evaluations organised into four dimensions.

Practical	
Accessibility	Access to nature and mobility-inclusive locations are not guaranteed.
Note-taking	Automatic note-taking could significantly increase convenience, and enable participants to focus on conversations.
Equipment	Specialised equipment may create a new barrier to participation, but currently it is challenging to work outdoors due to a lack of facilities.
Environment	
Nature and Exercise	Nature exposure and physical activity were commonly considered the most positive aspect of walking communication.
Focus and Distractions	Public outdoor locations can be distracting environments for work.
Weather	Unconstrained outdoor environments can negatively impact work.
Safety	Participants must be able to monitor their surroundings while they are working in public to ensure personal safety.
Social	
Informal	Walking meetings are less formal, which could be an asset or a hindrance depending on the topic and participants.
Shared Experience	Walking together at a distance evokes feelings of connectedness, but participants felt that it could not fully replace personal interactions.
Aversion to Tech	New wearable technology in public spaces may be met with resistance until the device becomes commonplace.
Cognitive	
Interaction with Memory	Ubiquitous capture for note-taking augments the human memory system, which excited and concerned participants.
Privacy and Security	Recording conversations created concerns about data security and negative feelings of being watched.

6.3.1 Practical. Accessibility—As noted in the initial interviews, walking meetings face several accessibility challenges from both mobility and monetary perspectives. These challenges were also recognised by the questionnaire participants:

> *You have to find a large park and some people have limited mobility.* [Q52, F1]

Access to large, safe parks is a privilege that depends directly on work location. The ability to even leave the workplace to walk for a meeting is also not available to all workers. Further, inclusivity in terms of physical mobility is not guaranteed when conducting a walking meeting, particularly on an unknown path outside of the office space. It remains an open challenge as to how to make physically active meetings an inclusive practice for all workers.

One participant we interviewed identified a critical issue related to an assumption of high speed mobile data connections outdoors. Several scenarios included technologies that would require a quality connection to communicate with remote colleagues, which is not guaranteed in all locations:

> *In ever so many places in the global south this would be impossible - no parks or the signal is not strong enough (a wifi in a house or office might with some luck some days allow for a not too signal-heavy contact).* [P5]

Note-taking—Technology-supported note-taking was incorporated into the design fictions as a response to our initial evaluation, and the concept received positive feedback from the questionnaire respondents. One participant noted, "*I especially like the fact that the notes are taken automatically*" [Q29, F1]. The responses primarily focused on the increased convenience of receiving notes without needing to manually write anything. One interview participant identified a potential imbalance in an artificial note-taking system based on differing language abilities:

> *I see the danger here that all people who do not (yet) speak a language perfectly are disadvantaged or that the AI generates wrong summaries or notes.* [P6]

Equipment—Several respondents indicated concern that "*the lectures required special equipment*" [Q9, F3]. Indeed, when technology designers create fictional future scenarios we often use or create complex technology to solve perceived problems. This approach inherently creates issues regarding access to specialised, potentially expensive, equipment. Normalising technology-supported walking meetings may unintentionally create a new barrier to participating in such meetings for those who do not have access to the correct equipment.

On the other hand, one of the interview participants identified the logistical issues of hosting a lecture in a park with current technology. Multiple features that are commonplace in a classroom, such as prepared notes, presentation screens, writing surfaces, are not easily replaceable in an outdoor setting:

> *The facilities in a university or on campus, I can carry the flip chart to my classroom and I don't have that in the park.* [P4]

6.3.2 Environment. Nature and Exercise—Multiple participants noted that the most positive aspect of the scenarios was "*being outside*" [Q3, F4] and highlighted the freedom of not being limited to a classroom:

> *This is a great opportunity to take classes without being tethered to a classroom or indoor computer.* [Q67, F3]

Participants also focused on "*The physical benefits of being active instead of sitting*" [Q59, F4] and commented on walking having a positive health impact.

One participant, however, noted that the separation of learning and relaxation spaces may be deeply rooted. We are taught from a young age that learning occurs indoors while nature is for relaxing and recreation:

> *Primary school and kindergarten start indoors...as a student you are not used to learning in nature. You relax in nature. You study indoors.* [P6]

Focus and Distractions—Despite the positive reactions to experiencing nature, participants also expressed concern for potential distractions in a public setting. All of the design fictions took place in a park, which is a common location for walking meetings. Participants noted the "*potential for distraction with other park activities*" [Q29, F4] which could create a poor environment for communicating and performing work tasks.

Weather—The weather was noted by many participants as a potential drawback to hosting meetings and lectures outdoors. One respondent expressed concern over the fact that the unconstrained outdoor environment could lead to negative situations beyond their control:

> *I would feel anxious about situations beyond my control negatively impacting my grade (weather).* [Q79, F3]

Moving work to the outdoors creates a less constrained environment that can be influenced by weather and nearby people. This increase in complexity compared to an office setting must be considered when designing technology to support working in nature.

Safety—Safety concerns were raised by multiple participants in response to the design fictions. Several of the fictional scenarios involved using an AR headset in a public location, and respondents expressed concern over not being fully aware of their surroundings. One participant stated "*some parks may not be as safe and well lit, there is danger in focusing on an AR system while out in a park*" [Q52, F4]. This is a valid concern when working in outdoor public environments in general, since work requires users to divert their focus away from their surroundings.

6.3.3 Social. Informal—The walking scenarios were noted by participants to be more informal than traditional meetings or lectures. The sentiment about this informality was, however, diverse. Some participants noted that being informal was a positive aspect of the scenarios while others called the scenarios "*too informal*" [Q32, F1, F3]. One participant pointed out that *It could make you miss key details because of how informal it is* [Q47, F1].

The effect of informality evidently depends on the individual's perception of the situation. For certain types of meetings, or meetings with certain colleagues, a decrease in formality could be perceived either positively or negatively.

Shared Experience—The design fictions evoked feelings of a "*shared experience*" [Q52, F4] and "*feeling connected*" [Q3, F4]. These sentiments are particularly important for remote communication activities where users may feel disparate from their communication partners. One participant commented on a perceived increase in the level of connection when communicating through AR:

> *Using a system like this, while not as good as direct physical interaction, is a better substitute than simple video calling or phone calling.* [Q79, F2]

Aversion to Tech—Several participants pushed back against the technologies in the design fictions. One interview participant considered using higher-fidelity remote communication, such as the AR presented in the fiction scenarios, to compound negative feelings they already had towards video communication technologies such as Zoom:

> *Zoom is alienating enough - seeing someone's hologram I would find very obnoxious* [P5]

It is not surprising to find some backlash aimed at looking foolish while wearing a new gadget in public. This sentiment plagued media portrayals of Google Glass [62] and other similar technologies. In our design fictions, the characters were often wearing AR devices and would interact with people and objects only visible to themselves. The questionnaire respondents raised concerns over this, commenting that "*You might look crazy talking to a hologram only you can see walking around*

the park, until this becomes normal that is" [Q52, F2]. This comment shows great insight—new technology looks odd until it becomes commonplace.

6.3.4 Cognitive. Interaction with Memory—Using ubiquitous recording technology to continuously log experiences is akin to artificially augmenting the memory. Amplifying the mind [64] in this manner incited a range of responses from our participants. Some regarded enhancing memory with technology as a positive aspect, but others were concerned about "*over-reliance on technology to remember things*" [Q79, F2]. Several participants were concerned that "*The reliance on such a system can weaken one's own personal memory*" [Q59, F2]. This has interesting historical roots; Socrates famously believed that writing would weaken the memory of humans, and that knowledge could only be passed on through dialogue [60]. This conversation is likely to continue as more technologies are created that augment the human mind, and these concerns need to be taken into consideration.

Two of the design fictions [F3, F4] featured novel lecture formats where students were required to move from place to place between lecture segments. An interview participant highlighted that walking would allow time to process information between inputs:

> *Walking to the other location allows the student to digest, so that might be good and let that sink in.* [P4]

Privacy and Security—Both of the synchronous scenarios used ubiquitous capture to generate automatic notes from meetings. Ubiquitous recording often raises issues of ethics and data privacy, and this study is no exception. Privacy concerns were mentioned by many participants, with some variant of "*Who else can see the notes?*" [Q52, F2] being repeated multiple times. Transparency in the data pipeline is crucial to garnering trust in users, particularly when it comes to ubiquitous recordings. Users want to know how their data is being handled and who has access.

Participants also expressed negative feelings towards recording conversations: *Everything you do is monitored, so it feels like "big brother" is watching* [Q29, F1]. This is important for designers—if technology makes users uncomfortable, then they are highly likely to avoid using the product.

7 DISCUSSION

At the outset of this paper we asked the research question: "What are the requirements and constraints for designing technologies that empower users to integrate movement into meetings in motion?" In this section we will dive deeper into the requirements and constraints that result from triangulating the outputs of our evaluations.

7.1 Dimensions and Themes

We identified four dimensions that describe the themes generated from each of our studies. The dimensions are called: (1) *Practical*, (2) *Environment*, (3) *Social*, and (4) *Cognitive*. The four dimensions are depicted in Figure 6.

Examining the themes generates a deeper understanding of the hierarchy of the dimensions. As an example, changing a *Practical* dimension, such as the inability to take notes, would enable participants to focus more on the environment, their relationship, and their conversations, thereby impacting all other dimensions. The aforementioned example resonates with past work [5] which showed that moving away from one's desk for a 'walkabout' had a positive effect on communication and awareness. On another note, Ciolfi et al. [20] discussed the place as a key element of the overall meeting experience. Our dimension *Environment* extends this notion by encompassing a designated place as well as additional contextual factors such as weather conditions, which can also have a significant influence on the overall meeting experience. Hence, the environmental conditions (e.g. a designated place, weather) can set the overarching tone of a meeting in motion. Thus, the

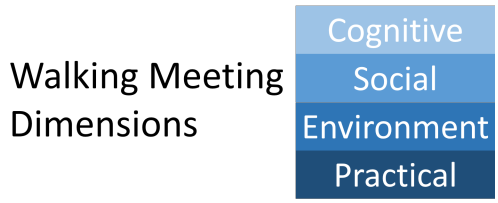


Fig. 6. The four dimensions of walking meetings with *Practical* as the base, and *Environment*, *Social*, and *Cognitive* building upon one another.

environment should be actively considered in design solutions for meetings in motion instead of trying to keep environmental factors as equal as possible or to control them. The *Social* dimension offers starting points for future systems that support meetings in motion. For instance, our findings imply that future technologies for walking meetings should allow users to dissolve hierarchical boundaries and create a shared meeting experience. We hypothesise that such an approach has the potential of fostering engagement in the walking meeting participants in line with findings from Muller et al. [51] and Ahtinen et al. [3]. The *Cognitive* dimensions extends previous findings, e.g. [26]. Our dimension goes beyond infrastructural support for walking meetings [26]. Instead, it illustrates facilitators and barriers of augmenting the cognitive.

The hierarchy between the dimensions is not strictly linear, but the depiction describes important aspects of the relation between the themes. This hierarchy can be important for technology creators to identify development priorities. Focusing on the base of the pyramid and working upwards is likely to have a larger impact than the reverse.

Figure 7 depicts each of the 19 themes and 4 dimensions we identified, and highlights the connections between the studies, the themes, and the dimensions. Further, Figure 7 visualises the results we derived based on triangulating evaluations from a set of different methods. As can be seen in the figure, there are several themes that were common to the two studies, but each study also generated a large amount of unique information.

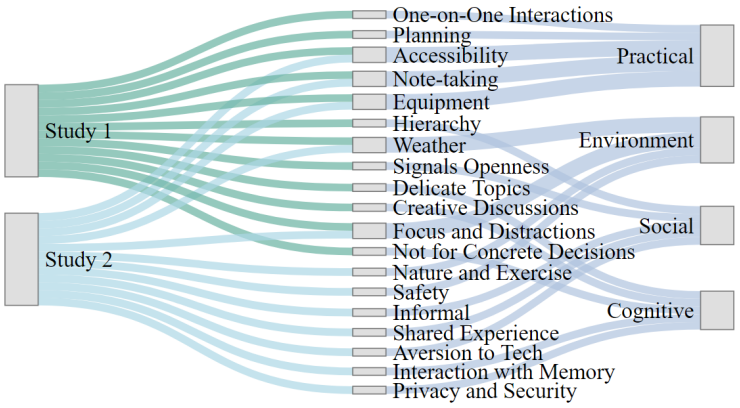


Fig. 7. The information flow from each study to the generated themes and the subsequent clustering into dimensions.

7.2 Requirement Space

There are several interesting dichotomies that were identified in both Study 1 and 2 analyses. The dichotomies were created based on themes and concepts in our analysis that were contradictory. Four important dichotomies that can help navigate the requirement space of moving while working are depicted in Figure 8.

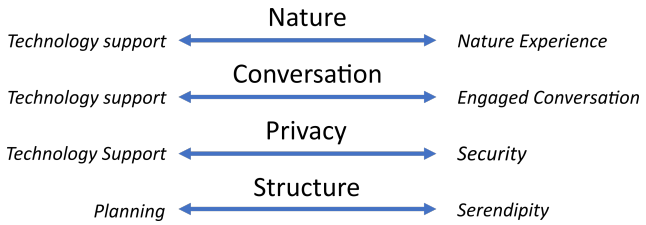


Fig. 8. Four scales that describe dichotomies in the requirement space.

The first dichotomy is between an expressed need for *technology support* and a desire to *experience nature*. Participants identified practical problems with walking meetings such as the inconvenience of taking notes and an inability to share visuals and documents. Without notes and resources, the types of meetings that can be hosted while walking is limited. These problems appear well-suited to technological innovation, but we also observed resistance to technological interventions. An opportunity to experience nature is a source of health benefits [35] and one of the primary motivators for participating in walking meetings. Users are reluctant to use technology that could detract from this experience. It is therefore crucial to create products that minimally interfere with the nature experience. It is also important to consider whether the best technology is *no technology* in some cases. Particularly for meeting where notes are not important, the opportunity to disconnect from technology may be an attractive feature of walking meetings.

We also identified a tension between *technology support* and *conversation*. Participants were interested in technology to expand the types of meetings they could conduct while walking, but were concerned that the technology would interfere with the high quality of conversation they expect. Technology that is too complex or expensive could also act as a barrier to entry for new users. A careful balance must be established, ideally through participatory design practices, to create technologies that do not hinder the conversation. Surprisingly, despite the variety of technologies already available, none of our interview participants used technology to augment their walking meetings. This may indicate that existing technological solutions do not satisfy the particular needs of walking meeting participants, highlighting the importance of this work.

A third scale involving *technology support* is the tension with *privacy*. Ubiquitous capture technologies are a logical leap to create hands-free meeting assistants for walking meetings, but the ethical and security issues related to this approach must be considered. Additionally, user trust and public perceptions of recording technologies are critical to design.

The tension between a desire for increased technology support and the three aspects of nature, conversation, and privacy, are important constraints for designing technologies to support walking meetings. Early adopters conduct walking meetings specifically for reasons associated with nature, conversation, and privacy, so a deep understanding and consideration of these issues will greatly benefit future designers.

Finally, the Structure scale describes a balance between *planning* and *serendipity*. Multiple aspects of walking meetings could benefit from planning support, from scheduling, route finding, and accessibility. However, spontaneity is also important. Users enjoyed impromptu walking

meetings in response to nice weather and typically wandered through parks without a defined route. Serendipitous interactions are beneficial for knowledge dissemination [11], personal interactions [37], and forming new collaborations [19]. Walking meetings are also a prime opportunity for conversation to progress to deeper, more personal topics. Technology designers must consider the aspects which benefit from planning while maintaining opportunities for serendipity. While the general opportunities of offering planning support was discussed, our results are interestingly different from previous work e.g. [1, 3] where the importance of instructions and gamification elements was highlighted.

7.3 Considerations for Design

Previous work by Ahtinen et al. [1, 3] made recommendations for using discreet or social persuasion methods to encourage workers to adopt healthy work habits and restorative nature experiences. They found that a combination of digital and non-digital persuasion methods was the most effective, and advocated for using this paradigm to increase the uptake of walking meetings in the workplace.

Damen et al. [27] highlighted several design considerations, recommending context aware planning support systems, adaptability based on experience level, embedding active ways of working into the infrastructure, utilising landmarks, and the use of walking to improve social dynamics. Each of these considerations were evident to some extent in our evaluation and can be found in our themes. As such, we can reaffirm the findings presented in [27], and extend the recommendations with additional insights from our analysis.

Both Ahtinen et al. [1] and Damen et al. [27] derived their recommendations from users of walking meeting prototypes. We sought to extend the fundamental knowledge about current and potential walking meeting users outside of the context of a prototype. Furthermore, we aimed to include both in-person walking meetings as well as meetings where people located in different places and time zones walk together. Our work confirms the findings from earlier artefact-driven research and broadens our understanding of walking meetings. Below, we contribute design considerations stemming from our results, which are different from previous research.

7.3.1 Embrace Interactions with Nature. Our participants found interacting with nature to be one of the most attractive parts of walking meetings. This was also one aspect people perceived as beneficial in the studies by Ahtinen et al. [3]. Nature experiences reduce stress [35], although our participants also indicated that the outdoors can be distracting. Rather than trying to combat outdoor distractions, technology designers should aim to embrace the surroundings and facilitate shifting focus between conversations and nature. Previous work has shown that the meeting experience is important [54] and that mobility is important for creativity and social processes [5]. This results in a design opportunity for technology supporting walking meetings. Such systems could be designed to recognise when participants are engaging with nature and support them resuming their conversation when their focus shifts back to the meeting. However, the tension between nature and technology also creates a potential paradox for technology designers. As mentioned, in some cases the best technology may be *no technology*, particularly for meetings that do not need document support or when participants want to disconnect.

7.3.2 Expand Topics with Document Support. A common sentiment in the literature is that walking meetings are only suitable for creative and abstract topics [1, 3, 27]. By closing the gap in facilities between walking meetings and traditional meetings, technology designers can expand the range of viable walking meeting topics. There is a need for technology that supports automated note-taking during walking meetings while embracing the inherent nature of meetings in motion. Participants in our study desired agency in note-taking and spontaneity in walking routes, so systems are needed that allow for shared control and move beyond built-in infrastructure to support serendipity.

Enabling users to easily take notes while walking could encourage them to discuss more detail-oriented topics. Automated note-taking has the additional benefit of removing the burden of trying to remember specific points and empowering users to focus more on their conversations.

7.3.3 Build in Accessibility. Until now, accessibility has not been a consideration in walking meeting literature. Our participants highlighted multiple accessibility concerns, including limitations in physical mobility and financial inequality. As such, we implore future designers and researchers in the area of walking meetings to explicitly consider how they can bolster inclusivity and start thinking about meetings in motion instead of walking meetings. From a technology perspective, future tools could automatically analyse potential routes and recommend appropriate paths based on accessible maps [31]. Continued development of accessible maps and inclusive infrastructure will also globally improve the opportunity for inclusive participation in meetings.

7.4 Moving on From Walking Meetings: Meetings in Motion

Throughout this paper we have referenced accessibility challenges associated with walking meetings. These challenges are multi-faceted, relating to physical mobility, financial requirements, and location opportunities. Several of these are open problems that can be improved through technological, architectural, or civic innovations. However, one fundamental issue can be easily addressed by simply changing how we write and speak about "walking meetings."

The term "walking meeting", while prevalent in the literature, is not inclusive to users who move wheelchairs or other individuals with differing mobility capabilities. The term also does not capture the full potential of the concept, which primarily revolves around getting users out of their offices, potentially out of doors, and engaging in rich collaboration with their colleagues in a new setting. To address these issues, we propose that collaboration while moving or physically active collaboration of all kinds should be referred to as *Meetings in Motion*.

7.5 COVID-19

This study occurred in the midst of a global COVID-19 pandemic, and our work interacts with pandemic restrictions in several interesting ways. Governments around the world have instituted recommendations for "social distancing" and increased ventilation [18, 33] since physical separation has been shown to reduce transmission [72]. Office workers have turned to video conferencing services for meetings, but meetings in motion could be a safe alternative for geographically close colleagues. Meetings in motion can be hosted while maintaining the recommended physical separation in well-ventilated outdoor spaces. Additionally, an unprecedented number of people are now working in sub-optimal home offices with poor ergonomics [28]. Developing technologies to enable working in motion could create opportunities for workers to be physically active during the workday and combat some of the negative effects of poor home office ergonomics. There is an opportunity to develop technologies that enable workers to walk at work while also empowering them to employ safe social distancing practices.

8 LIMITATIONS

Although we have gained valuable insights from the evaluations presented in this study, we can identify some limitations in our work. We generated requirements based on current experiences and fictional scenarios with the intention to drive future design, but have not yet implemented prototypes based on these findings. We acknowledge that the lack of field studies in our current work is a limitation. Using virtual interviews, questionnaires, and design fictions enabled us to conduct our study safely during the COVID-19 pandemic, when in-person field studies could have

exposed our participants to unnecessary risk. The information in this paper is intended as a basis—the findings must be implemented in practice to confirm and expand the knowledge generated here. Future work is also required to test the assumption that supporting meetings in motion with technology will make them a more viable option in the workplace.

Another limitation in our study is the fact that all of our interview participants work in positions related to research. In universities and other research-related workplaces, it is possible that the ability to conduct walking meetings is higher than in other office settings, so future work is needed to expand our results to other industries where schedules or other corporate structures may have an impact.

Design fictions are a difficult tool to effectively implement and evaluate. We followed literature recommendations and presented the design fictions to potential users and early adopters and received rich feedback. However, generating the narratives was carried out by one of the authors, who is invested in and excited about the combination of near-future technologies and meetings in motion, and therefore the narratives inherently contain biases. The responses to design fictions are always tied to the style and quality of the narratives, which are an uncontrolled variable. Within the design fictions, we used lectures, rather than traditional meetings, for scenarios 3 and 4. Each of these scenarios was intended to be an example of an asynchronous meeting, and lectures are a specific subset of asynchronous meetings. We chose to use lecture scenarios since two of our interview participants mentioned walking seminars, but we acknowledge that there is also a limitation which arises from this decision. In future work, other types of asynchronous communication methods should be explored to extend the results further.

9 CONCLUSION

We conducted a multi-method evaluation to generate a set of requirements and constraints for designing technology to support meetings in motion. We conducted an initial online questionnaire to learn about meeting habits, and then interviewed early adopters to gain in-depth insights into the practices and pitfalls of meetings in motion in daily routines. Using these two sources of information, we created four design fictions corresponding to the four quadrants of the space-time CSCW matrix. We presented these design fictions to average users through a second online questionnaire and also received feedback from the initial early adopters. We combined insights from all stages of this evaluation and identified numerous themes across four dimensions: *Practical*, *Environment*, *Social*, and *Cognitive*. Finally, we synthesised the results to identify requirements and design considerations for meetings in motion as well as opportunities for future work. This study provides in-depth constructive knowledge for HCI researchers and designers of technologies to support *meeting in motion*, and creates a basis for a wide range of future developments.

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