CollaboRanger: Coordinating Differences of Individuals in Group Coordination

by

Qianqia Zhang

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Author .....
Department of Electrical Engineering and Computer Science
Aug 12, 2022

Certified by .....
David R. Karger
Professor of Computer Science and Engineering
Thesis Supervisor

Accepted by .....
Katrina LaCurts
Chair, Master of Engineering Thesis Committee

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Abstract

People form habits in the way they work and former research in personal task and information management found that these personal preferences vary drastically. In collaborative settings, these different forms of personal habits can make it challenging to coordinate among teammates. In this work, we investigate the methodology of a smooth transition from the personal working sphere to group coordination. Through our workshop study with 11 knowledge workers including program coordinators and admins, we understand how they manage the gap between personal differences and lead to group coordination. Our finding indicates that even for the mundane and basic coordination tasks like scheduling a meeting task, there are several underlying conflicts, such as fear of being judged and overstepping others' contributions. Instead, they focus on accommodating differences of each participant (e.g., in the case of scheduling, tools that they use for keeping up with schedules) and spend a substantial amount of time aggregating information in different formats for each participant.

We propose a system called CollaboRanger, where coordination participants do not have to change their habits for each coordination, but at the same time, it is easy to combine information from each. Using CollaboRanger, coordination participants can collaboratively gather responses from the participants in a table and summarize their decisions. To evaluate our system, we conducted a within-subjects experiment (N=18) to assess our design with knowledge workers. We found that when teams are using our system, they were able to sensemake distinct responses comprised of personal preference and tool choices much easier and faster than using email. These results indicate that one does not have to totalize the individual's response when they coordinate, yet they can still efficiently make group decisions. We conclude with design implications and opportunities for bridging gaps between personal work routines and groupware designs.

Thesis Supervisor: David R. Karger
Title: Professor of Computer Science and Engineering

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Chapter 1

Introduction

With the advance of technology, it enables different forms of collaboration. Teams are much *ephemeral* and formed and dispersed around a project in a task force manner [46]. Due to the fast change of the team membership, in such ad-hoc teams, it is challenging to grasp and coordinate people given how people are different and team members have little understanding of each other [21]. Starting from managing their notes, and to-do, to managing scheduling, individuals develop their personal habits of management [5]. Once individuals settled into a habit, they hardly budge on it; when introduced to newer software or software updates, while individuals grasped the idea or potential benefits of adopting the new technology, they lack self-motivation to actually adopt the technology [31]. This is because choosing particular tools to work on various tasks not only *is influenced* by personality, but also *influences* users [34]. Hence, over time, users of a tool adjust their working style in accordance with the tool that they are using. Furthermore, users prioritize finishing the immediate task quickly in the present moment despite the bigger benefits in the future [37, 23]. Considering all this together, individual users are unlikely motivated to switch tools or methods that they handle various tasks, let alone change them for ephemeral teams.

Unlike traditional teams in an organization, ad-hoc teams inherently lack time, norms, and roles for working together with their "temporal" colleagues. Given coordinating and adopting tools take long time to nurture, our understanding of tool adoption in traditional, long-term groups no longer applies to ephemeral teams [38].

In this work, we first explore tool adoption in ephemeral teams. To start with, we conducted a workshop study with 11 participants who engage in coordination with various people outside of their organizations as a part of their daily jobs (e.g., client-relation manager, admins) to understand how different people cope with gaps between personal tools and group-decision making. Our findings indicate that there is careful negotiation happening in the group-decision process. However, they often "gave up" protesting for their preference due to the fear of being judged rude or inconsiderate, even if it means that the group-decision making process becomes jarring and inefficient. We also identified two classes of people in the group-decision process. The first class is a bystander type, who engages at a minimal level. The second is a leader type, who is not necessarily the leader of the group, but takes on additional efforts to get through the group decision process.

A possible response to these challenges of coordination in ephemeral teams is to design systems that make individuals to keep their personal tools for tasks while allow sharing and combining different sources of information from each tool more smoothly to make a group decision. Unfortunately, personal tools and groupware possesses a large gap [12]. The group tool requires individuals to totalize the way they provide responses for sense-making; individuals with different tools for managing and formatting their information have to gather in a uniform way. Previous work sought unified semantics of different information in different tools, so information could be used across different tools [24]. Unfortunately, computationally processing and merging information from different users is not feasible, as individuals represent the same information vastly different [5, 33].

We developed CollaboRanger[1], a messaging system that allows participants to collect responses from different people without needing to compromise or totalize individuals' choice of in what form the contribution should be shared. CollaboRanger helps users to collect static information from individuals' choice of tools and help them to have a visual comparison between them for more efficient and ef-

[1]CollaboRanger means collaboration for a range of different users. CollaboRanger helps a group of people with different tool preferences to work together.

fective coordination; CollaboRanger allows coordination participants to build a table where each cell is a response linking to different tools, so that participants can see responses in various tools on one sight. Furthermore, our approach does not require a dedicated notetaker, allowing users of different classes (bystander vs. leader) spontaneously lead the collaborative sensemaking process.

To evaluate and inform future development of CollaboRanger, we conducted a within-subject experiment consisting of lab and deployment studies. We recruited knowledge workers (N=18) to conduct various coordination tasks (e.g., scheduling group meetings, organizing networking, planning trips) with CollaboRanger or email. Even with unfamiliar and new interfaces, CollaboRanger users were able to finish the same task significantly faster than using email, were more informed and made more effective group decisions with less effort. While supporting flexibility for group members in choosing roles between leaders and bystanders, CollaboRanger facilitated more socially bounded group dynamics and promoted engagement even for the bystanders.

This work makes the following contribution: it introduces a method for embracing the difference between people and letting them make informed decisions through flexible and spontaneous interfaces. More generally, it suggests a methodology to bridge gaps between personal and group tools.

In summary, the contributions of the thesis are as follows:

- Through a workshop study, we identified how ephemeral teams adopt and choose tools for coordination. We compare our results with personal and organizational tool adoptions.

- CollaboRanger, a tool that helps individuals who are using different personal tools for information contribution to engage in smooth coordination and make group decisions.

- We conducted lab and deployment studies to understand how CollaboRanger helps coordination. As a result...

Chapter 2

Related Work

The scope of our work touches upon several aspects in HCI that have been explored by prior researchers. In our review of related works, we focus on three main areas. We first describe individual differences in behavior and preference for personal task management. Given these distinctions among individuals, we then examine previous works describing group dynamics and behaviors of choosing and using tools. Finally, since the focus of our work is to support better sense-making for groups across individual contributions, we consider a series of successful systems for both individual and collaborative information gathering and sense-making.

2.1 Individual differences in personal task management

An essential part of personal task management is creating a list of to-dos. Early study trying to understand natural practices of task management identifies that there's a wide range of tools employed by individuals for making a to-do [5]. Online resources include email, calendar, online folders and special purpose to-do list, while physical tools include paper notepad and planner. In addition to different ways of creating reminders, individuals also diverge in their practice for collecting and organizing information necessary to conduct a particular task as explored by studies in the closely

related field of personal information management [30, 44, 40]. Bruce and Jones observed a variety of strategies for organizing web-based information including bookmarking a web page and sending the URL to oneself through email [6]. Haraty et al. investigated more closely on tools used for conducting task and discovered that individuals tend to use a combination of tools with preferences ranging from paper planner, word document, email, online calendars, to browser tabs [17].

Many online tools were created and can be personalized to address the variety of habits and preferences in task management. Haystack [24], a customizable general-purpose information management tool, specifically allows individual to work with information in his or her own way, which can be useful to incorporate for performing personal task. However, despite the support for customization to accommodate individual preferences and make personal task management tools more adaptable, individual differences introduces challenges to group coordination.

In fact, there remains noticeable gap between personal tools and group tools when it comes to collaboration [13]. While the work is highly collaborative in group tasks, the tools to conduct work "remain stubbornly isolated" [13]. It takes effort to collate together pieces of individual works when the individual contributions are done in isolated tools. Therefore, as personal preference for conducting individual parts of the group work can be drastically different, there is no way of coming together without compromising to a shared tool or requiring significant coordination effort. In our work, we aimed to design interfaces that brings in the isolated work and individual users can preserve their way of working during group interactions.

2.2 Group behavior on choosing and using tools

Computer-Supported Cooperative Work (CSCW) has been an active field of HCI studied by many researchers. Over the last decades, studies have identified a base set of findings regarding group choice and adaptation of CSCW systems including societal influence and the inflexibility of usage patterns.

Groups develop norms for using CSCW systems over time [38]. Societal norms

and values play a significant part in determining how groups negotiate individual choices and reach consensus [11]. In more community-oriented cultures, people prefer collective decision-making with distributed responsibilities; while in individualist cultures, people are less affected by the decision of others [28]. In turn, societal values influence group's choice in what tools to use for collaboration. Furthermore, social activities are believed to be fluid and nuanced, where individuals demonstrate considerable agility in handling interactions and may change the way they work and collaborate according to the organizational norms [2].

Among different types of groups, tool usage and adoption in organizations are widely studied. In organizations, choosing tools are more strategic based on organizations' goals, instead of organic, and come from top-to-bottom [39]. Hence, individuals take a more passive role when it comes to decide tools to use for various tasks. For example, Orlikowski studied the tool introduction and adaptation process at two different organizations with a diverse priorities and practices. The first organization, a manufacturer of precision metal components, prioritized manufacturing process improvements and production where factory personnel were introduced to capital equipment for such purpose. The second organization, a multi-national software consulting firm where hours spent on software production translate directly into fees billed to clients, had the dominant objective to maximize production for current revenues. Engineers at the second organization were thus introduced to computer-aided software engineering tools. However, the patterns of adaptation in both organizations were highly discontinuous in Orlikowski's study when introduced to technologies believed to support more productive operations [39]. Initial intensive episode of adaptation was followed by rapid decline. The learning curve of new technologies and the established stable routines and habits that requires less discussion, coordination and effortful decision making were among the main factors causing the decline in adaptation. One of possible ways to combat the learning curve of a new system is to make one user in a group integrates the system on top of existing systems and hide it from the rest of the group [8, 27]. Calendar.help [8] helps a group of people to find a time to meet when a user forwarded a message thread to the system. This allows

the smooth introduction of the system to the rest of people, where the rest of users (i.e. bystander class) might not even realize that the system was being used.

Taken together, previous work suggests that deciding tools to use for groups is influenced by group norms, hence it takes long time to nurture. In this work, we build on previous work of tool adaption in groups and focus on ephemeral groups. Unlike organizations or long-term teams, ephemeral teams lack norms, fixed roles and time to organically adopt tools as a group. Through our workshop study, we discovered how tool adoption happen specific to ephemeral teams when they did not have norms or fixed roles.

2.3 Systems for sense-making

Collaborative tasks often involve group members jointly contributing and constructing consensus based on their individual opinions (e.g., preferences, knowledge or expertise). Due to the complex relationships between the members' opinions, collaborative tasks can benefit from better sense-making of individual contributions; visual awareness of the relationships across individual contributions can support consensus building for group tasks [16, 19, 20, 22, 43]. Here we review a series of systems that researchers have built and explored for complex information gathering and sense-making for both individual and group to inspire our work.

Extracting and gathering critical information are the first steps to effective sense-making. To help people better make sense of online information, various systems enable users to first collect useful snippets of content from multi-media [1], web pages [9, 41, 42] or group discussion [8, 27] and later gather them into a single place for easy access and processing. The systems support users to help collecting information in different manner, some of the tools are merely helping users to have different information in one place, whereas others system employ crowdsourcing techniques to extract information in a uniform way that users can further use and process. For example, prior work in email management extracts information of interest from senders, then a user can customize auto-drafted responses depending on the extracted infor-

mation [27].

Once relevant contents are collected, how to categorize, organize and synthesis the complex information collection becomes key to decision- and sense- making [15]. Unakite [29], a decision-making tool for developers, build upon the idea of collecting snippets to empower users to save desired content as snippet cards through text selection and drawing bounding box around targeted area. For each decision they are making, Unakite guides users to create a table to compare different options across multiple criteria. By categorizing and organizing the collected snippets into corresponding table cells, Unakite facilitate users to more easily visualize information and compare the trade-offs for better decision-making.

Collaborative decision-making task introduces new challenges to sense-making as it not only involves information of complicated relationships but also sensitive human preferences to be addressed. An extensive amount of previous literature have explored the use of visual awareness to facilitate the process for group tasks [10, 14, 45]. For example, [3, 35, 47] visualize responses from different group members and highlight the difference between the responses. Twine [26], designed to support collaborative sequence construction, also utilizes side-by-side visual comparison of individual's preferences to promote more efficient and effective sense-making and consensus building from the complex pool of group opinions.

Our work takes inspiration from these previous designs for information collection and synthesis, but improves to allow collaborative sense-making across multiple media and platforms on one sight simultaneously. In our work, we aim to augment previous work so that individuals can contribute using their own tools while being able to easily make effective group decisions.

Chapter 3

Workshop Study

We sought to understand how individuals of casual groups cope with differences in tool preferences and information sharing in group coordination and what are the decision factors or challenges they are currently facing. We conducted semi-structured workshop studies with individuals whose jobs require coordination with various background and occupations.

3.1 Study design

Study protocol Each workshop was 60 minutes long and was driven by slides that presents sample collaborative scenarios to participants and proposes follow-up questions about their current practices under each scenario. Participants were also asked to conduct simple activities to reflect on their feelings regarding their current task completion process.

Pre-workshop survey. To prepare the sample scenarios so that most participants will be familiar with them and experienced enough to offer insights, we designed a survey to explore the most common requests received and sent via email or messaging apps during daily working scenarios. We provided an initial list of task categories [appendix] for participants to choose from and they were also encouraged to contribute new examples with a reward of $20 for unique and creative answers. The survey was

distributed through various mailing lists within a private university and was taken by 123 people who are professors, managers, administrative assistants, company employees, accountants, head music producers, undergraduate student, graduate students, and postdoctoral researchers.

Our survey concluded with 86.6% of participants on average having engaged in event scheduling tasks (both asking others to do and being asked to do), 74.8% on average in providing feedback, and 63.85% on average in preparing documents and approvals. Other frequently mentioned coordination tasks contributed by participants included work coordination and planning, networking, as well as invitation to event.

Based on the survey result, we built three example scenarios for our workshop around two of the most common collaborative task, event scheduling and networking. The first two scenarios shared the same setting where participants were asked to imagine that one of their team members, Queenie, is trying to schedule a 1-1 meeting and shares her availability through email. The third described the setting where a student, Queenie, is assumed to have worked with our participants and is not asking for help with networking to find job opportunities.

To discover how people react to receiving information shared by other group members in the forms that's similar or different from their tools, we designed the scenarios to include several different ways and different level of tool usage for information sharing as summarized below.

- **Scheduling Scenario 1** *Plain text*

  The team member Queenie uses a personal calendar and when sharing her availability, she chooses to send a list of her free slots as bulleted plain text. Figure 3-1 shows the slide that was shown to participants describing this scenario.

- **Scheduling Scenario 2** *Link to third-party calendar*

  Queenie takes advantages of a third-party platform—YouCanBookMe[1]—to track

[1]https://youcanbook.me/

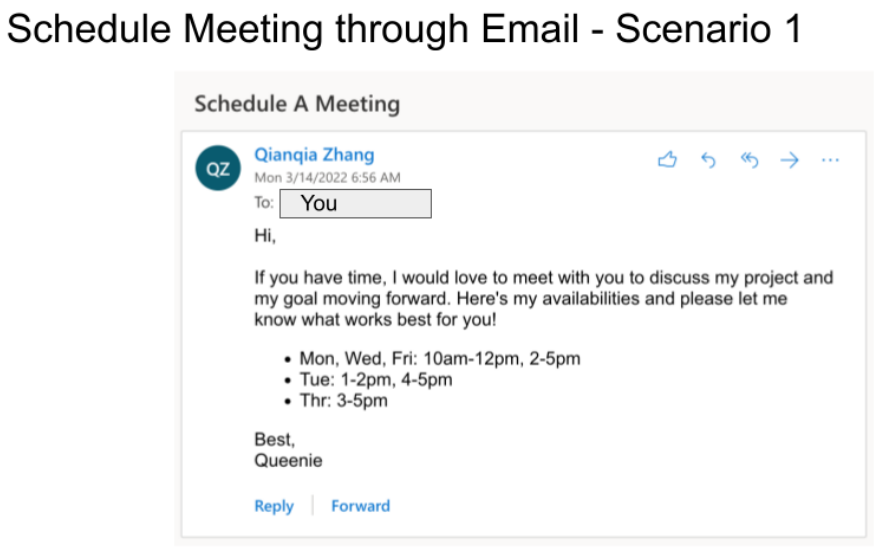

Figure 3-1: Slide describing scenario 1 to participants.

her appointments. The platform displays her availability in a calendar-like form where others can directly sign up for an available block and receive an auto-generated email for the appointment. Therefore, Queenie decides to send through email the link to her YouCanBookMe page to our workshop participants trying to schedule a meeting. Figure 3-2 displays the second scenario as it was shown to participants during the workshops.

- **Networking Scenario** *Link to third-party tool for request management*

  The student Queenie finds it overwhelming to send all the relevant information in the email body including when she wants to be connected, her transcript and resume, as well as a list of people or company she'd like to be connected. Therefore, Queenie decides to use a third-party request management tool that organizes all task related information on one sight, which she believes will help both her and the participant to track the status of the networking progress. Figure 3 displays the third scenario as it was shown to participants during the workshops.

Upon being presented with each given scheduling scenario, participants were asked

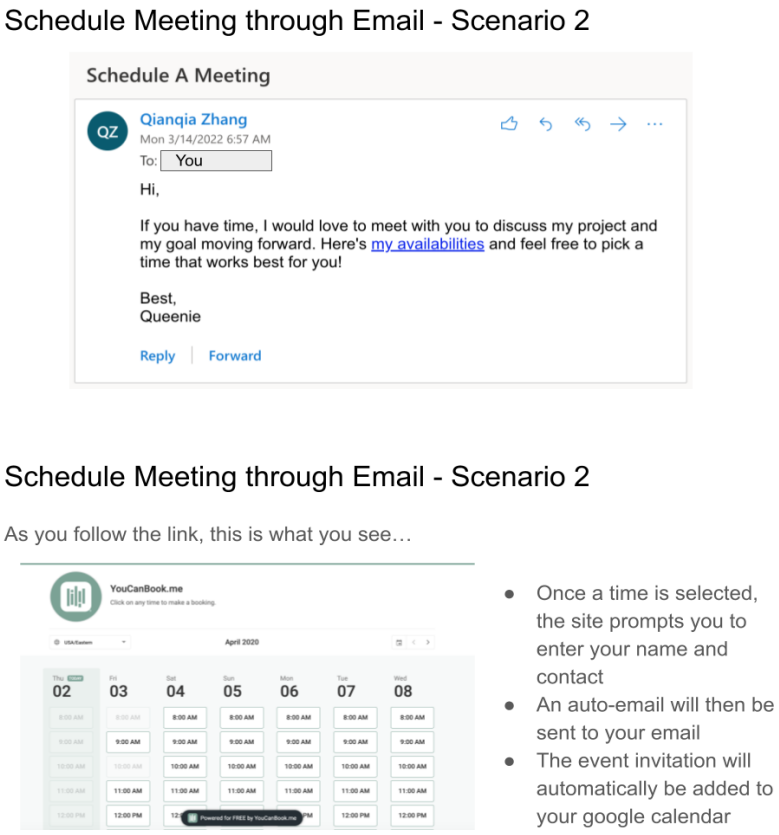

Figure 3-2: (Top) Email received and (Bottom) content of the link attached in the email.

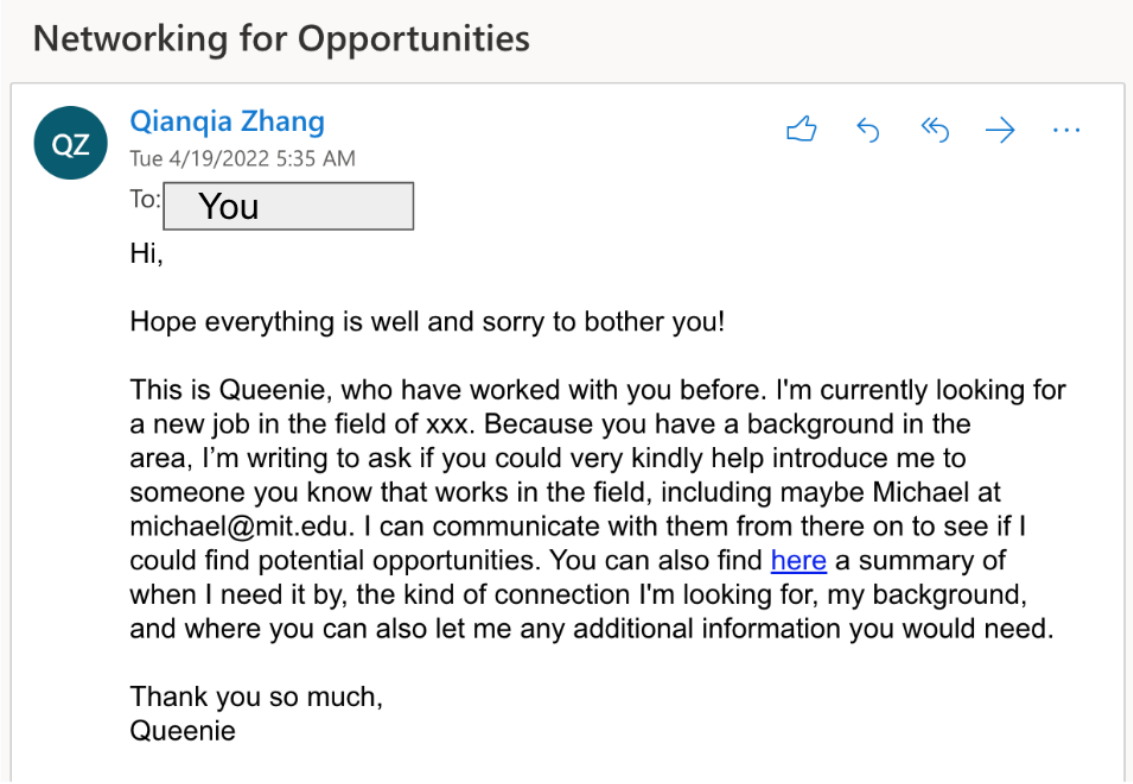

Figure 3-3: Slide describing scenario 3 to participants.

to each walk through the series of actions they would normally take to complete the scheduling until a meeting time is agreed upon. Following this, inspired by [4], we instructed participants to place a sticky note on a *comfort board* to indicate their perceived level of 'usefulness' and 'easy to use' regarding the task completion process and the form in which availability is shared in the situation. 'Usefulness' here refers to the amount of useful information that one could receive from how the availability was presented: whether it provides exactly what one needs, lacks crucial elements, or introduces redundant distractions. 'Easy to use', on the other dimension, refers to the level of simplicity and intuitiveness of interaction required to complete the task given the way availability is shared. Participants were asked to write down brief reasoning for the position they chose. Figure 3 shows a photo of the comfort board for one of the groups in response to scenario 1 and 2.

After taking positions on the board, participants engaged in facilitated discussions to elaborate on their sentiments towards and the potential challenges faced in com-

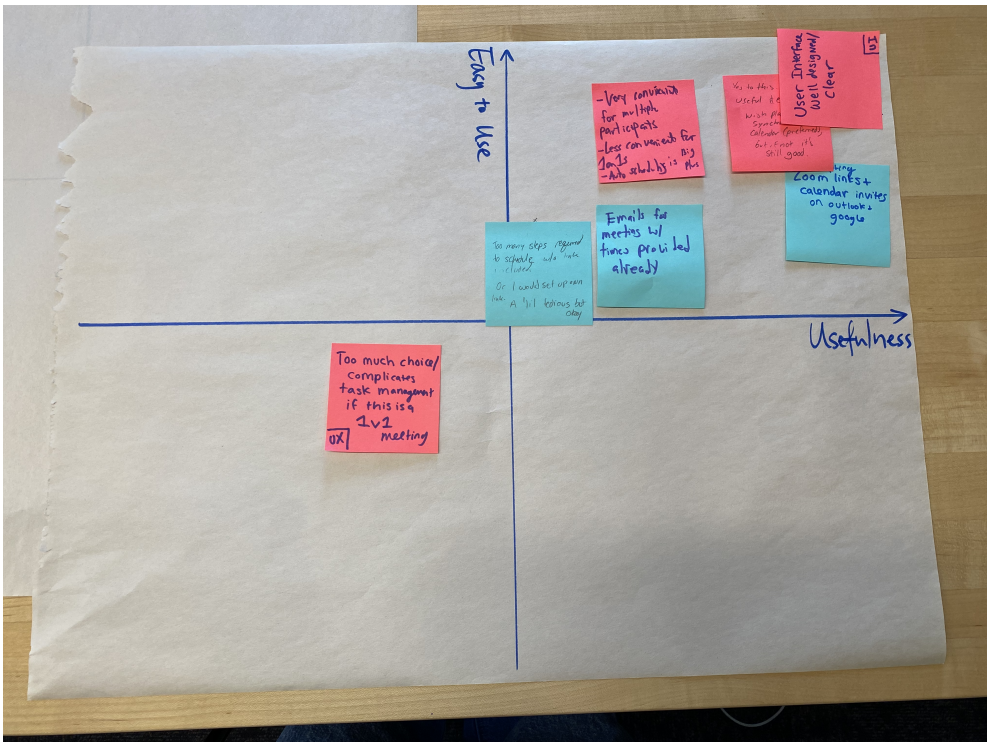

Figure 3-4: Sticky notes on the comfort board placed by one group during their workshop study.

pleting each given scheduling task scenario. Then following the discussions about the scheduling scenarios, participants were presented the networking scenario to expand the discussion about their experience in a broader range of task types.

We concluded the study by prompting participants to brainstorm for other example group tasks beyond the scenarios presented that they find challenging to coordinate and propose wishful thinkings.

Participants We recruited participants via posting on mailing lists of a private university and word-of-mouth. Each interviewee was compensated $20 for their time. In total, 11 (9 females, 2 males) participants were recruited and assigned to a group of three to four participants. Participants' ages range from 26 to 62 (mean age=35) and occupations included administrative assistants, client and corporate relations coordinators, digital media strategist, graduate students, and professors.

Data Collection and analysis Two sets of data were collected through the workshop studies. Data set 1 consisted of photographs taken for participants' sticky notes placed on the comfort boards in response to each scenario; while Data set 2 was composed of verbal comments made by participants as we recorded the full-length of each workshop discussion.

At the conclusion of workshops, relative positions of sticky notes between two scenarios from Data set 1 (visual comfort board) was manually translated for each participant. The comments written on sticky notes and made verbally during conversation were transcribed into a spreadsheet which we later conducted interview coding to identify concepts and categories and compared with result from Data set 1 to extract unique findings.

3.2 Result

In this section, we discuss several main themes that emerged from our workshop sessions. These results together allow us to discover two findings regarding how ephemeral teams cope with group decisions when they lack group norms and fixed roles. Along with these findings, we also discuss desirable features that our participants wish to have in addressing challenges raised by current practice and consider attractive for new tools to aid coordination tasks.

3.2.1 Group norms

Ephemeral groups are inherently lack of group norms as they were just formed as a group. It felt as though there is no guideline on how to coordinate with the group members. As a result, in ephemeral groups, it is much harder to communicate intents and benefits of adopting a new tool. Group members are cautious of potential societal judgement and judge another member who attempts to reinforce groupware system for group decisions.

Prioritizing social acceptance over efficiency in choosing tools Based on the sticky notes position on the comfort boards, 7 out of 11 participants had identified sharing availability using YouCanBookMe to be more easy-to-use and offer more useful information. These 7 participants placed their sticky notes in the YouCanBookMe scenario at a greater position on both 'easy to use' and 'usefulness' scales compared to their notes for the plain text version. Some of their comments read *"Easier to schedule. I just have to find a time in my calendar select it in theirs. Then everything else happens automatically"* Other comments include *"reduces back forth [in email writing]"*.

However, participants only like this tool *ideally*, but they doubt that they can use this tool realistically; when asked what way they would adapt to for coordinating group scheduling event, even for some of the ones who preferred YouCanBookMe, they would still use the previous tool that they have been using. We discovered that apart from people's adhesiveness to their habitual way of working in organizations discussed in prior works [39], participants of ephemeral groups are less familiar with each other and are more careful with their social appearances; they fear to be judged rude to ask others to compromise onto their tool even when they believe their tool could bring efficiency to the group. They feel inadequate not only asking someone else to use these centralized tools but also getting asked to use the tools. Participants expressed their sentiments towards receiving links or other *"fancy"* tools that are different from their go-to tools for the task. For example, one participant commented, *"I just say step one when I took a look at these [links] my step one is: I'll be judging the person, "Oh look at how fancy you are""* Another participant added, *"I wouldn't reply with a Calendarly. I feel it's not nice."*. A participant who found productivity tool very useful and is *"a big fan of them"* uses Trello for personal organization. However, even though they were enthusiastically explaining *"it's really great for collaboration"*, they would be more cautious of suggesting using a new tool for coordination, especially to people who they hadn't coordinated much before: *"our team as a whole doesn't use tools like Trello so I wouldn't try to get [people outside of my team] on board with it."*

As the reasoning behind negative sentiment towards adopting centralized tools

is summarized into two; first, participants felt that they are making that they are making others to do more work. A participant argued that *"It does feel kind of like ... you're offloading work from the sender onto the receiver."* Next, they worried that introducing such tool in the middle of coordination might come across other people who already contributed to the conversation. For example, if one suggests to use When2meet when others already share availability, it might look like others' responses are ignored. In other words, they wanted to make sure that they are accidentally overwrite other's people contribution to coordination.

Based on our study, we discovered that even for people who are open and excited to use new tools to increase efficiency, they don't consider it feasible to use them as centralized tools for everyone in coordination. Individuals in group "give up" promoting their own tools, sticking to their productivity tool only for personal uses, and when it comes to coordination, they would take the extra effort to merge information from individuals' tools. This finding is surprising because people are intentionally choosing an inefficient way of working despite knowing alternative tools that could help getting things done much more efficiently – they are afraid of social overheads. This workshop finding contributes insights in that, unlike neither in-organization or personal tool adoption explored by previous literature, tool choices of ephemeral teams are less studied and we've discovered that ephemeral teams sacrifices efficiency for social acceptance in group coordination.

Cross-channel coordination makes group-decision demanding As a direct consequence of the above finding, because member of casual groups are afraid to request others to compromise, when organizing and coordinating a group-decision task, group members contribution can all come in different forms. The most prominent challenge in this case, as identified by our workshop participants, becomes working across multiple platforms containing information shared by other members of the group. How currently the participants are coping with these challenges is both mentally and physically demanding.

As the participants described for scheduling tasks, when receiving availability in

different forms (e.g., a list of availability, links to their public calendar) from different members, *"it takes time to switch between [their] email and [my] calendars. They're all in the same browsers [so I] have to switch tabs so that... can be annoying"*. Some participants pull the email or shared calendar up in another window and resize it to view side by side with their own. Others utilize another separate monitor screen to view multiple windows of calendars at the same time. Participants indicated that all these actions are "tedious" and repetitive; opening up in new tabs, dragging the tabs to view in a new window, then resize and position carefully to compare the content are all time-consuming and jarring actions to perform on laptop.

Moreover, this difficulty drastically rises as the number of people are involved in the scheduling increases. One participant noted, *"I usually struggle with scheduling especially when we're doing user studies [where] I have to schedule a lot of things."* Others also mentioned the challenge when there's many parallel and potentially conflicting parts in a task. For example, when there's a list of people participants need to meet 1-1 but each with location preference and availability shared in separate thread and various forms, it becomes hard to track the status and compare across the sub parts to make sure the meeting times don't conflict. Therefore, participants yearned for tools to mitigate the challenge of cross-channel coordination especially at scale as discussed in the following paragraph.

People turn to tools that can capture moving parts of coordination Our participants, even though tend to judge about receiving information in a new tool as discussed earlier, pointed out that when the task involves multiple people, tools become attractive: *"So I think ... initially I thought I was turned off by ... a link, instead of just having the time given to you right there, however, tools like this (YouCanBookMe) is much better if there's multiple people in the meeting ... who are also going to input their times.* In terms of wishful features, participants demonstrated great interest in the wishful tool that could bring together different views on one sight: *"I actually like this idea of I can see my calendar [and] see their calendar, at the same time"*. Others proposed that *"what might have been like more useful is Like*

two slides side by side, so you can see all their information and then respond to it".

3.2.2 Members' roles

Similarly with group norms, ephemeral groups were often formed without specific members' roles. To get the coordination tasks done, we found that members in ephemeral groups organically take on roles.

Coordination procedure naturally inherit roles of leader and bystander While we already learn from previous work [2] that people possess noticeable agility in handling interactions and adjusting the amount of effort put into them based on each situation, our study result helps us to further identify a specific pattern of roles taken in coordination tasks of ephemeral teams. As our participants shared their general experience in various coordination scenario, group members naturally take on two types of roles: the leader (either being dedicated or naturally evolved into) who is willing to put in extra effort to gather everyone's response and to oversee the progress, and the bystander who only does the minimal part of sharing his or her own contributions.

These roles can be dedicated in some scenarios. One of our participant who works as a corporate relations coordinator described how they would facilitate meeting scheduling with different companies: *"if [I'm] working with foreign entities, defense companies...or other companies...[who] are not using zoom.us, some will use zoom.gov or... Webex, we have our own portfolio...to remember [their preferences]".* Due to the nature of his job, this participant takes the role of a leader and would have to do the extra work to remember and adjust to the ways that his clients, the bystanders, would prefer.

However, in more casual groups and tasks, these roles can also naturally evolve from personalities and social expectations. For example, organizing group lunch was mentioned by many of our participants where *"there [first] has to be someone who initiate"*, then *"someone constantly checking"* on responses. After others all responded, *"someone needs to be 'Ok, so what's happening"'* to start moving it forward and collect

everyone's responses. As described by participants, there can be multiple leaders at different stage of a group task and they can be multiple different members. In addition, in cases where a member of the team would like to schedule a meeting with everyone, it feels like asking for a favor. Our participants in the position of the requester, who wants to initiate the meeting, naturally would put in the effort to *"text someone on Whatsapp, texting the other on messenger, or email all"* to make sure others can be reached in the way they prefer. While if in the position of receiving these requests, our participants preferred doing minimal work and expressed concern against *"offloading the work that's supposed to be on requesters"* if they had to do extra coordinating works. This also echoed the societal judgement in Section 3.2.1 in terms of under what situation the judgement is mostly likely to occur.

In many of these cases, no one in the group is appointed the job to organize the event, but either personalities or social expectations drive some members of the group to take on more responsibilities in coordinating everyone's responses. As previous collaboration tools either require all members to on board new ways of working or reinforce fixed role for each member, group tool adaptation becomes hard to reinforce given the organic leader and bystander dynamic.

3.2.3 Summary

From our workshop findings, we derived several design requirements to design CollaboRanger. We found that people in ephemeral groups prioritize social acceptance over efficiency which hinders the convergence to a centralized group tool and leads to challenges for sense-making group responses linking to multiple platforms. Toggling between or manually creating a "gallery view" to work across multiple channels simultaneously becomes the most demanding task especially at scale for group coordination tasks. Furthermore, as individuals working in a group naturally take on roles of leaders and bystanders, either appointed or evolved through interactions, this difficult job to coordinate across multiple platforms usually falls on the leaders while bystanders do their minimal part of sharing contributions in their preferred forms.

Thus, interfaces of CollaboRanger ought to facilitate easy collection and visual

comparison between different format of information shared among conversation. Such features should also be able to accomplish the same result at a higher level across tasks to accommodate challenges when there are multiple parallel sub parts to a task (R1). Lastly, to allow both leaders and bystanders of a group to flexibly engage in the coordination process while easing the job for leaders, a tool should preserve ways to contribute for bystanders without adaptation while supporting additional collaborative coordination features that are visible to everyone and which natural leaders emerged can hop on to at any moment during the coordination (R2).

Chapter 4

CollaboRanger: A Coordination System for Aiding Ephemeral Groups with Different Tool Preferences

This section introduces the interface of CollaboRanger. We present 2 main types of features. First, we discuss features to support light-weight communication with flexible level of engagement. This includes providing synchronous messaging system among group members with image upload capability. Additionally, we sync the messaging platform on CollaboRanger with Gmail API to allow bystanders to more flexibly engage and still receive updates if they chose to participate at minimal. Second, we provide features for easier and scalable sense-making of responses shared in different formats in complex coordination tasks. This includes a *collaborative table* that, for each group consensus to build or decision to make, guides users to consider relevant options from discussions, offers various ways to collect and structure snippets from responses to fill in the details for each option, and to track and compare these details at scale. In addition, the table supports a *gallery view* that lets users visualize on one sight the content of complex responses such as links and image files, which were previously only accessible by switching to separate channels. Finally, to aid information processing across complex responses, the table further implements a *summary* feature to allow users to write down notes as they synthesize the responses.

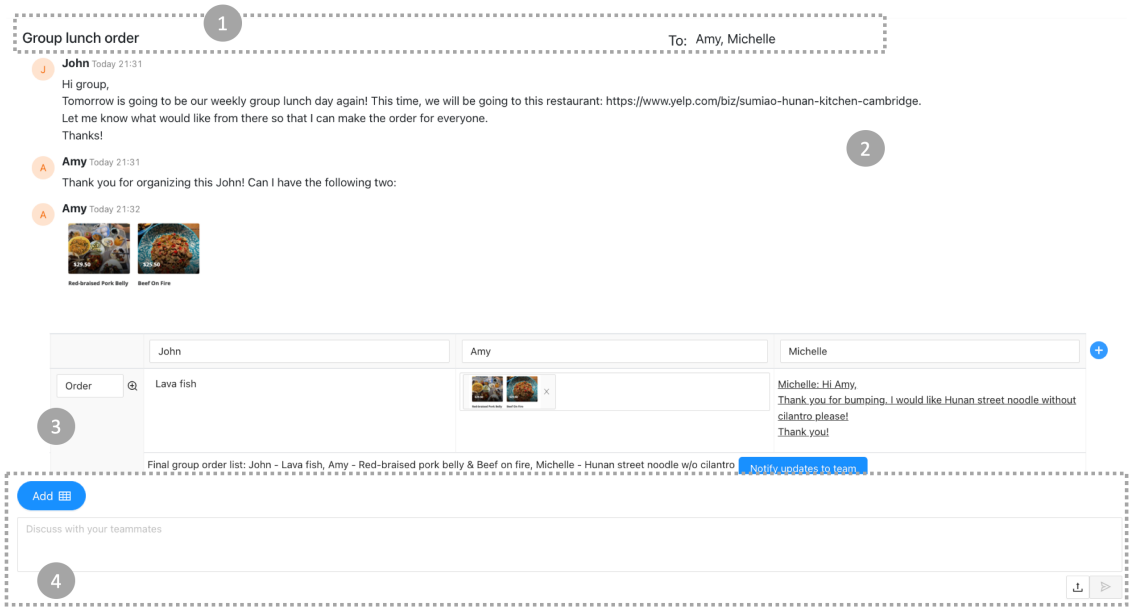

Figure 4-1: The messaging interface of CollaboRanger for each group task. (1)High-level task information: title and participants. (2)Messaging history. (3) *Collaborative table* for response collection and coordination. *Notify updates to team* button auto-completes a message in the messaging box for updating members the corresponding summary made using table. (4)Interface to add contribution to conversation including: *Add "table icon"* for creating new *collaborative table*, messaging box, and file upload button to upload images.

4.1 Features to support light-weight communication and flexible engagement

4.1.1 Messaging system

CollaboRanger provides synchronous and light-weight messaging feature (Fig. 4-1) to maintain the momentum building discussion to encourage collaboration among group members as mentioned by our workshop participants. Having simple messaging around more advanced coordination features also allows people of the bystanders class we identified in workshops to contribute minimally as they prefer without having to on board new technologies.

4.1.2 Syncing with Gmail API

To further support flexible level of engagement for the bystanders in groups, we recognize the possibility where bystanders may not frequently monitor and oversee progress if it's on a new collaborative tool. Therefore, we designed CollaboRanger to connect with Gmail API so that even if bystanders stay off of our platform, they can still be notified of any updates through email threads.

Users of CollaboRanger would sign in with their Gmail account and grant access to *read*, *compose*, and *send* from their mailbox on their behalf. Then with each message users send on CollaboRanger, an email will be send on their behalf to the Gmail account of all group members including that of the bystanders not using CollaboRanger. For each group task, an email thread would be generated based on the first message sent and the following messages will be added to the thread so that bystanders only looking at emails would also be able to easily track the progress.

Even though we are syncing all messages on CollaboRanger with a dedicated email thread for each task, the *collaborative table*, which will be introduced in the next section and aiming to aid sense-making of conversation, is not shared through email. This design decision is to echo the societal acceptance concern expressed by our workshop participants so that leaders coordinating using the additional coordination

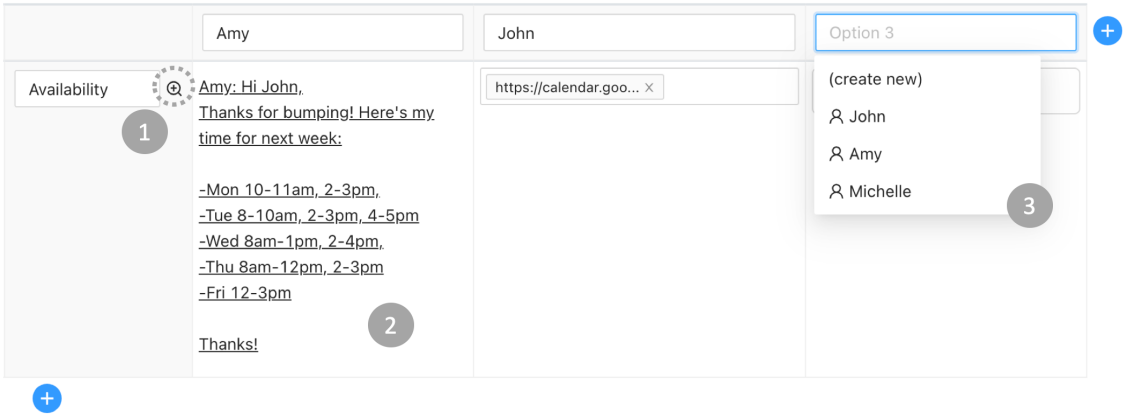

Figure 4-2: Collaborative table for collecting and coordinating responses. (1)Clicking *zoom-in* icon will open the gallery view for the corresponding row. (2)Cell tracking sub email thread and showing the most recent message in the thread. (3)Drop-down list for headers.

features on CollaboRanger don't have to reveal it to bystanders and worry about being rude to send "fancy" tools. Our next section dives into detail how CollaboRanger makes sure that bystanders are still kept up to date with new conclusion generated using the *collaborative table* even though the table itself is not being shared.

4.2 Features for easy collection and visual comparison of responses in different forms at scale

4.2.1 Collaborative table

Inspired by Unakite[29], which is a tool that uses trade-off tables to successfully facilitate developers with decision making, we hypothesized that the table structure would also be helpful in organizing different opinions in group coordination. We implemented a collaborative table (Fig. 4-2) to help users of CollaboRanger to collect, visualize, and compare responses whenever they want to make better sense of the conversation.

To provide clear guidance for users on how to structure their information, CollaboRanger table is designed to be column-major where each column represents an option while each row represents an attribute that users would like to compare across

all options. For example, if a group is trying to schedule a meeting together where members are asked to provide availabilities, one can put member names on columns and "Availability" on one row as the attribute to compare across the different members (Fig. 4-2).

We chose column-major over row-major to address how normally people position responses especially when the responses are in multiple different channels. According to our workshop results, the most common way for response comparison is to open each response in a separate window and place them side by side horizontally. Therefore, CollaboRanger table guides users to use column for comparing options side by side and this way of information structure also aligns with the gallery view layout introduced in (Section 5.2.3).

One last additional shortcut to ease users job is that, for each row and column header, aside of custom input, CollaboRanger table also auto-completes for member names of the team so that if users are trying to organize and compare responses by person, they can simply pick from the drop down list(Fig. 4-2).

4.2.2 Response collecting

Because we are trying to use a table structure to further organize and synthesize responses from conversation, the ability to easily collect important snippets from messages into the tables becomes crucial. CollaboRanger provides three different approaches in total for response collecting in the collaborative table.

Direct input

The simplest way to add information into a table is to directly type in a cell. This is useful for collecting simple and short message sent where users might find it straightforward enough to simply type it in. This is also useful when users are sharing their own opinions. In this case, they could either send a message or if they see a table already exist for them to input relevant information, they may speed up the process by directly inserting their response into corresponding cells.

Selection modal

The next way to collect relevant snippets from conversation is through a selection modal. To fill in details for a specific cell, users can click the "Select from conversation" button in the cell which will lead them to a new modal page (Fig. 4-3). The top of the modal displays the entire message history of the task while below that is a cell preview of snippets selected and collected and how it is going to be like once saved back to the table. To select text, one can highlight multiple sections of text across multiple messages. Each section that one highlights will become a tag to indicate that it was directly selected from the messages and will be added to the cell preview. If an image is being shared in the conversation, one can select and add an image to the cell by checking the checkbox next to the image file. Once saved to the table, to remind users of where each selected section comes from, one can click on each tag of selected text and it will scroll the messaging interface and take them back to the highlighted original message where the tag was selected from.

Link with new sub message thread

The last approach for response collecting is to link a cell with a new sub email thread. While the previous two are mostly based on responses shared within the main task, this functionality allows users to start a new individual sub-conversation among group members and track on a higher level all sub-conversations happening in sub-tasks of the main thread. This is useful when a task involves coordinating across multiple separate 1-1 conversations. It could also be helpful when the user is organizing everyone's response while still waiting on some to reply. In this case, the user can directly bump each of those people by creating a new individual conversation. To create a new sub-thread, one can click the "Link with a new email" button which will open up a message or email drafting modal (Fig. 4-4). If the cell is under a column with a group member as the header, the recipient will automatically be filled in with that group member. If a previous sub thread has already been created inside the main task, when starting another sub thread in the same main task, CollaboRanger also

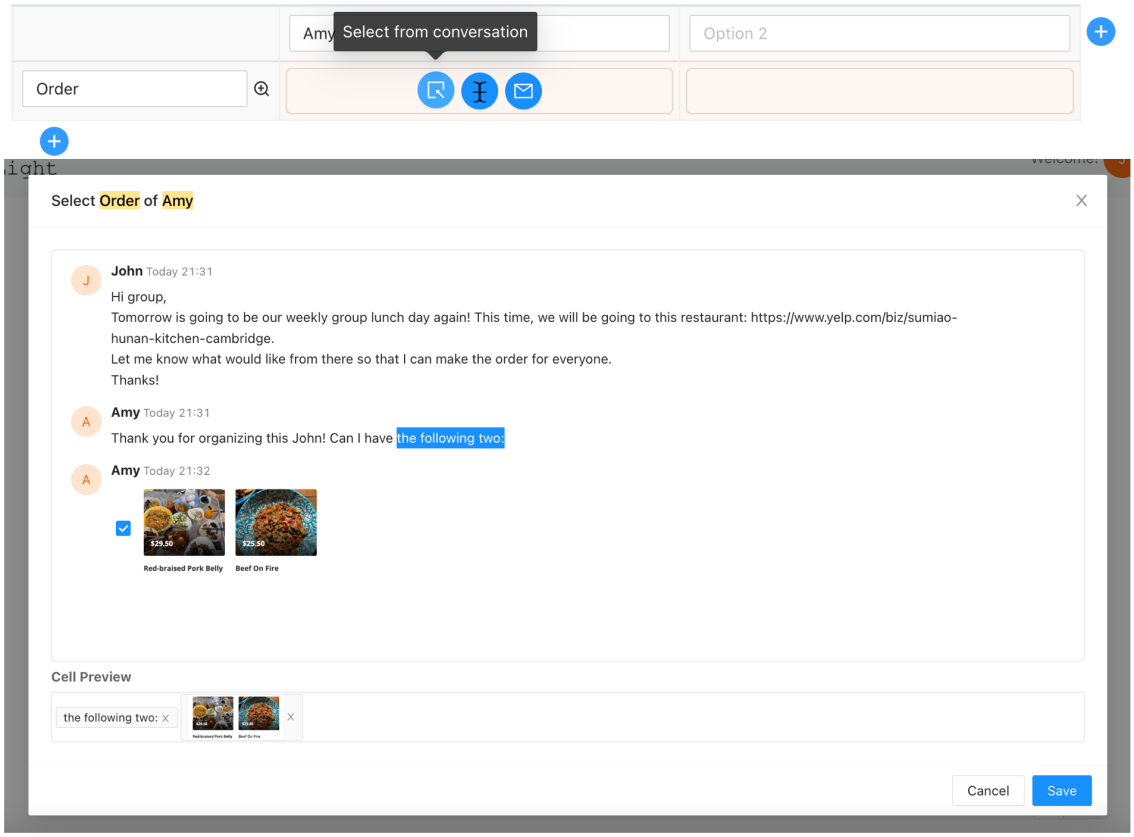

Figure 4-3: To collect part of response from conversation, hover over cell in collaborative table and click on the *Select from conversation* button. This leads users to the select modal where the top shows all messaging history to select from while the bottom is the cell preview collecting all selections.

caches and auto-fills from the previous message created using the drafting modal to save redundant steps for repetitive parallel sub tasks. Once created, the last message in the sub-conversation will be displayed in the corresponding cell (Fig. 4-2) to allow leaders coordinating the sub-tasks to directly compare across all status of sub-tasks on a higher level. Lastly, users can either reply to sub-conversations directly from the table cell or switch to the new separate page for the sub-conversation by hovering over the cell and click the sub-task title to message normally (Fig. 4-5).

4.2.3 Gallery view

One core feature of CollaboRanger is the gallery view to allow users to visualize content of complex responses side-by-side on one sight. Building on top of the collaborative table structure where users can compare across columns of options by each row of attribute, CollaboRanger includes a zoom-in icon next to each row header (Fig. 4-2). By clicking this icon, it takes users to the gallery view for the corresponding row to compare more in detail across columns (Fig. 4-6). Specifically, each cell of the row turn into a resizable panel with the cell content enclosed. When there's image selected in the cell, zoom in and zoom out capability is supported to allow users to look at details and view in comfortable size. If the cell includes only one link, the panel for the cell directly displays the web page content of that link. When there are multiple links or text around links, the panel first displays the original links then when on click, the panel will replace the corresponding link with its web page content. The gallery view auto-generates the collaging of multiple windows of information on one sight so that it reduces mental load for users to toggle between tabs and it cuts the redundant steps for users to create their own "gallery view" by opening in new window, resizing, and positioning them side-by-side.

4.2.4 Summary feature

Even with the help of auto-generated panels to visualize across multiple channels of information at one sight, the comparison process can still be hard depending on

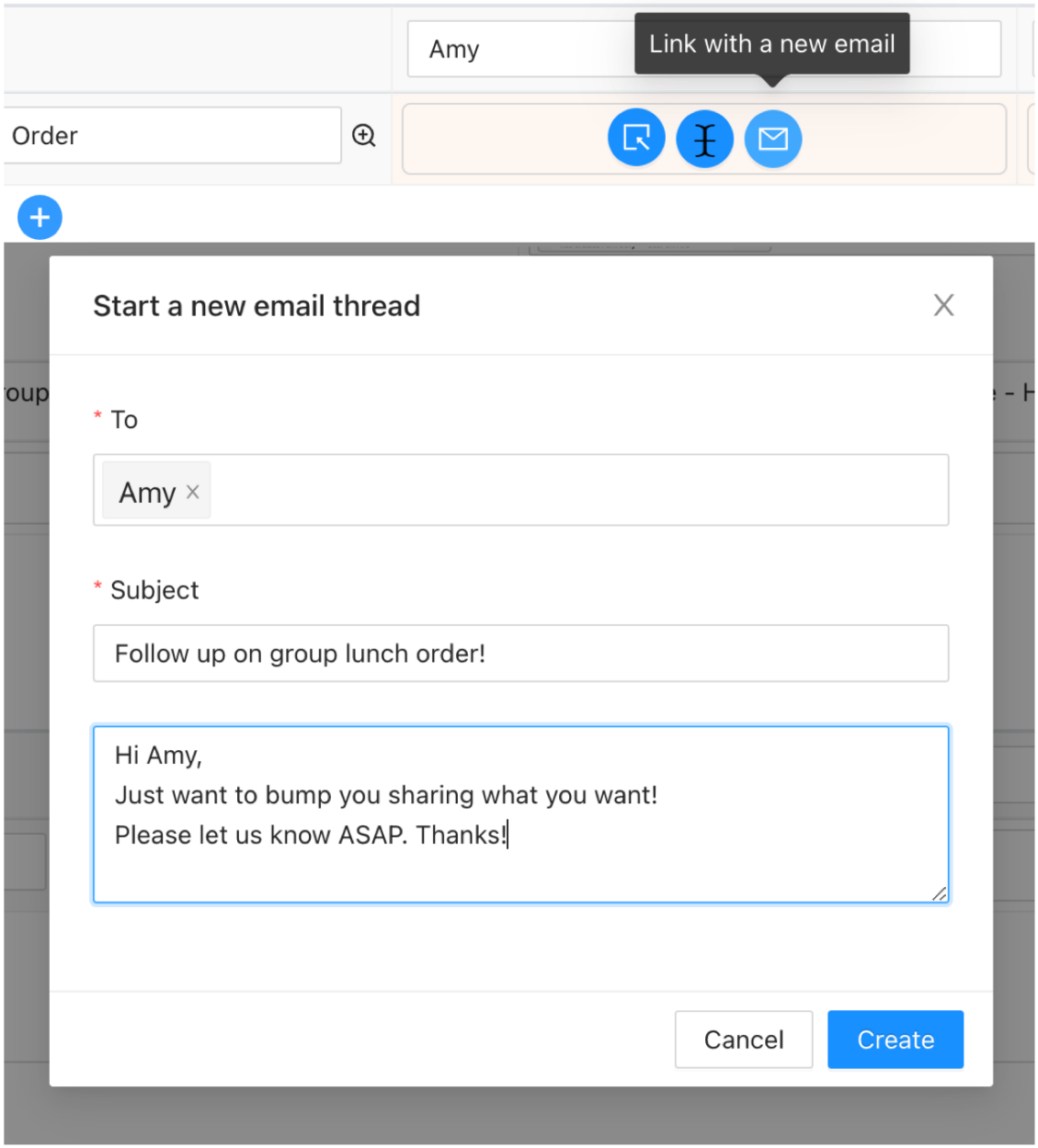

Figure 4-4: To link a cell with a new sub email thread, hover over the cell and click the *Link with a new email* button. This leads users to the email composing modal to write and create a new sub email thread.

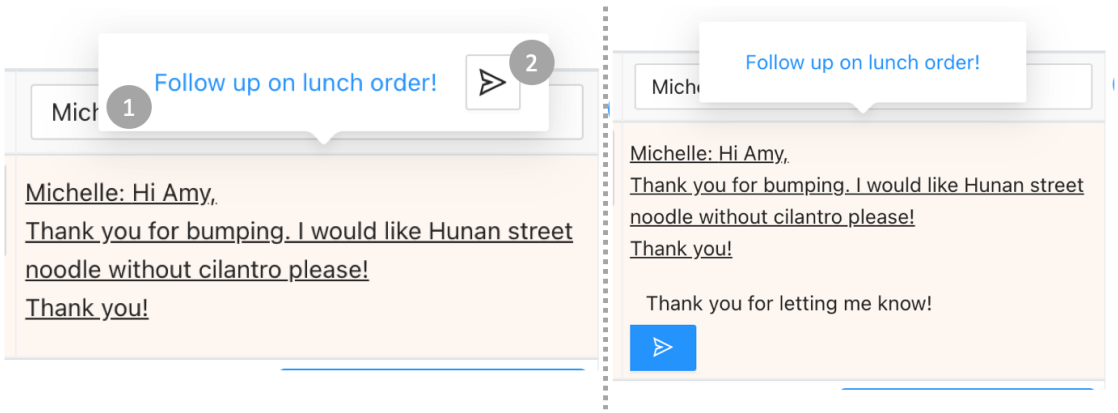

Figure 4-5: CollaboRanger supports two ways to reply to a sub email thread tracked in table cell. (1)Users can click the subject of the sub email thread to go a separate messaging page like the main thread to reply. (2)Users can also reply directly from cell by click the **send** icon.

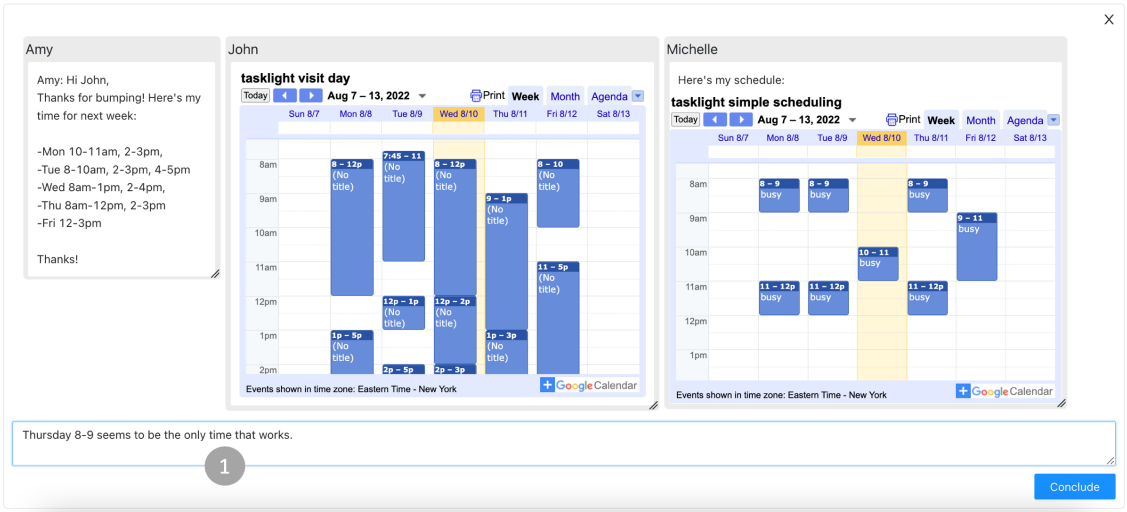

Figure 4-6: The gallery view for visualizing on one sight the content of complicated responses along one row. (1)The summary feature which allows coordinators to write down intermediate notes or summary based on their comparison.

the amount and complexity of information included. And once a decision is made or conclusion is drawn, it would be intuitive to have it remembered so that users don't have to re-perform the demanding comparison. CollaboRanger aids the synthesize process across multiple panels of information in the gallery view and the preserving of conclusion drawn by providing a summary feature. In the gallery view below the panels, CollaboRanger presents a text box where users can write down intermediate notes or conclusive summary regarding the comparison for the attribute row of interest (Fig. 4-6). Once concluded, the notes or summary will be inserted into the collaborative table below the corresponding row and span all columns to indicate and preserve result of sense-making. As the table itself will not be sent to group members through email as discussed in Section 5.1.2, if users would like to notify the team on any new sense-making result that has been generated, they can click the "Notify to team members" button to create an auto-completed message in the message box (Fig. 4-1). They can then edit how they would like the update to be sent and bump a new message to the team. The summary feature alleviate the mental demand for users to remember everything during the information synthesis process and preserves for users the intermediate or finalized sense-making result to avoid redundant repetition and improve efficiency overall.

Chapter 5

Use Cases

In this section, we present four use cases of CollaboRanger of common scenarios in collaborative settings - group scheduling, hybrid visit-day organizing, creating shopping list, making group decisions, and collaborative writing outlining.

5.1 Group scheduling: Finding commonalities across responses

CollaboRanger can facilitate group scheduling across multiple forms of availability (e.g. text, image, Google Calendar link, or Calendly.com link) shared by group members within one site. Group scheduling or event scheduling in general is ranked the top frequent activity that occurs in daily working settings as according to our pre-workshop survey. However, it is the group leaders' job, either appointed or naturally evolved, to coordinate everyone's time and find a common time to meet together. CollaboRanger can make this coordination process easier especially when the availability are shared in various forms by letting coordinators to directly view the responses in resizable panels next to each other horizontally and display the web page content if a link is included. Fig. 5-1 illustrates the workflow. Leaders can create a table to collect all attendees availability with attendees on column, "Availability" as the attribute to compare across, and time shared by each person in their correspond-

ing cells. In this example, Amy is trying to schedule a time to meet together with John and Michelle, where John directly shares his calendar link while Amy had to bump Michelle individually for her schedule. Amy inputs her own Google calendar link and select from John's response to put in to the table cell. To conclude on a time to meet, Amy opens the gallery view for "Availability" to compare everyone's schedule and writes down the time she finds to work for everyone. She finally updates everyone with the decided time by bumping another message using the "Notify updates to team" button and sending.

5.2 Hybrid visit-day organizing: Parallel sub-tasks managing

CollaboRanger allows users to easily manage and work across parallel sub-tasks at a higher level by embedding sub-conversation thread into a table. Such a feature is integral to large scale collaborative tasks that involves multiple parts as the parallel sub-tasks may often conflict or influence the progress of each other. Take for example that Maria is working at a company and there's a visiting week coming up for the company where potential future colleagues are going to visit the office. Maria's work admin asks her to schedule and give a 1-1 tour for each of the three potential colleagues for her department, Amy, John, Michelle. The admin creates and send to Maria a table of visitors that she needs to follow up with confirm time individually. Maria uses the cell for each visitor to send out individual messages and compare across all visitors' responded time preference to decide when to meet whom so there's no conflict (shown in Fig. 5-2). Once she's done with the her decision, she confirms with all visitors in each individual thread.

5.3 Shopping list: Finding union of responses

CollaboRanger supports users to aggregate and find the union of responses to collectively create lists of items. List-making appears in task such as ordering for

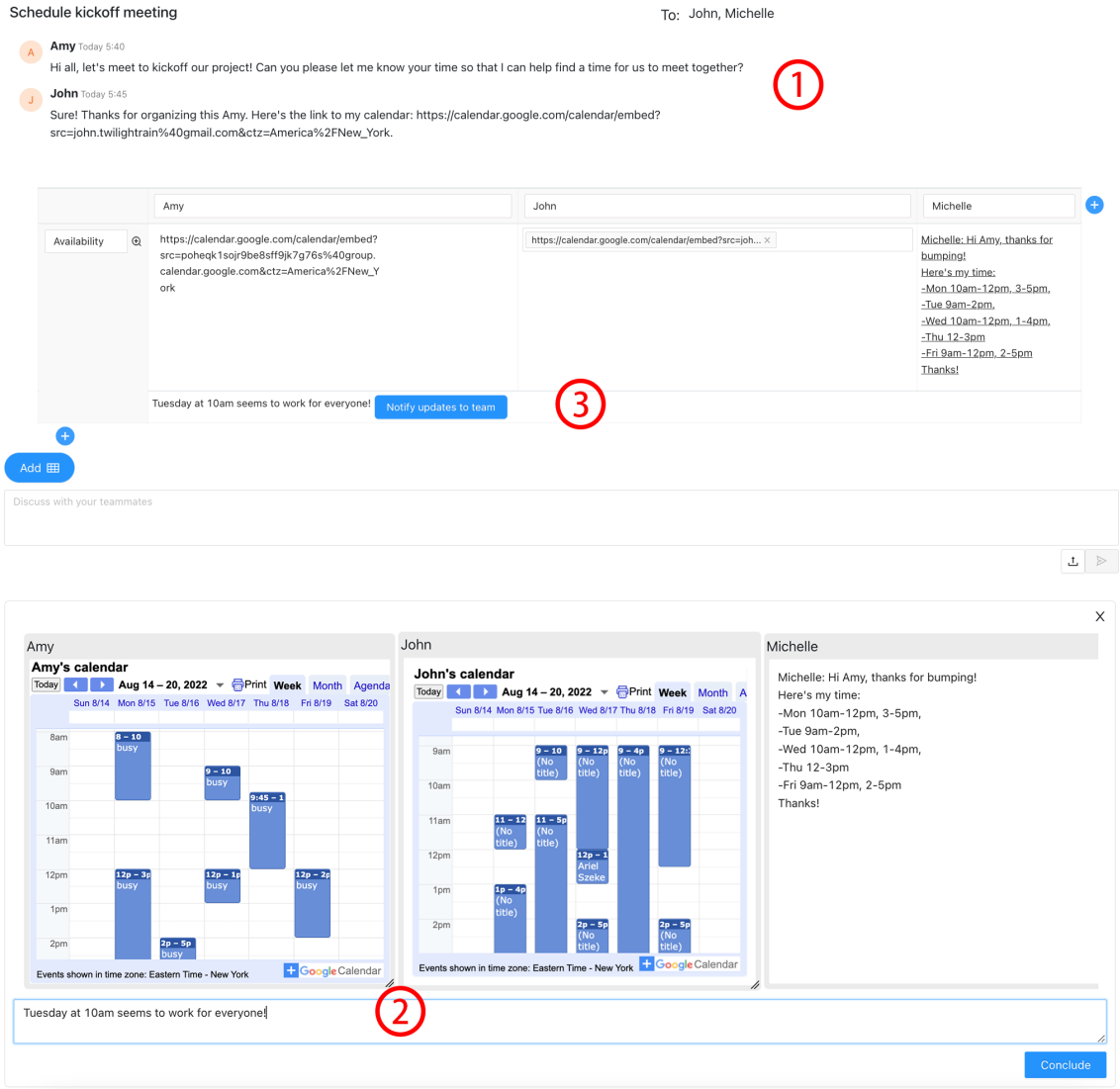

Figure 5-1: The workflow for meeting scheduling. (1)Users directly shares availability and can organize them into table for better comparison. (2)Coordinator view all responses and conclude on a time. (3)Update final decision to the team.

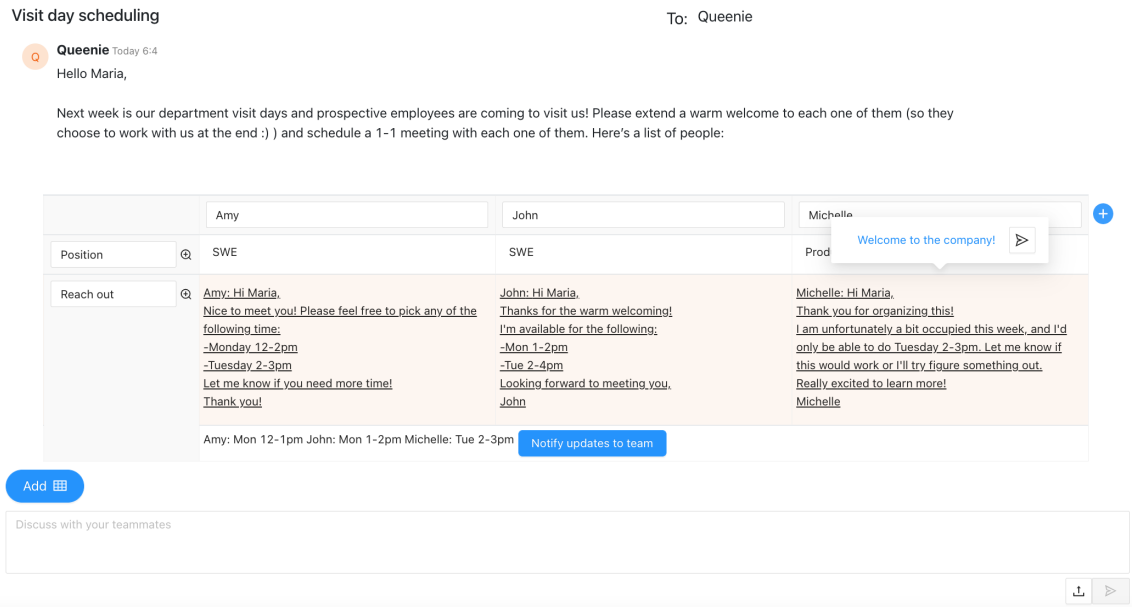

Figure 5-2: Users can simultaneously track and compare across several individual sub thread of a main task. Coordinator can reply individually to each thread directly from the table with the summary feature as a hint.

group lunch or preparing a shopping list to buy for the group. Take shopping list creation as a example. In Fig. 5-3, Maria is going to the supermarket and she offers to help bringing back things that her friends would also want from the market. Maria creates a table for everyone in her friend group where they can each put in what they want. For the ones who hasn't filled in anything, maria can directly bump them through an individual message thread. She later use the summary feature to keep as a checklist of everything that is in-stock and that she's able to get for her friends. By updating the checklist to her friend group, everyone would also be able to know what's bought and what's not.

5.4 Group decisions: Preference gathering and trade-off comparison

CollaboRanger facilitate group decision-making involving multiple steps by using the collaborative table with different purpose for each decision to make. Apart from

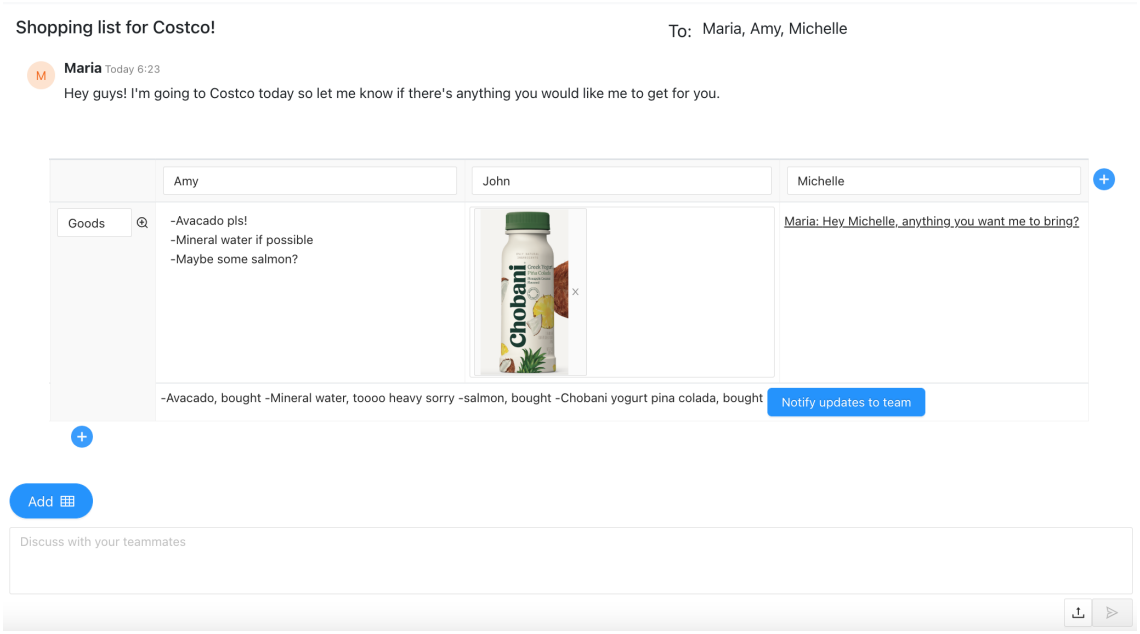

Figure 5-3: Users use the table to collect and track wishlist for each member. The summary feature can be use to aggregate a list of all individual wishlists.

the previous two uses cases where the table can be used to view calendars, it can also be extended to collect other forms of group member preferences or to compare trade-offs of several options with multiple attributes to help the group to reach a final choice. Fig. 5-4 demonstrates an example scenario. In the example, Amy, John, and Michelle is going on a trip to NYC and they are looking at hotels to stay in. They first use a table to collect hotel suggestions by group member and aggregate them into a list of candidates to make sure that everyone's preferences are being addressed. Then they use a second table to compare between the hotel candidates based on amenities that the group members care about. Further discussion evolve around the second table until they reach a final consensus. The first table guides users to consider and build from all members' opinion while the second table aids users to compare trade-offs among the potential candidate choices.

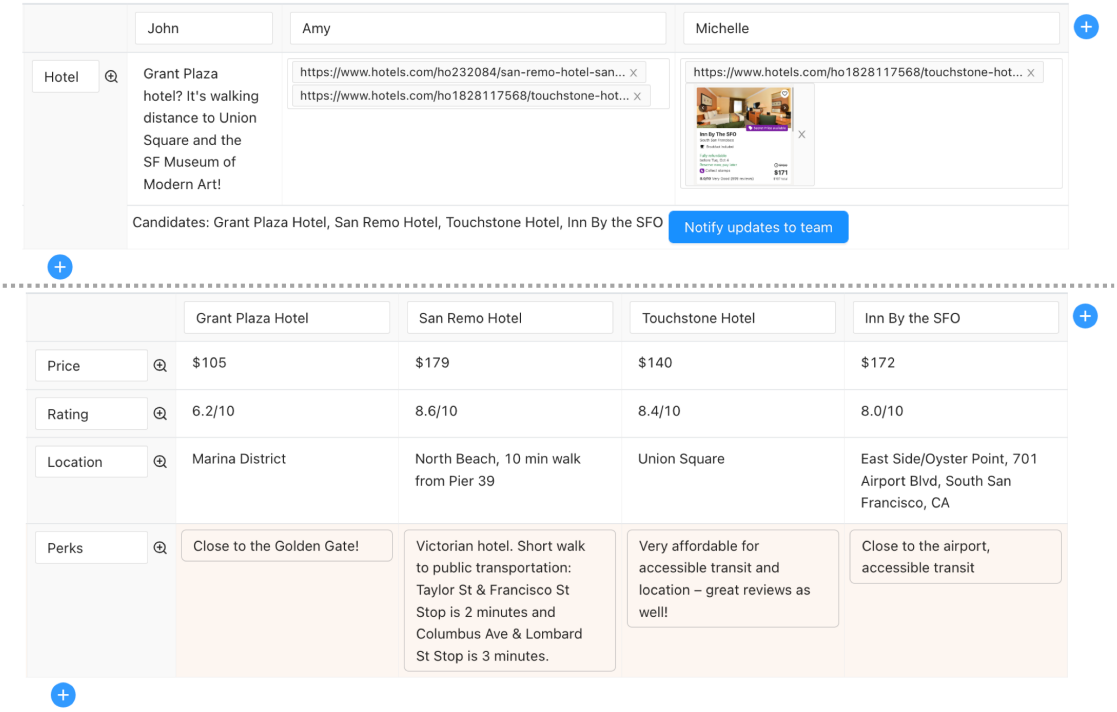

Figure 5-4: (Top) Table to collect hotel suggestions of each member and aggregate a candidate list. (Bottom) A second table comparing corresponding amenities across candidate hotels generated from the first table.

Chapter 6

System Evaluation

We conducted lab and deployment studies to see how CollaboRanger affects users' experience in coordinating different formats of information in ephemeral teams. In this study, participants were given several group tasks involving processing various forms of information and were asked to perform each coordination.

6.1 Study Design

Tasks The primary tasks were to lead and collaborate in group coordination tasks with various purpose. The purpose of tasks included scheduling a group meeting, scheduling multiple 1-1 meetings for a department visit day, and hotel picking for the group's trip planning. These tasks were prevalent among evaluating novel groupware systems [26, 27]. Each participant first acted as the lead for organizing and coordinating other group members' availability in the first two scheduling tasks. Then in the last task, participants collaborate in groups with no assigned leaders to come to an agreement on what hotel to stay in. These tasks were instantiations of "decision-making" task in the McGrath's Task Circumplex Model [32] and as such required team members to share personal opinions in various forms and engage in discussion and coordination to arrive at a solution.

Study protocol To explore how CollaboRanger may change the experience in coordinating different forms of information shared in ephemeral teams, we conducted a within-subjects study. Participants were asked to conduct tasks in two different interfaces (email and CollaboRanger) with their collaborators. The order in which they used the interfaces was randomized. The procedures were as follows:

1. Tutorial (30 minutes): Each participant was invited to a tutorial session on the day to start the study, where they received a tutorial on how to use CollaboRanger and tried it out on a sample task. We also introduced them to the last task they would conduct over the next two days. Participants attending the tutorial on the same were grouped together to conduct the final task after the tutorial.

2. Group-scheduling task (maximum 15 minutes, x2): A group was trying to meet together for an hour and participants were asked to reach out to other members, ask for their availability, and help schedule a time for the group meeting. A Google calendar was given to each participant as his or her own schedule and the other three imaginary members shared their availability in different forms, ranging from bulleted plain text, google calendar link, to Calendly.com [1] link. Like prior work [27], the responses from the rest users in the group were pre-programmed and sent automatically once the participants send the message. If a participant can't finish the task in 15 minutes, we stopped them and recorded the completion time as 15 minutes.

3. Visit-day-organizing task (maximum 15 minutes, x2): Each participant spent a maximum of 15 minutes to conduct a hybrid visit-day-organizing task in both interfaces (control version and CollaboRanger). The participant acted as an employee at a company where there was a visit day event coming up. Each participant was assigned by the work admin to reach out to the three visitors individually, send them warm welcoming, and schedule a 60-min 1-1 meeting

[1] https://calendly.com/

with each of them in the coming week. Each participant picked and confirmed a time to meet each of the three visitors individually in the coming week.

4. Trip planning task (over three days, x2): The group of participants spent two days engaging in a collaborative hotel-picking with both the control version interface and CollaboRanger in randomized order(repeated with the other interface). The second round of the task using the other interface began when the group wrapped up with the first round using the first interface by reaching an agreement of what hotel to pick. We chose two cities in the US, namely New York City (New York) and San Francisco (California). In the control condition, the group was asked to plan a trip to and pick a hotel in New York City, while the experimental condition asked the group to plan a trip and pick a hotel for San Francisco. For each round, each member shared a few hotel suggestions from their preferred hotel-booking website by sharing different mediums such as links and screenshot of the website, and explain their brief reasons. Then the group engaged in discussion regarding candidates based on everyone's preferences and compared the hotel amenities to collectively pick one. Specifically for the Experimental condition, group members were asked to create a list of hotel candidates using CollaboRanger table based on everyone's suggestions and then another table when comparing the hotel candidates by their amenities. How exactly the tables should be structured was not specified and was up to the participants to decide. At the end of the task, participants were asked to submit a brief write-up about what hotels they picked and their reasons in each condition through an exit survey. The conversation logs during the collaboration tasks were analyzed using the linguistic dictionary Linguistic Inquiry and Word Count (LIWC) [36]. This type of analysis using LIWC is prevalent among the literature in studies of novel systems for group work [25, 7]. Participants also filled out a NASA-TLX survey [18] on their experience with their overall experience using CollaboRanger.

Table 6.1: Comparison of messages exchanged in different conditions. Groups at the top row had one of others condition followed by CollaboRanger, whereas the bottom row had CollaboRanger first. When participants used CollaboRanger first, they tended to have similar amount of total word counts. However, for the opposite cases, they tended to be drastic decreases in word counts when they used CollaboRanger. Group 1 and 2 used CollaboRanger first while Group 3 and Group 4 used email first.

	Group 1		Group 2	
	CollaboRanger	Email	CollaboRanger	Email
# of messages	13	12	14	7
Total word counts	264	235	265	266

	Group 3		Group 4	
	CollaboRanger	Email	CollaboRanger	Email
# of messages	12	13	11	9
Total word counts	265	502	133	280

5. Exit interview & survey (30 minutes): At the end of the study, participants engaged in a 30-min exit interview and survey focused on understanding their experience and eliciting feedback on our system. The interview was semi-structured and guided by a list of questions attached in Appendix.

Participants We recruited participants using the same method as our workshop study. Each participant was compensated $40 per person for their time. We recruited 18 (12 females, 5 males, 1 prefer not to say) participants and assigned them to one of 4 groups. Two people dropped out after signing up (remaining 10 females, 5 males, 1 prefer not to say). Participants' ages range from 19 to 60+ and occupations included undergraduate students, graduate students, research associate, software engineer, mechanical engineer, designer, and client relations coordinator.

6.1.1 Study Results

To evaluate how CollaboRanger changed the experience in coordinating responses shared in different formats of personal tool preference and in facilitating group decision making, we asked participants to reflect on their group's decision making process in

Table 6.2: Results of self-rating by study participants. They are analyzed using a mixed effects model with random effects for teams and participants fit by maximum likelihood. As a result, there are marginal differences between different treatments (control and experiment) in successfulness, and significant difference in all other attributes ($p < .01$ ***, $p < .05$ **, $p < .1$ *)

Metrics	Informed decision		Trade-off comparison		Mentally demanding	
Fixed effects	(Intercept)	Treatment	(Intercept)	Treatment	(Intercept)	Treatment
Coefficient	5.64 ***	0.857 ***	5.07 ***	1.43 ***	4.43 ***	-2.07 ***
p-value	<.001	.005	<.001	.004	<.001	<.001

Metrics	Hard work		Stressed		Successfulness	
Fixed effects	(Intercept)	Treatment	(Intercept)	Treatment	(Intercept)	Treatment
Coefficient	4.14 ***	-1.71 ***	3.57 ***	-1.64 ***	6.21 ***	0.35 *
p-value	<.001	<.001	<.001	.004	<.001	.05

trip planning task. Specifically, they rated on a scale of 7 (1=definitely disagree, 7=definitely agree) in each condition, if they thought their team were able to make an informed decision and if they were able to compare trade-off between the different suggested hotel options. Table 6.2 shows the self-rating results comparing the control version and experimental version including the above ratings specific to group-decision process in trip planning tasks as well as users' response to the NASA-TLX survey for their overall experience in all three tasks during the study.

CollaboRanger lets users to more easily collect and compare across responses made by their own preferred tools Users were able to more efficiently conduct coordination tasks across multiple format of information using CollaboRanger than using email. In the group-scheduling task and visit-day-organizing task, we measured the amount of time taken to complete each task in both the control and experiment conditions. Specifically as shown in the Figure 6-1, we found from the measured completion time that when using CollaboRanger, users (μ=3.9) were significantly faster in the group-scheduling task (p<.01, charts 6-1.left) than when using email (μ=6.6). They (μ=4.8) are marginally faster in the visit-day-organizing task (p<.1, charts 6-1.right) than when using email (μ=6.3). Users believe that the gallery view cuts redundant steps from their normal practice to manually create sim-

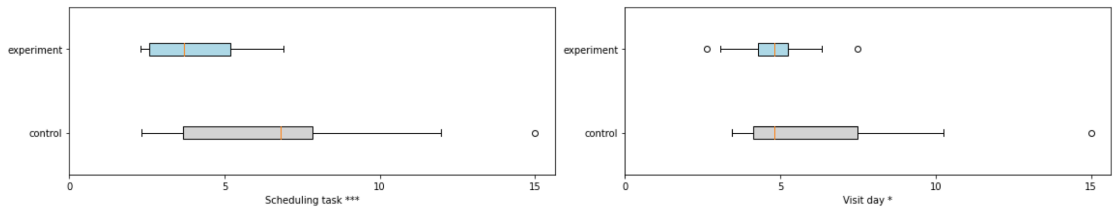

Figure 6-1: (Left) Comparing completion time for scheduling task in both conditions. (Right) Comparing completion time for visit-day-organizing task in both conditions.

ilar effect. In the control condition, they had to go back and forth remembering information across multiple windows or even threads in the visit-day-organizing task where multiple individual threads were involved. It became easy for them to forget comparisons already being made and would have to recheck. To mitigate such challenges, some participants even open up personal notes or Google doc to write down their thinking process. When using CollaboRanger, however, participants commented, *"I can write down the times I'm comparing using the summary textbox and ... cross things out if it doesn't work for everyone"*. CollaboRanger helps them to track their thought. One of the participants mentioned that the table-making process was "tedious", but it had "the great paid-off". They sought automatic response extraction using NLP techniques for better user experience.

In addition, users felt that, coordinating information from different tools overall using CollaboRanger comparing to email, it was significantly less hard to achieve even marginally more successful result in accomplishing the task they were asked to do (Table. 6.2). Specifically, users found CollaboRanger to be *"more convenient"* as they can *"have the options side by side [and] look at [their] notes for each of the different options all in a singular place without having to scroll (along long conversation threads) or switch tabs"*. CollaboRanger also made them feel less mentally demanding as it offloaded the memorization that users would have to do when working across multiple channels linked to by the responses. One participant described his mental stress using email: *"I had to like open three different emails or calendars and I have to try to remember when I was scheduling times. I had to try to remember when everyone was free."*. When using CollaboRanger, however, *"even*

doing multiple things, the information is already sorted out for me in one screen (so it) required much less mental bandwidth."

CollaboRanger also led groups to make more informed and effective decisions (Table. 6.2) and was influential in the way users coordinate. CollaboRanger not only facilitates coordination, it even influenced noticeably the groups' behaviors. As analyzing the conversation behavior for the trip planning task in both conditions (Table. 6.1), we discovered that teams who start with CollaboRanger first preserve the same pattern of conversation whereas groups who used email first were greatly impacted by CollaboRanger. In fact, one of the group, which conducted the experimental version first, adopt from CollaboRanger the table concept to create a collaborative-editing spreadsheet later on for their control version using email. When asked to compare the collaborative-editing spreadsheet with CollaboRanger table, participants pointed out that CollaboRanger table would be more convenient for opening up and view linked pages on one sight.

Natural group leaders lead with less stress and bystanders stay more informed with less effort using CollaboRanger Users participating in the trip planning tasks as ephemeral groups indeed organically and dynamically took on the role of leaders and bystanders, echoing our workshop findings. As our participants described in the exit interview, throughout the two versions of trip planning tasks, leaders differed from task to task and there were also multiple leaders during different parts of the coordination process within each task.

Among those who identified themselves as a leader in some parts of the decision making process, users felt they were less stressed in coordinating responses and moving things forward (Table. 6.2). A leader said, *"When I was making that table with all the amenities, I could just pick their URLs and and I can go to the URL viewer mode (gallery view) and open all of them."* By seeing all the amenities and summarize them in another row, they thought *"it was definitely easier to process and address everyone's response here"*. Another user mentioned that they were "so stressed" when they were conducting the task using email, because they worried that they accidentally forget to include some of responses from some users in their team.

Users also felt more comfortable leading the progress as making the CollaboRanger table could also act as acknowledging others' responses and contribution. One leader said, *"It feels actually more comfortable in this case as leaders like normally have to take on extra responsibility of what they say"* as explained by one user. Another leader said that filling out the table is like better version of emoji in chatting interfaces. They explain that it is not only acknowledging each participant's response but also helping to sensemake everyone's responses.

Lastly, organizing responses using the collaborative table made it easier for natural leaders to keep track of the teammates making sure everyone had their input. *"I don't have to dig into the long threads of messages and usually like things gets easily missed"*. Specifically, based on the tables participants created, two of the groups used the sub email thread feature to bump for responses and they found it convenient having the response going right into the cell. One leader even created a third table bumping individually and collecting everyone's final choice to address and better visualize potential consensus across all members' opinion.

Among those who described themselves to be more like a bystander in some cases, users didn't feel overwhelmed by the "fancy" table created by leaders as they might have judged others according to our previous workshop participants when being presented YouCanBookMe. They thought the table structure made it clear enough of what it meant. Furthermore, bystanders even appreciated the table for helping them keep update with the progress. Specifically, users felt it required less effort from people who are not organizing and CollaboRanger made the conclusion very visible with the summary feature. For some bystanders who joined in late for sharing suggestions and for discussion when other members have already moved to started to win on some choices, they just *"looked at the table at what they're talking about and it made sense."* On contrary, participants argued that this would be hard to achieve using email or even other online chats as *"even if people add [bulleted list], we kind of get lost in the sea of text"*.

Moreover, even giving the natural roles of leaders and bystanders, groups using CollaboRanger were in general more engaged in conversation and with more equal

roles among members. Through analyzing the discussion thread in both control and experimental conditions using LIWC, we discovered that teams when using CollaboRanger had an increase in use of *you* (p=.03) to address each other. This was echoed by users feedback during exit interview where they thought the sub-thread feature in table made it easier to address and track individual group members. Furthermore, there were also more *social* words (p=.007) used when discussing on CollaboRanger, indicating that group members were more socially connected with each other on CollaboRanger [25]. This was surprising as even bystanders start to engage more. One participant describing herself to be more of a bystander in both trip planning tasks expressed that, once someone in the group had strong preference or the majority seemed to agree, she tend to trust and follow with their choice. However, she felt that the table their group made and organized by members seemed to more *"equalize"* the opinion of all members even if it might can be a minority idea, promoting her to still make her input.

CollaboRanger helps users to stay informed when the task span longer period. By preserving the structured information and relevant summary made, *"when going back and trying to refresh the memory ... a few days later, it was definitely much easier in* CollaboRanger*"*. When asked to submit a brief write-up for the final hotel decisions and the reason why it was picked over the others, users were able to come up with more detailed explanation in much shorter time when answering about the decision made using CollaboRanger, regardless of the order of the task. Users even came up with other use cases in which they would found CollaboRanger supportive when discussing their experience using the tool. *"I would imagine it to be useful in scenarios when I'm reaching out to a lot of people for job referrals and I want to make sure like keep track of our conversation to be able to come back easier."* as one user commented.

Chapter 7

Discussion

We presented CollaboRanger, a messaging system that supports group coordination across responses from different people in individuals' choice of form. Our design was inspired by previous literature regarding individual differences in task management, gap between personal tools and group tools, sense-making system as well as our workshop study. Here, we also share the potential of having structured interpretation of conversation as a way to increase social acceptance for ephemeral group coordination tool and tighter connection between personal tool preference for information sharing and easier group coordination. We also discuss that

7.1 Design implications: Structured interpretation of conversation as opportunities for more intelligent coordination system

While some people prefer highly structured information, especially for coordinators (leaders) who are responsible for bringing everything together, others prefer the momentum-building free-form of communication and would feel overwhelmed and shed away by overly-structured tools. From our workshop study, this was among reasons why individuals would tend to judge new tools shared by others. A careful balance between the two would be crucial to ease the job for coordinators while al-

lowing smooth communication between all members. Previous works [8, 27] decided to hide entirely the coordination tool from the bystander class.

In our user study, we allowed visibility to the coordination features for all members yet observed that both coordinators (leaders) and regular participants (bystander) felt comfortable and benefited from the additional features when they used CollaboRanger. By building another level of structured, yet familiar, interpretation (e.g., table) directly sourcing from participants' responses, individuals felt found the synthesized information, though structured, to be more closely tight to original opinions and were intuitive and easy to parse through. Having the table displayed within the free-form discussion channel and being able to view responses on one sight even if they link to other web pages, both coordinators (leaders) and regular participants (bystanders) also found it more straightforward in terms of how to contribute to the group sensemaking, what decision or conclusion have been made, as well as the reasons why. Thus, we envision that structural, familiar and universal representation of conversation while embedding all relevant information on one sight can overcome various barriers in adopting new coordination tools and facilitate better coordination for ephemeral groups.

7.2 Opportunities for discussion to evolve around different level of coordination

To aid information synthesis and preserving such results in coordination tasks, we chose to support the summary feature in CollaboRanger. When designing its functionality, we made the design choice for the summary to span entire row for comparison across all columns, give coordinators the choice of whether to notify the team with a separate message, and only allow the notification to be sent once. The rationales behind our decision was to guide users to use a separate table for each decision or conclusion to make so that there's no confusion of which new updates results from which table.

However, there can be many other alternatives to the design of intermediate note-taking and presenting conclusion made. In fact, participants from our user study mention the need for more flexible and dynamic discussion regarding different level of details during coordination. We envision that CollaboRanger can provide opportunities of better tracking discussions evolving around different coordination level. For example, instead of supporting the summary feature more like a "statement", we can imagine that allowing conversation to happen for the comparison across the options would allow all members to hop on discussing what the conclusion should be, making it more like a collaborative consensus than one person's say. Furthermore, supporting comments for each cell in the table may also bring benefits as participants can address specific concerns without always having to flood the messaging channel.

Chapter 8

Limitation & Future Work

Although CollaboRanger targets tool coordination, which is a universal problem in group tasks, our workshop study and user study are highly based on populations from academia. We attempted to draw our insight from participants of different team and occupation natures, such as coordinator for client and corporate relations, students at school, and few engineers or designer working in industries. It still remains as a future work to see if our findings expand to other populations. We next aim to deploy our system on a larger level in different backgrounds and examine how our system situates for various ephemeral groups.

We also plan to support more visual aid for interacting with the table to improve the coordination and decision making process. As some of our users suggested in the exit interview, people some time feel lazy to write down explicit word when they just want to express simple "yes" or "no". They mentioned the "thumbing up" or emoji reactions implemented in many nowadays chat interface to be very helpful for further engagement with the table structure. They also argued that with more visual aids than just the summary feature would make the distribution of preference more visible when narrowing down on the options to reach conclusion. Therefore, we next aim to explore more simpler yet dynamic interactions with the table to promote even easier engagement and visualize group reactions towards the information being compared. This could include giving a title for each table so that users are aware of one dedicated goal they are reaching, adding simple reaction to each cell for users

to voice more specific opinions and visualize opinion distribution, and supporting transposing of the table when listing of comparison gets long and when users prefer viewing it vertically.

Chapter 9

Conclusion

We presented our tool CollaboRanger as a solution to collect and synthesize responses in ephemeral groups without having participants to compromise the form in which they choose to share their contributions. The design of our tool was motivated by workshop studies on coping individual differences in group coordination tasks. We found that in ephemeral groups, individuals prioritizing social acceptance over efficiency in choosing tools to use which raises great challenge having to coordinate across multiple channel. In addition, organically developed roles of leaders and bystanders among ephemeral groups makes group tool adaptation even harder. To address these challenges, we designed CollaboRanger as a coordination tool to facilitate at scale easy collection and visual comparison across multiple forms of responses and allow both leaders and bystanders to flexibly engage. Our user study revealed that CollaboRanger fares well as a group coordination tool that enables users to coordinate more easily and efficiently while all roles of the group are more comfortable and successful at what they want to accomplish. In the near future, we plan to support more visual aid to further facilitate group consensus consolidation and deploy CollaboRanger to various teams of individuals to run a full-scale evaluation study. In the meantime, we hope that the needs and findings discovered in our workshop studies can guide designers and developers of group coordination system.

Appendix A

Workshop study and exit interview

A.1 Initial list of task categories for pre-workshop survey

1. What are you asked to do from the colleagues via email or messaging apps (e.g., slack)? Select all that apply and add to "Others" anything that's not included.
    - Code related: e.g. fix bugs, add features, migrate data, verify code, etc.
    - Scheduling meetings, rescheduling and sending reminders
    - Prepare documents by deadline
    - Approvals: e.g. sign a document
    - Provide feedback on projects, ideas, etc.
    - Review a conference paper
    - Recommendations: e.g. how to design user studies, list of relevant papers, etc.
    - Asking for letters: e.g. recommendation letters, department letters
    - To participate in user study: e.g. fill out a survey, fill out a form
2. What do you often ask your colleagues to do via email or messaging apps (e.g., slack)? Select all that apply and add to "Others" anything that 's not included.

- Code related: e.g. fix bugs, add features, migrate data, verify code, etc.
- Scheduling meetings, rescheduling and sending reminders
- Prepare documents by deadline
- Approvals: e.g. sign a document
- Provide feedback on projects, ideas, etc.
- Review a conference paper
- Recommendations: e.g. how to design user studies, list of relevant papers, etc.
- Asking for letters: e.g. recommendation letters, department letters
- To participate in user study: e.g. fill out a survey, fill out a form
- Can you help me with my computer problem (to IST)?

A.2 Exit Interview Questions

1. Please open your email thread for your team's NYC trip planning. Please write a brief explanation of what hotel your team picked and the reason why.
2. Please open the CollaboRanger thread for your team's SF trip planning. Please write a brief explanation of what hotel your team picked and the reason why.
3. Can you compare the experience of planning a trip using email vs. CollaboRanger?
4. Overall, please describe your experience using CollaboRanger.
5. For the scheduling and visit day organizing task in our tutorial session, you were able to finish much faster using CollaboRanger than when you use email. What do you think the reason is?
6. Are you normally leading to get through the decision, or let someone else lead you when coordinating something with others?

- (if they say leader) With CollaboRanger, are you able to lead and make your team progress like you would?
- (if they say bystander) With CollaboRanger, are you able to see your team leader's contribution and make sense of information?

7. Are there scenarios in which you'd use one over the other when coordinating contributions?

8. How willing to engage (to actively coordinate and drive decision-making) were you when using CollaboRanger and when using email for each task?

9. Would you, and in what scenarios, continue to use CollaboRanger for task coordination in the future?

    - if yes, why? what did you like about it?
    - if no, why? what's stopping you from using it?

10. Features: Table row vs. col, Select from conversation, Link with a new email, Gallery, Summary

    - How did you use this feature?
    - How often did you use it?

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