AmbientTeams

An approach to stay socially connected in remote teams

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Master Thesis

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URL:	https://github.com/HASEL-UZH/PA.AmbientTeam
Project period:	15.2.2021 - 22.7.2021

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Acknowledgements

credits für avatar library

Abstract

With the significant shift towards remote work, casual, informal conversations are no longer guaranteed to happen because of the lacking serendipity. Such informal discussions are further challenged because of missing cues from co-workers about their availability or social states. In addition, despite increased challenges with mental health, tools focusing on the social challenges of remote work are still lacking. For this reason, we developed AmbientTeams, a casual and informal tool that attempts to reduce the perceived distance in remote work by creating opportunities for more informal interactions. AmbientTeams attempts to achieve this by sharing moods and status messages with the team, or more generally, fostering informal communication among team members. We evaluated our research prototype on a group of 6 knowledge workers who agreed on using AmbientTeams for one workweek. We found ...

Zusammenfassung

Mit der signifikanten Verschiebung in Richtung Fernarbeit sind zwanglose, informelle Gespräche aufgrund der fehlenden glücklichen Zufällen nicht mehr garantiert. Solche informellen Gespräche werden außerdem durch fehlende Hinweise von Kollegen über ihre Verfügbarkeit oder ihren sozialen Status erschwert. Darüber hinaus gibt es trotz der zunehmenden Herausforderungen im Bereich der psychischen Gesundheit immer noch keine Tools, die sich auf die sozialen Herausforderungen der Fernarbeit konzentrieren. Aus diesem Grund haben wir AmbientTeams entwickelt, ein zwangloses und informelles Tool, das versucht, die wahrgenommene Distanz bei der Fernarbeit zu verringern, indem es Möglichkeiten für informellere Interaktionen schafft. AmbientTeams versuchte dies zu erreichen, indem es die Möglichkeit schafft, Stimmungen und Statusmeldungen mit dem Team zu teilen, oder allgemeiner gesagt, die informelle Kommunikation zwischen den Teammitgliedern fördert. Wir evaluierten unseren Forschungsprototyp an einer Gruppe von 6 Wissensarbeitern, die sich bereit erklärten, AmbientTeams eine Arbeitswoche lang zu nutzen. Wir fanden ...

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Chapter 1

Introduction

In Software Development, remote working has become very popular over the past years. Due to the Covid-19 pandemic, this trend has grown even stronger, forcing many companies and their employees to work from home. Further, the majority of managers expect to have more flexible work from home policies post-pandemic, and employees would like to continue working from home at least partially [Spa20b], making the topic very much relevant also after the pandemic.

While working from home has numerous benefits, it also comes with a range of challenges. On the benefits side, employers can realize savings in real estate costs, and the employee can benefit from more flexible work hours and spending less time and money commuting [Mul+09]. However, shared challenges from working from home are that communication is reduced [KEG88] and suffers in quality [Mul+09]. More specifically, informal communication drastically reduces when working from home [HM05]. This reduction of informal communication can lead to difficulties building trust, maintaining work relationships, or not feeling attached to the team [Com+20; OO06]. Another consequence of remote work is the feeling of workplace isolation [Mul+09; MMM07]. The feeling of isolation leads to not knowing whom to turn to in case of a problem or not feeling part of the company and is said to be caused by missing support from co-workers and opportunities for social and emotional interactions in a team [MMM07]. The pandemic further reinforces this influence leading to almost 60% feeling less connected to their co-workers compared to before the pandemic [Spa20b]. Since strong team cohesion has been shown to have a positive impact on the team's effectiveness and productivity [Car+17], and the feeling of being disconnected from colleagues have been shown to impede engaging in productive tasks [Eco20], the connectedness with the team is of particular interest to us.

A lack of awareness causes the challenges of working remotely: less information about co-workers is exchanged, e.g., no or fewer cues are available to identify team members' interruptibility or emotional states. This missing information makes it a lot harder to find opportune moments to initiate a conversation because it is often unknown whether a person might be in a deep focus state or whether a person might be more than happy to chat. Informal communication is further challenged because serendipity is missing when working remotely because people no longer randomly bump into each other at the water cooler or the coffee machine. Therefore, improving awareness in the workplace is the foundation of our approach.

While there are several prior approaches to improve awareness within teams by showing the current coding tasks and work items that others are working on [Bie+07; Jak+09], they do not focus on the person behind that work item. They thus do not put teams into the center of attention. To make this point stronger, recent research shows concerning numbers in regards to workers' well-being and mental health, stating that the pandemic has led to an increase in stress for 65.9% of people and 44.4% reported a decrease in mental health [Qua20]. Therefore, our concept, AmbientTeams, follows a different approach by "putting the people first". It includes an

ambient always-on-top overview of the core team members and their moods, status messages, and other states. Other solutions (e.g., [ES10; ES08; Zha+10]) follow a similar philosophy by studying micro-blogging at the workplace, an informal and easy way of broadcasting short texts. Their results look promising and indicate higher connectedness with team members. Extending the purely text-based microblogging systems, Dullemond et al. [Dul+13] developed a microblogging system that shares selected moods in addition. We use their idea as a foundation for our work, to study the behavior of mood sharing when making it optional, something that was not done by Dullemond et al. [Dul+13].

In addition to microblogging, we aim to study further possibilities to foster and motivate serendipitous, informal exchanges with the team or individual team members while keeping interruptions at inopportune moments low.

In the next chapter, existing approaches are discussed before our approach, and their differences are introduced. Our approach is then analyzed in the scope of a preliminary evaluation, and its results are discussed.

Related Work

Remote work offers numerous benefits for both the employee and employer compared to traditional co-located work. Benefits on the employee side include a more flexible schedule, higher job productivity, and less time and money spent commuting [Flo19; Mul+09]. The increased flexibility and autonomy allows employees to more easily deal with their family responsibility and leads to higher levels of job satisfaction and higher employee retention [Mul+09; GH07; Mad11], both highly beneficial for the employer. The employer can further profit from savings in real estate costs and increased productivity [Mul+09]. In addition to those general benefits, there is another popular reason for building distributed teams: the possibility to build teams with talents from all over the world [Car99].

However, remote work creates new challenges for the company and its employees. Therefore, it is not surprising that much research has been done in this area, most of which coming from Computer-Supported Collaborative Work (CSCW). The general goal of existing solutions is to support distributed teams in accomplishing work as effectively and efficiently as possible. While a lot of research goes into collaboration and coordination challenges in remote work, the goal of AmbientTeams is fostering social, informal interactions. As a result, we identified four main social challenges that are the result of working remotely. Together with existing solutions aiming at solving those problems, all of them are discussed in this chapter.

2.1 Workplace Isolation

Marshall, Michaels, and Mulki [MMM07] defines workplace isolation as the "[...] desire to be part of the network of colleagues who provide help and support in specific work-related needs. It represents employees' perceptions of availability of co-workers, peers, and supervisors for work-based social support." They further suggest a categorization into social isolation and organizational isolation. Oranzisational isolation comes from the perception that remote workers might feel "out of sight, out of mind" [BK99]. Social isolation relates to the fact that remote workers miss informal chats, spontaneous discussions, and meetings around the water cooler [CK02]. For those reasons, a closer look at informal communication will be given in the following.

2.2 Communication

Research states that co-workers are the most used source of information used by developers [KDV07], emphasizing the importance of team communication inside software development teams.

In the context of remote work, studies find different results regarding the communication frequency: while Kraut, Egido, and Galegher [KEG88] and Allen et al. [All+84] find a decrease in communication, Mulki et al. [Mul+09] find increased communication. A possible reason for more communication include the need for remote workers to over-communicate their availability status to their co-workers [KSO12]. Reasons for communication reduction could be the active effort to bring back ad-hoc meetings [Mil+21]. Regardless of communication frequency, working remotely and thus using software to communicate leads to having more misunderstandings due to missing cues and thus reduces communication effectiveness [Mul+09]. Other researchers argue that the reason for those misunderstandings is the fact text-based communication (which is often used in software development) has very limited capacity, and thus a lot of socio-emotional information (non-verbal cues) is missing [Has+17]. Face-to-face communication is still very important for many developers [Sto+16] and a lack thereof, which is caused by working remotely, can lead to workplace isolation making it harder to develop personal relationships and build trust [Mul+09]. Gajendran and Harrison [GH07] state that working from home with high-intensity (more than 2.5 days a week) harmed relationships with co-workers, something that is enforced because of Covid-19.

2.2.1 Informal Communication

To facilitate communication, some awareness tools also have basic informal communication tools built into them. Cheng et al. [Che+03] introduces JazzBand, a tool visualizing the team members to increase peripheral awareness enhanced with status messages and chat functionality. However, by being an Integrated development environment (IDE) Plugin, we argue the communication likely is tightly coupled to the code, thus being work-related and only used when coding and limited to software developers. AmbientTeams expands the JazzBand ideas and bundles them in a more general-purpose awareness desktop application with informal communication functionality.

Kraut et al. [Kra+] define informal communication as "[...] communication that is spontaneous, interactive and rich". Differences to formal communication include lack of planning and the fact that the content of the communication unknown in advance. They further state that over 85% of all conversations are informal and informal communication happens more often if there is a short physical distance between parties. Similarly, Hinds and Mortensen [HM05] find that members of distributed teams engage less in informal communications. This reduction of informal communication is unfortunate since informal communication is crucial for achieving high productivity and social goals [Kra+]. More concretely, in the field of software development, informal communication plays a critical role due to the fast speed at which informal communication distributes knowledge across a team or company [FL98; MH01]. Also, informal communication can increase awareness, enabling developers to work efficiently [HM01]. In the ever-changing field of agile software development, this is particularly useful because requirements can change, and formal communication channels cannot spread the news as fast. In addition, informal communication is essential for conflict identification and handling [HM05]. Since teams with a high degree of social interactions often have better team cohesion [SCS14], and informal communication is normally much more frequent than formal forms of communication [Kra+], increasing informal communication is likely highly beneficial for team cohesion.

Because of those benefits, it is no surprise that numerous approaches are fostering informal communication inside distributed teams. One of the earliest proposed solutions for promoting informal communication in distributed teams was VideoWindow [FKC90]. Despite being an early solution, the authors already identified two essential requirements such a system must offer: low personal cost and the need for a visual channel. Suppose the prices for initiating conversations are too high. In that case, the system will not be helpful because it will not be used. The visual

channel plays a vital role in recognizing the presence of other people. Sasaki [Sas99] developed a 'hallway' system that was able to raise awareness and helped to indicate that one might have a question but failed to promote casual interactions. In comparison, Lou et al. [Lou+12] manages to provide awareness information that is relevant to engage in everyday conversations and a low-effort mechanism to initiate such informal discussions. It does so by providing social cues which help understand the availability of others and thus creating a context for subsequent communication.

As a consequence of the global pandemic, many commercial tools have been published recently. Branch[1], Reslash[2], Wonder[3], or Gather[4] follow a similar goal set of increasing spontaneous, informal communication. By mimicking the real office, those virtual office approaches all have the same downside: requiring a fair bit of user interaction due to the visually complex interface. We argue that this adds a lot of unnecessary overhead and reduces long-term usability. Thus, AmbientTeams avoids this overhead, and its goal is to be as ambient as possible while still fostering informal communication. Tandem[5] takes a similar approach in that it is less playful than the other commercial tools but still very focused on collaboration and communication. In comparison, AmbientTeams additionally includes a glanceable overlay and team members' moods and status messages.

In regards to status messages, the concept of micro-blogging is very similar. Studies have shown that micro-blogging is a form of informal communication [ES10] that is "[...] like a virtual coffee machine as a meeting place" [ES08]. Further, many existing micro-blogging approaches have found that micro-blogging results in people feeling more connected [ES10; Zha+10]. Their study participants found microblogging very helpful because it allowed them to stay aware of what their team members are doing [Zha+10]. In addition to purely share text-based contents, Dullemond et al. [Dul+13] developed a micro-blogging system that allows the users to attach a mood to each message which helped the teams feeling more connected. What they did not measure, however, is the isolated effect of mood sharing.

We see a lot of value in providing additional awareness and sharing moods in the workplace, which is why the following two sections focus on those two concepts.

2.3 Awareness

Part of the reason for coordination and communication challenges in a remote work environment is the lack of awareness, so it is of great interest to us to increase awareness in distributed teams. Gutwin and Greenberg [GG96] defines group awareness as a combination of:

- **Informal Awareness**
  The general sense of the presence, availability, and activities of others. It is the "glue that facilitates casual interactions" [GG96].
- **Group-Structural Awareness**
  "Group-structural awareness involves the knowledge about people's roles and responsibilities, their positions on an issue, their status, and group processes" [GG96].
- **Social Awareness**
  "Social awareness is the information that a person maintains about others in a social or conversational context "[GG96]. It includes things as the attention state of the other person, their emotions, or the level of interest [GG96], or whether a person can be disturbed [GG95].

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[1] https://branch.gg
[2] https://reslash.co
[3] https://wonder.me
[4] https://gather.town
[5] https://tandem.chat/

- **Workplace Awareness**
  Defines the awareness that results from the 'real-time' combination of elements workers keep track of when working together. Such elements could be people, actions, objects, and many more [GG95].

It is important to note that those four awareness types are not excluding but rather overlapping with each other. Put differently, informal, social, and group-structural awareness are all part of workplace awareness. In the case of software developers, for instance, a study shows that developers checked the availability status of their co-workers almost as many times as their compiler output [KDV07]. This indicates the importance of informal awareness. Providing group-structural is essential because of difficulties when trying to find experts in a distributed team [HM03]. Social awareness is highly relevant due to the high communication needs of software developers [PSV94]. Additionally, with less face-to-face communication and more computer-mediated communication, it is consequently more difficult to transfer emotional information [RCB96].

Despite the seemingly precise categorization of awareness above, the literature does not agree on one common categorization. Alternative terms such as general awareness, peripheral awareness, co-existent and cooperation awareness, and objective self-awareness are used to describe and categorize awareness. Due to the popularity and granularity of the above definition, it is the definition of choice for this work.

To address the problem of missing awareness when working remotely, a wealth of research developed approaches to increase awareness in distributed teams. Popular tools made explicitly for software development teams focus on providing awareness by on work items, developers' activities (e.g., which files they have opened or recently changed) and thus put the code base and tasks in the foreground of coordination [Bie+07; Jak+09; ESS+92; DCR05]. While the team awareness gained by those tools allows developers to understand who you are working with and what they are working on, and what the impact of a change can have on others, which is essential for successful collaboration [DB92], they only cover a very limited view of awareness by providing very limited social or emotional information. García, Favela, and Machorro [GFM99] already mentioned the need for emotional awareness inside groupware in 1999. Similar to [MRM11], we argue the awareness of moods in a work environment is underrepresented in research, especially in a society where many are facing mental challenges caused by the global COVID-19 pandemic.

While the majority of the above-mentioned awareness tools require user interactions to be helpful, there have also been attempts for creating ambient approaches to raise awareness in the work environment [MCR20; OMF06; DPH12; AD12; Röc+04]. Downs, Plimmer, and Hosking [DPH12] define ambient devices as devices that "[...] present dynamic information in an at-a-glance manner and have low attentional requirements". Unfortunately, while they increase informal awareness in a non-intrusive way, none of them focus on social awareness, both of which are types of awareness important at the workplace [GGC96]. Additionally, many of the above approaches include physical devices (e.g., from [DPH12; AD12; Röc+04]), which might not be suitable for a remote team setting due to the size of the device or the device with the awareness information would not be visible to off-site team members.

The focus of AmbientTeams is to raise team/group awareness in an ambient manner, but by putting teams and people in the foreground, similar to [Whi+04], yet to foster informal communication instead of email.

2.4   Well-being: Emotions, Moods, and Sentiments

A common finding in research regarding remote work is that employees work longer hours, experience more stress, and have difficulties with mental health [Spa20a; Mul+09; Qua20]. A recent

study in the context of the global Covid-19 pandemic lists the negative impacts from working from home, such as increased burnout, lack of separation between work and life, and feeling disconnected from co-workers [Spa20a]. A Psychological study highlights that the mental health of remote workers should be considered and is very important to be communicated and talked about [GWS13]. For those reasons, we see a need for better and more accessible communication of well-being and mental health and tools that increase connectedness among teams. This is a similar finding to Kuwabara et al. [Kuw+02] who highlights the need for connectedness-oriented communication because it is critical for developing social relationships and harder to do over distance. McDuff et al. [McD+12] further state the usefulness of being able to assess one's emotional state (e.g., when considering mental health issues). Their approach, AffectAura, is developed using different kinds of sensors to predict emotions and provide an overview of them in a diary-like fashion with the purpose of self-reflection [Dul+13]. Guzman and Bruegge [GB13] emphasizes the importance of emotion in software development, however focusing on the emotional state towards a project, not of individuals. MobiMood is a mobile application focusing on individuals by letting them share their moods, but not targetting a work environment [CHO10]. Saari et al. [Saa+08] developed another mobile application with mood sharing features aimed at knowledge workers. However, while the researchers developed the prototype, their approach's usability and use cases were not studied. Both of which will be analyzed in the scope of our preliminary evaluation. Further, a mobile application might not be ideal to use in a work environment since this might also introduce more room for interruptions.

Of particular importance for text-based communication tools is the fact that emotions are an essential part of communication and can get lost/misunderstood inside text messages due to the lack of cues in text-based communication [Höö+08].

To communicate one's well-being, different types of affective responses exist that could be useful for sharing with the team, namely emotions, moods, and sentiments. Emotions are typical reactions to events and therefore have a definite cause and are typically short-lived. Emotions differ from moods in that moods are longer in duration, have no clear target, and are less intense [Fri+94; BN07]. Sentiments can be described as states associated with objects rather than individuals and therefore are relatively permanent [BN07].

When it comes to measuring well-being, the literature does not reach a consensus of one best measurement. However, the valence-arousal dimensional model is most commonly referred to as the "better" model [Rus80; MR09]. It is a two-dimensional model where the arousal dimension contrasts states of pleasure with states of displeasure, and the arousal dimension contrasts states of low arousal with states of high arousal [MR09]. Results of this model can then be used to map onto a discrete set of basic emotions such as surprise, fear, disgust, anger, happiness, or sadness [BN07].

Chapter 3

Approach

Our approach aims to help software developers in remote teams facing challenges with workplace isolation, team awareness, informal communication within their team, and well-being. We aim to tackle these issues by allowing knowledge workers to quickly learn about the availability, moods and emotions, and other states of their core team members. The critical underlying concepts of our approach are listed and explained in the following.

Ambient always-on-top, people-centered team view
At the core of our approach sits the decision to create an ambient tool that does not require significant, additional effort to be helpful. Having a limited amount of information on an ambient display is critical for both not being interruptive and costly to use [DK04]. With the help of the ambient display, the goal is to create a sense of presence within the team, even when working from different locations. By constantly showing the most central team members, the goal is to foster a sense of belonging.

Compared to existing awareness-increasing approaches focusing primarily on task-related awareness and their implications for more effective and efficient collaboration, our policy puts the humans behind the work items into the center of focus. By fostering more social communication, our approach does not conflict with or replace existing communication patterns established in a company. Instead, it aims to provide additional social information about the individual team members.

Transience and topicality
We want to keep interactions light-weight and casual, so the functionality is kept simple, maybe even limited, by design. The information shared and displayed will be transient. Following this approach brings the benefit of really fostering informal communication because there is no guarantee that messages will be read. In addition, our approach visually emphasizes the topicality of information displayed to avoid outdated data that clutters the user interface.

Mood and context sharing
As the primary text-based informal communication possibility, our approach focuses on status messages that can be broadcasted to the entire team. This concept is known as micro-blogging, with the difference that common micro-blogging platforms often are public (e.g., Twitter), and our approach is scoped to a team. Dullemond et al. [Dul+13] state that micro-blogging is another strategy that allowed software engineers to share activities and moods with other team members with the result of feeling more connected to each other. Our approach is very similar to theirs in terms of functionality of mood-based status sharing, yet we do not force the users to share moods accompanied by a status message; we are interested in use-cases for the combined and isolated usage of the two features. Further, topics that are usually blogged about are informal [ES10] which aligns with the goal of our approach. Furthermore, mood sharing seems to acts as

a springboard for conversations according to Church, Hoggan, and Oliver [CHO10], which suits our goal of fostering communication.

Ever-running break room

Additionally, allowing to see the team (and not just relying on text-based information) is possible by joining an ever-running break room. The goal is to mimic the water-cooler in the office. Thus, visiting a breakroom as simple as possible, similar to just walking to the coffee machine in an office and signaling to the other team members that you are now on a break, is required. This effortless joining of a breakroom is motivated by Chang and Ehrlich [CE07], who emphasizes that initiating a conversation must be as simple as possible. This approach also applies to the next concept on the list, interactions that target individual team members.

1:1 interactions

For scenarios where the content you want to share is intended for a single person, or you want to get another team member's attention, there's an easy way to start a private conversation. This can be done through a direct message or by nudging a team member. This concept aims to help in cases of help-seeking, a known problem when working remotely [HM03]. Recalling the transient nature of our approach, this communication mechanism is best suited for making a non-interruptive request that is not urgent. Should a user feel the need to talk to another team member, they can indicate that now would be an appropriate time for a short informal conversation. If other team members feel the same, two team members can randomly be paired up for a virtual video call.

Minimizing interruptions

When developing an ambient always-on-top visualization, minimizing interruptions and distractions is one of the most important design principles. Specifically, this means a very targeted use of notifications and the ability not to be contacted and hide potential distractions if desired.

Chapter 4

Prototype

The above outlined key concepts were then developed into the key features of our research prototype, *AmbientTeams*. Before stepping into the core features employed in AmbientTeams and aligning them to the above-mentioned key concepts, a brief introduction into the more technical aspects and a general overview of the application are given.

AmbientTeams is a cross-platform desktop application based on Electron[1]. To facilitate the implementation of the interactive user interface, VueJS[2] was used. To maintain JavaScript as a common language for the front-end and back-end, NodeJS[3] is used on the server-side. The server provides both a REST API for basic CRUD functionality for users and teams, as well as a WebSocket endpoint since much of the data required for AmbientTeams comes from the server in real-time.

AmbientTeams comes with two main windows. The team overview window is responsible for maintaining a connection to the server, authenticating, login functionality, settings. Additionally, once the user has authenticated, they are redirected to the team overview view where all teams and team members are visible (see Figure 4.1). By clicking on the edit icon next to the team name, the user can select team members from each team that will then be displayed on the other main window, the ambient window. This is demonstrated in Figure 4.1, where the user is selecting the team members to be displayed on the ambient window.

TODO: Talk about avatar library TODO: Talk about different team 'types': local and remote

Ambient always-on-top, people-centered team view

AmbientTeams consists of two main windows; a team overview window and the so-called ambient window. The ambient window always sits on top of other windows, making it prone to interruptions and distractions. To keep the ambient overlay as ambient and minimal as possible, we employed a transparent window. Further, certain functionality is only visible when the user is hovering over this window. When hovering over the ambient window, the user can select the team they want to show and sees the names of the individual team members, as shown in Figure 4.2b.

Transience and topicality

To ensure that information shared within AmbientTeams is up-to-date, a couple of measures have been taken. The first is a purely visual effect which leads to the avatars fading out when no recent activities took place Figure 4.2a. Such activities include status and mood sharing, direct messages, and nudging. In addition to potentially motivating users to interact with such faded-out team members, this automatic fading out facilitates spotting colleagues' updates quickly. Since the goal

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[1]https://www.electronjs.org/
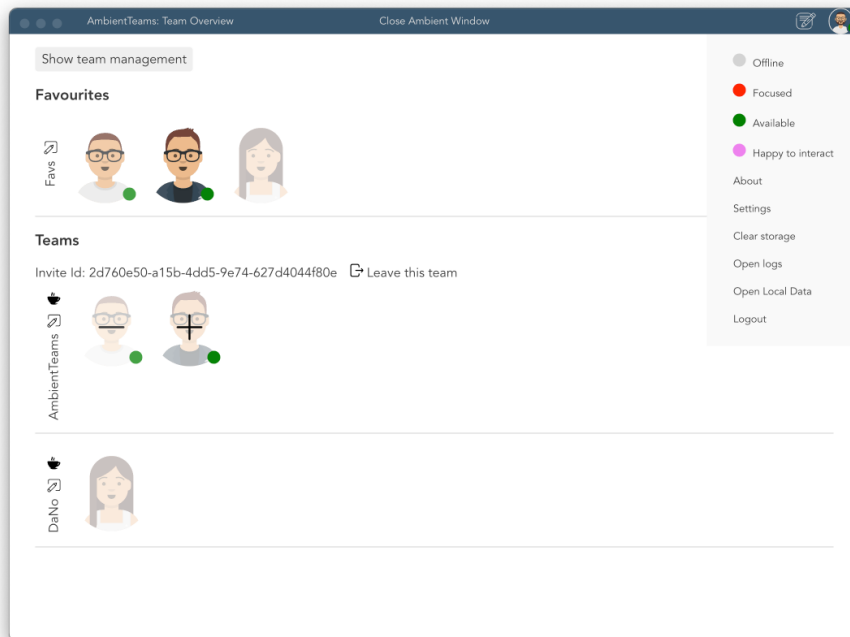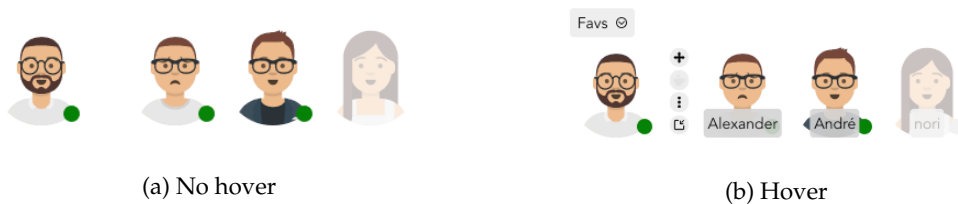[2]https://vuejs.org/
[3]https://nodejs.org/

Figure 4.1: Team overview window

(a) No hover

(b) Hover

Figure 4.2: Ambient window

of AmbientTeams is to foster informal communication, it has no chat history or any other history built into the application. With this transience, we aim to promote less formal communication and hope to avoid the AmbientTeams becomes just another tool to keep track of for work.

TODO: auto-reset status at midnight

Mood and context sharing

The user can open the sharing window from both the team overview and the ambient window, as well as the system tray menu. All of those actions will open the sharing window as shown in Figure 4.3a, where on the left, a preview of the current avatar and the selection of predefined moods are listed. There are nine available moods, visualized using popular emoticons. The first four emoticons are more optimistic, the fifth is a neutral face, and the last four are emoticons representing rather negative emotional states. The selection of the emoticons started with the basic emotions surprise, fear, disgust, anger, happiness, or sadness. This list was expanded over time to, in our opinion, suit the work environment better by adding a neutral and tired emoticon, as well as two more positive emotions (loving hearts and grinning) to make the selection more balanced. Due to limitations with the avatar API, we were not able to render the emotion fear well enough, which led us to remove it. On the right, a textbox for providing additional context

is shown. The contents of this textbox are, if available, pre-populated with the current status message for the currently selected team. Additionally, the text is highlighted when the window is created, facilitating overwriting the current status without using the mouse to select the text manually. Status messages' length is limited to 140 characters, motivated by the initial limit of Twitter (TODO: cite). Below the textbox, the user can find a button to share the status message with either all teams or a single team.

As a reminder for the user to share his moods and/or additional context with the team members, the sharing window is also automatically scheduled to appear on the lower right corner of the user's primary monitor to minimize the distraction potential. All in all, the window has the same functionality but includes two additional buttons to postpone the prompt for either 5 minutes or 1 hour (see Figure 4.3b). The scheduled sharing window is shown at three predefined times throughout the day, namely at 9:00, 13:00, and 16:00 local time.
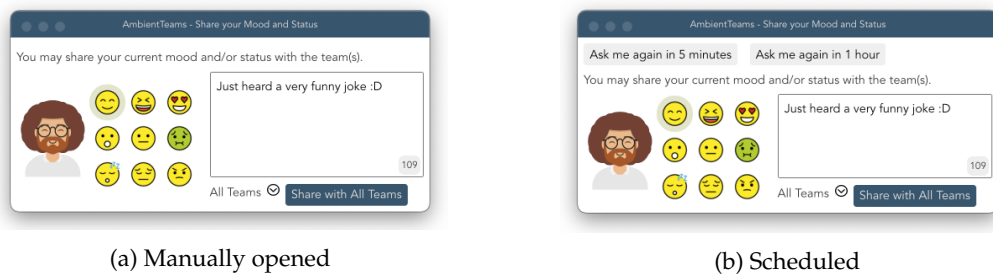

(a) Manually opened

(b) Scheduled

Figure 4.3: Sharing window

Ever-running break room

As stated before, our goal was to make the creation of ever-running break rooms as effortless as possible. Figure 4.4a shows the state of the ambient windows when the user clicked on the coffee icon. Having clicked on this coffee icon, the other members of the team see an indication that there is an ongoing break room (see Figure 4.4b). However, to not unnecessarily set up a break room and potentially interrupt the initiating user, the break room is only created once another user clicks on the coffee icon.

(a) Initiating a breakroom creation

(b) Joining a breakroom

Figure 4.4: Breakroom creation

Once at least two team members are interested in a break room, a break room is actually created, and the two are redirected to the break room view (see Figure 4.5). At any point, other team members can join and leave the breakroom, and it stays active as long as at least one team member is part of it. We want to avoid users forgetting the time and staying too long in the break room. For this purpose, whenever a user enters a break room, a 15-minute timer is started. When

this timer reaches its end, the user automatically leaves the break room.
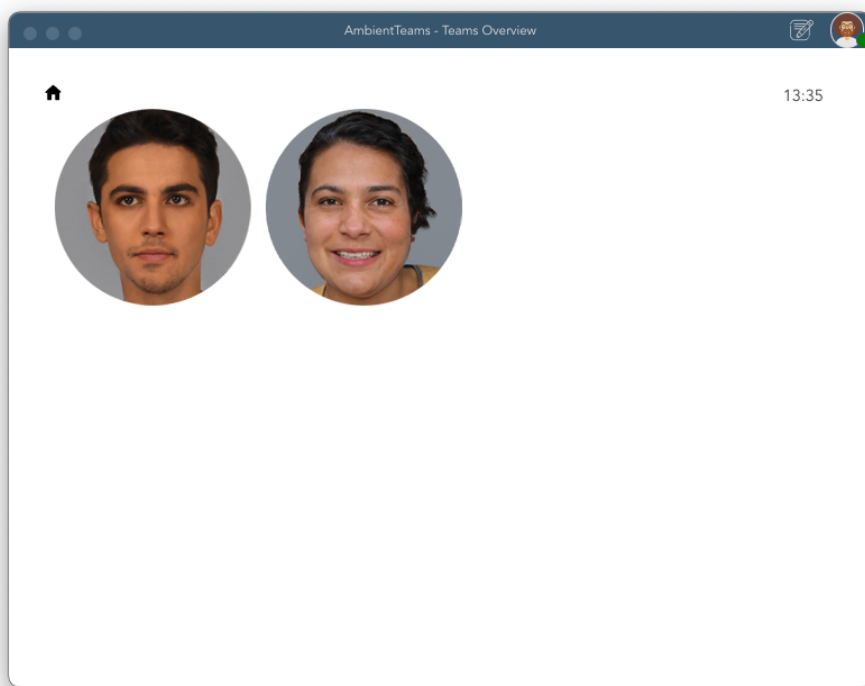

Figure 4.5: Breakroom, pictures are artificially created with `https://generated.photos/`

1:1 interactions
Random calls

Minimizing interruptions
Availibility status -> focus

Chapter 5

Preliminary Evaluation

To evaluate the above mentioned research questions, a small pilot study was conducted. Optimising and improving our approach with the help of feedback from a small team consisting of knowledge workers is the main goal of this master thesis. Further, by collecting additional data hope to get valuable first insights into the following areas:

1. Common workflows and patterns
   RQ1: How do knowledge workers use and interact with AmbientTeams? How do they integrate it into existing workflows?

2. Mood sharing behavior
   RQ2: Do knowledge workers want to share their moods with their remote team members? If so, what causes knowledge workers to share their moods with their team?

3. Feeling of isolation
   RQ3: Can a people-focused team mood and status sharing approach decrease the feeling of isolation in remote knowledge worker teams?

4. Information consumption
   RQ4: What do knowledge workers learn from information shared by their team members? What kind of information is the most valuable?

The data used to answer the above research questions came from three different sources. Given the relatively few participants, it was important to have both quantitative and qualitative data. After having a look at the study procedure in the next chapter, each of the three data sources and their relevance for the research questions are elaborated.

To find participants, a recruitement flyer (see .) The study was conducted with two knowledge worker teams, each team fulfilling the following paritication requirements:

1. At least three team members

2. Three or more common working days a week

3. Spending the majority of their work day on the computer

4. Having all the required rights to install AmbientTeams on their work computer

5. Willingness to use AmbientTeams during at least 3 full days of work (approximately 0800 - 1700)

6. Using macOS or Microsoft Windows

7. An active internet connection

5.1   Procedure
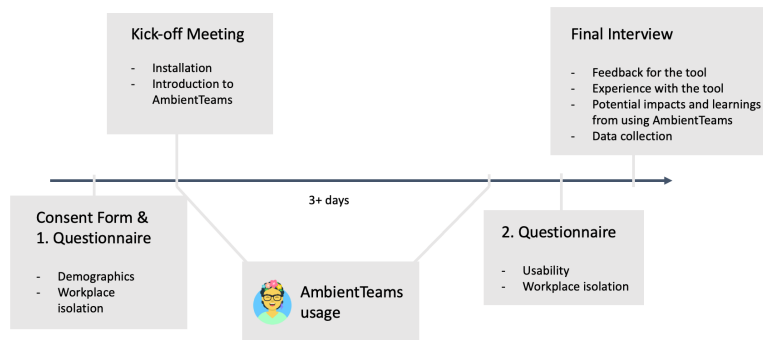
Figure 5.1: Study timeline

1. Initial meeting: Installation, registration, team creation, give each team member a participant ID (see section 5.2)

2. Pre-study questionnaire (see section 5.3)

3. Evaluation phase (see section 5.4)

4. Post-study interview (see section 5.5) with data collection (see section 5.6)

5. Post-study questionnaire (see section 5.3)

5.2   Initial meeting

Installation

5.3   Pre- and post-study Questionnaires

The pre and post study questionnaires are used to asses the feeling of workplace isolation before and after the evaluation period. The questions are taken from ....

5.4   Evaluation Phase

How long?
During the study notes from notion

5.5   Interview

Interview questions and their relevance for the research questions

5.6   Data Collection

Table 5.1 shows an overview of all data collected and for which research question they are relevant.

Data collected	Storage	Relevant for
cell4	Local	cell5
cell7	Local	cell8

Table 5.1: The data collected during the preliminary evluation and its relevance for the RQs

Results

Chapter 7

Conclusion

Appendices

Appendix A

Additional Documents

Interview Transcriptions

Bibliography

[AD12]   Hamed S Alavi and Pierre Dillenbourg. "An ambient awareness tool for supporting supervised collaborative problem solving". In: *IEEE Transactions on Learning Technologies* 5.3 (2012), pp. 264–274.

[All+84]   Thomas J Allen et al. "Managing the flow of technology: Technology transfer and the dissemination of technological information within the R&D organization". In: *MIT Press Books* 1 (1984).

[Bie+07]   Jacob T Biehl et al. "FASTDash: a visual dashboard for fostering awareness in software teams". In: *Proceedings of the SIGCHI conference on Human factors in computing systems*. 2007, pp. 1313–1322.

[BK99]   NBKDE Bailey and Nancy B Kurland. "The advantages and challenges of working here, there, anywhere, and anytime". In: *Organizational dynamics* 28.2 (1999), pp. 53–68.

[BN07]   Scott Brave and Cliff Nass. "Emotion in human-computer interaction". In: *The human-computer interaction handbook*. CRC Press, 2007, pp. 103–118.

[Car+17]   John R Carlson et al. "Virtual team effectiveness: Investigating the moderating role of experience with computer-mediated communication on the impact of team cohesion and openness". In: *Remote Work and Collaboration: Breakthroughs in Research and Practice*. IGI Global, 2017, pp. 687–706.

[Car99]   Erran Carmel. *Global software teams: collaborating across borders and time zones*. Prentice Hall PTR, 1999.

[CE07]   Klarissa T Chang and Kate Ehrlich. "Out of sight but not out of mind? Informal networks, communication and media use in global software teams". In: *Proceedings of the 2007 conference of the center for advanced studies on Collaborative research*. 2007, pp. 86–97.

[Che+03]   Li-Te Cheng et al. "Jazzing up Eclipse with collaborative tools". In: *Proceedings of the 2003 OOPSLA workshop on eclipse technology eXchange*. 2003, pp. 45–49.

[CHO10]   Karen Church, Eve Hoggan, and Nuria Oliver. "A study of mobile mood awareness and communication through MobiMood". In: *Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries*. 2010, pp. 128–137.

[CK02]   Cecily D Cooper and Nancy B Kurland. "Telecommuting, professional isolation, and employee development in public and private organizations". In: *Journal of Organizational Behavior: The International Journal of Industrial, Occupational and Organizational Psychology and Behavior* 23.4 (2002), pp. 511–532.

[Com+20]   Santiago Comella-Dorda et al. "Revisiting agile teams after an abrupt shift to re-
           mote". In: *Retrieved July* (2020).

[DB92]   Paul Dourish and Victoria Bellotti. "Awareness and coordination in shared workspaces".
           In: *Proceedings of the 1992 ACM conference on Computer-supported cooperative work*. 1992,
           pp. 107–114.

[DCR05]   Robert DeLine, Mary Czerwinski, and George Robertson. "Easing program compre-
           hension by sharing navigation data". In: *2005 IEEE Symposium on Visual Languages
           and Human-Centric Computing (VL/HCC'05)*. IEEE. 2005, pp. 241–248.

[DK04]   Laura Dabbish and Robert E Kraut. "Controlling interruptions: awareness displays
           and social motivation for coordination". In: *Proceedings of the 2004 ACM conference on
           Computer supported cooperative work*. 2004, pp. 182–191.

[DPH12]   John Downs, Beryl Plimmer, and John G Hosking. "Ambient awareness of build sta-
           tus in collocated software teams". In: *2012 34th International Conference on Software
           Engineering (ICSE)*. IEEE. 2012, pp. 507–517.

[Dul+13]   Kevin Dullemond et al. "Fixing the 'Out of sight out of mind'problem one year of
           mood-based microblogging in a distributed software team". In: *2013 10th Working
           Conference on Mining Software Repositories (MSR)*. IEEE. 2013, pp. 267–276.

[Eco20]   The Economist. *In Search of Lost Focus - The engine of distributed work*. `https://
           lostfocus.eiu.com/downloads/EIU_Dropbox_focus_executive_summary.
           pdf`. [Online; accessed 5-June-2021]. 2020.

[ES08]   Martin Ebner and Mandy Schiefner. "Microblogging-more than fun". In: *Proceedings
           of IADIS mobile learning conference*. Vol. 2008. 2008, 155Y159.

[ES10]   Kate Ehrlich and N Shami. "Microblogging inside and outside the workplace". In:
           Proceedings of the International AAAI Conference on Web and Social Media. Vol. 4. 1. 2010.

[ESS+92]   Stephen G Eick, Joseph L Steffen, Eric E Sumner, et al. "Seesoft-a tool for visualizing
           line oriented software statistics". In: *IEEE Transactions on Software Engineering* 18.11
           (1992), pp. 957–968.

[FKC90]   Robert S Fish, Robert E Kraut, and Barbara L Chalfonte. "The VideoWindow system
           in informal communication". In: *Proceedings of the 1990 ACM conference on Computer-
           supported cooperative work*. 1990, pp. 1–11.

[FL98]   Andy French and Paul Layzell. "A study of communication and cooperation in dis-
           tributed software project teams". In: *Proceedings. International Conference on Software
           Maintenance (Cat. No. 98CB36272)*. IEEE. 1998, pp. 146–154.

[Flo19]   Marivic F Flores. "Understanding The Challenges Of Remote Working And It's Im-
           pact To Workers'". In: *International Journal of Business Marketing and Management (IJBMM)*
           4.11 (2019), pp. 40–44.

[Fri+94]   Nico H Frijda et al. "Varieties of affect: Emotions and episodes, moods, and senti-
           ments." In: (1994).

[GB13]   Emitza Guzman and Bernd Bruegge. "Towards emotional awareness in software de-
           velopment teams". In: *Proceedings of the 2013 9th joint meeting on foundations of software
           engineering*. 2013, pp. 671–674.

[GFM99]   Octavio García, Jesús Favela, and Roberto Machorro. "Emotional awareness in col-
           laborative systems". In: *6th International Symposium on String Processing and Informa-
           tion Retrieval. 5th International Workshop on Groupware (Cat. No. PR00268)*. IEEE. 1999,
           pp. 296–303.

[GG95]   Carl Gutwin and Saul Greenberg. "Support for group awareness in real-time desktop conferences". In: (1995).

[GG96]   Carl Gutwin and Saul Greenberg. "Workspace awareness for groupware". In: *Conference Companion on Human Factors in Computing Systems*. 1996, pp. 208–209.

[GGC96]   Saul Greenberg, Carl Gutwin, and Andy Cockburn. "Awareness through fisheye views in relaxed-WYSIWIS groupware". In: *Graphics interface*. Vol. 96. Citeseer. 1996, pp. 28–38.

[GH07]   Ravi S Gajendran and David A Harrison. "The good, the bad, and the unknown about telecommuting: meta-analysis of psychological mediators and individual consequences." In: *Journal of applied psychology* 92.6 (2007), p. 1524.

[GWS13]   Christine A Grant, Louise M Wallace, and Peter C Spurgeon. "An exploration of the psychological factors affecting remote e-worker's job effectiveness, well-being and work-life balance". In: *Employee Relations* (2013).

[Has+17]   Mariam Hassib et al. "Heartchat: Heart rate augmented mobile chat to support empathy and awareness". In: *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. 2017, pp. 2239–2251.

[HM01]   James D Herbsleb and Deependra Moitra. "Global software development". In: *IEEE software* 18.2 (2001), pp. 16–20.

[HM03]   James D. Herbsleb and Audris Mockus. "An empirical study of speed and communication in globally distributed software development". In: *IEEE Transactions on software engineering* 29.6 (2003), pp. 481–494.

[HM05]   Pamela J Hinds and Mark Mortensen. "Understanding conflict in geographically distributed teams: The moderating effects of shared identity, shared context, and spontaneous communication". In: *Organization science* 16.3 (2005), pp. 290–307.

[Höö+08]   Kristina Höök et al. "Interactional empowerment". In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. 2008, pp. 647–656.

[Jak+09]   Mikkel R Jakobsen et al. "WIPDash: Work item and people dashboard for software development teams". In: *IFIP Conference on Human-Computer Interaction*. Springer. 2009, pp. 791–804.

[KDV07]   Andrew J Ko, Robert DeLine, and Gina Venolia. "Information needs in collocated software development teams". In: *29th International Conference on Software Engineering (ICSE'07)*. IEEE. 2007, pp. 344–353.

[KEG88]   Robert Kraut, Carmen Egido, and Jolene Galegher. "Patterns of contact and communication in scientific research collaboration". In: *Proceedings of the 1988 ACM conference on Computer-supported cooperative work*. 1988, pp. 1–12.

[Kra+]   Robert E Kraut et al. "Informal communication in organizations: Form, function, and technology". In.

[KSO12]   Benjamin Koehne, Patrick C Shih, and Judith S Olson. "Remote and alone: coping with being the remote member on the team". In: *Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work*. 2012, pp. 1257–1266.

[Kuw+02]   Kazuhiro Kuwabara et al. "Connectedness oriented communication: Fostering a sense of connectedness to augment social relationships". In: *Proceedings 2002 symposium on applications and the internet (saint 2002)*. IEEE. 2002, pp. 186–193.

[Lou+12]   Zhe Lou et al. "PresenceScape: Virtual world mediated rich communication". In: *Bell Labs Technical Journal* 16.4 (2012), pp. 219–242.

[Mad11]   Susan R Madsen. "The Benefits, Challenges, and Implications of Teleworking: A Literature Review." In: *Culture & Religion Review Journal* 2011.1 (2011).

[McD+12]   Daniel McDuff et al. "AffectAura: an intelligent system for emotional memory". In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. 2012, pp. 849–858.

[MCR20]   Sarah Morrison-Smith, Lydia B Chilton, and Jaime Ruiz. "Facilitating Team Awareness Through Ambient Displays". In: (2020).

[MH01]   Audris Mockus and James Herbsleb. "Challenges of global software development". In: *Proceedings seventh international software metrics symposium*. IEEE. 2001, pp. 182–184.

[Mil+21]   Courtney Miller et al. "" How Was Your Weekend?" Software Development Teams Working From Home During COVID-19". In: *arXiv preprint arXiv:2101.05877* (2021).

[MMM07]   Greg W Marshall, Charles E Michaels, and Jay P Mulki. "Workplace isolation: Exploring the construct and its measurement". In: *Psychology & Marketing* 24.3 (2007), pp. 195–223.

[MR09]   Iris B Mauss and Michael D Robinson. "Measures of emotion: A review". In: *Cognition and emotion* 23.2 (2009), pp. 209–237.

[MRM11]   Simone Mora, Verónica Rivera-Pelayo, and Lars Müller. "Supporting mood awareness in collaborative settings". In: *7th International Conference on Collaborative Computing: Networking, Applications and Worksharing (CollaborateCom)*. IEEE. 2011, pp. 268–277.

[Mul+09]   Jay P Mulki et al. "Set up remote workers to thrive". In: *MIT Sloan Management Review* 51.1 (2009), p. 63.

[OMF06]   Benoît Otjacques, Rod McCall, and Fernand Feltz. "An ambient workplace for raising awareness of internet-based cooperation". In: *International Conference on Cooperative Design, Visualization and Engineering*. Springer. 2006, pp. 275–286.

[OO06]   Judith S Olson and Gary M Olson. "Bridging Distance: Empirical studies of distributed teams". In: *Human-computer interaction in management information systems* 2 (2006), pp. 27–30.

[PSV94]   Dewayne E Perry, Nancy A. Staudenmayer, and Lawrence G Votta. "People, organizations, and process improvement". In: *IEEE Software* 11.4 (1994), pp. 36–45.

[Qua20]   Qualtrics. *The other COVID-19 crisis: Mental health*. https://www.qualtrics.com/blog/confronting-mental-health/. accessed February 23 2020. 2020.

[RCB96]   Krisela Rivera, Nancy J Cooke, and Jeff A Bauhs. "The effects of emotional icons on remote communication". In: *Conference companion on human factors in computing systems*. 1996, pp. 99–100.

[Röc+04]   Carsten Röcker et al. "Using ambient displays and smart artefacts to support community interaction in distributed teams". In: *Proceedings of the OZCHI Conference*. Citeseer. 2004, pp. 22–24.

[Rus80]   James A Russell. "A circumplex model of affect." In: *Journal of personality and social psychology* 39.6 (1980), p. 1161.

[Saa+08]   Timo Saari et al. "A mobile system and application for facilitating emotional awareness in knowledge work teams". In: *Proceedings of the 41st Annual Hawaii International Conference on System Sciences (HICSS 2008)*. IEEE. 2008, pp. 44–44.

[Sas99]   VAkihiko Obata VKazuo Sasaki. "Video communication system that facilitates infor-
             mal communication among distributed offices". In: *FUJITSU Sci. Tech. J* 35.2 (1999),
             pp. 141–148.

[SCS14]   Wolfgang H Staehle, Peter Conrad, and Jörg Sydow. *Management: eine verhaltenswis-
             senschaftliche Perspektive*. Vahlen, 2014.

[Spa20a]   Jared Spataro. *A pulse on employees' wellbeing, six months into the pandemic*. `https://`
             `www.microsoft.com/en-us/microsoft-365/blog/2020/09/22/pulse-`
             `employees-wellbeing-six-months-pandemic/`. accessed February 25 2020.
             2020.

[Spa20b]   Jared Spataro. *The future of work—the good, the challenging & the unknown*. `https://`
             `www.microsoft.com/en-us/microsoft-365/blog/2020/07/08/future-`
             `work-good-challenging-unknown/`. accessed February 23 2020. 2020.

[Sto+16]   Margaret-Anne Storey et al. "How social and communication channels shape and
             challenge a participatory culture in software development". In: *IEEE Transactions on
             Software Engineering* 43.2 (2016), pp. 185–204.

[Whi+04]   Steve Whittaker et al. "ContactMap: Organizing communication in a social desktop".
             In: *ACM Transactions on Computer-Human Interaction (TOCHI)* 11.4 (2004), pp. 445–
             471.

[Zha+10]   Jun Zhang et al. "A case study of micro-blogging in the enterprise: use, value, and
             related issues". In: *Proceedings of the SIGCHI Conference on Human Factors in Computing
             Systems*. 2010, pp. 123–132.