

Tool for Enhancing Family Communication through Planning, Sharing Experiences, and Retrospection

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Abstract: Advances in mobile communication technology have eased time and space constraints in communication between individuals. Although communication support tools are efficient in non-frequent and transitory relations, they are not necessarily a breakthrough for communication among people such as families in which face-to-face communication serves a crucial role. To enhance family communication, we advanced a project to develop the tool in a phased manner. First, we conducted an ethnographic study to understand users and extracted insights related to family communication. The results of the ethnographic study revealed that a family who was maintaining good communication planned, experienced, and retrospected family events together. Based on these insights, we created the concept of a tool that combines features of a shared calendar and a photograph album. We iteratively prototyped and tested prototypes so as to increase user acceptability by improving user interfaces. Through user tests, the prototypes demonstrated that a parent and child could cooperate to plan family events reflecting their intentions and preserve past family experiences.

1 INTRODUCTION

Advances in information and communication technology (ICT) have led to the widespread use of various tools supporting communication between individuals. As these tools have been distributed to mobile devices, time and space constraints in communication have been greatly eased. Although the communication support tools are efficient in maintaining weak ties (Granovetter, 1973) such as non-frequent and transitory relations, they are not necessarily a breakthrough for communication among people with strong ties such as families. The use of ICT devices has various practical usefulness; however, it also has a negative aspect on the strong ties in which face-to-face communication serves a crucial role. For example, there is the further isolation of individuals and the lack of empathic abilities due to a shift of consciousness from face-to-face communication to mobiles. It is necessary to design a tool to emphasize an aspect of ICT underpinning of family communication.

A variety of research projects have addressed the development of ICT-based tools designed to enhance family communication by sharing experiences as an alternative to simple voice communication or messaging (Cao et al., 2010; Crabtree et al., 2004; Heshmat et al., 2017; Inkpen et al., 2013; Neustaedter et al.,

2009; Oduor et al., 2013; Wilson et al., 2017). For the offline situation in homes, interfaces that mediate family communication by sharing information such as daily tasks and family members' schedules have been proposed to improve the efficiency of home management (Brush and Turner, 2005; Neustaedter and Bernheim Brush, 2006; Neustaedter et al., 2009; Pan et al., 2015).

In response to concerns that the use of mobiles is increasing the isolation of people, our project reconsidered problems of family communication and designed a tool. We advanced the development of the tool in a phased manner from a user perspective by referring to a design thinking process (Dam and Siang, 2018; Culén and Følstad, 2014; Thompson et al., 2017).

In this paper, we report the current prototypes, and also report the development process and findings from a user study. First, we conducted a comparative ethnographic study. From observations and interviews, we focused on what family members do together in a problem setting for family communication. Then, we reviewed conventional approaches to the problem in family communication and designed the framework of this research. As a result, we created the concept of a tool that combines features of a shared calendar to manage future and current events and ones

of a photograph album to retrospect past events. To prove that family communication is complemented by sharing past experiences and future intentions, we developed prototypes of the tool. We iteratively refined the prototypes on the basis of feedback gathered from user tests so as to increase user acceptability by improving the user experience (UX).

2 ETHNOGRAPHIC STUDY

We conducted an ethnographic study on four families in their homes to understand their lives and ways of communication within a context by utilizing observations and interviews. We set two criteria for selecting the families. One is whether it is a family whose children are not preschool. In Japan where we conducted this study, there is a tendency for less communication with parents as children grow up. The other is whether father's involvement in child rearing and household tasks is high. We estimated degree of father's involvement in household tasks from proportion of sharing between spouses. We evaluated degree of involvement in child rearing based on whether a father had used company's support systems (e.g., child-care leave, sick/injured child nursing leave, reduction in working hours, and telecommuting). We sampled two families (Family 1 and Family 2) who satisfy all of the criteria and two families (Family 3 and Family 4) who don't satisfy all of the criteria.

We observed realities of family member's behavior and communication. After the observation, we conducted a detailed interview including items related to ways to record and manage family events and daily life. The home visit survey took about three hours per household.

In this section, we compare families whose communication styles are contrasting, and describe the findings. Family 1 and Family 2 were having diverse communication means. Family 3 and Family 4 were feeling a lack of communication between the parents and the children. Then, we identified insights that enable family communication to be maintained.

2.1 Summary of Findings

2.1.1 Family 1 and Family 2 — Families with Diverse Communication Means

Family 1 consists of four members: working parents, a son in high school, and a daughter in junior high school. Family 1 regarded household tasks as work to be done together by all members and shared them.

When the family members did household tasks together, they not only aimed efficiently to get tasks done but also were communicating with each other. For example, when the parents and the children did household tasks together, the mother taught the children how to cook and clean, and the children also positively asked how to do.

There were rules such as "Eat dinner together to the extent possible" and "Everyone at home should see off a member who leaves home" in order to consciously maintain face-to-face communication between the members. These rules were made from father's intentions to maintain opportunities for the family members to be considerate to each other. As an effort to complement family communication, they shared messages and tasks by using a white board, a calendar, and notes taped to walls, a fridge, and doors. The materials were visible everywhere in the house. The members conversed about the materials as topics. Moreover, they shared messages and photos of casual experiences by means of mobile devices on a daily basis. Family schedules were shared with the materials or verbal interactions in advance. They collectively organized photos and videotapes of past family events such as trips, and promoted conversation by retrospectively stored memories again. However, because they have recently taken photos with digital devices and have not developed them, the data are dead-stored in the devices and not retrospectively later.

Family 2 consists of four members: working parents and two preschool sons. The couple of Family 2 had the clearest distribution of household tasks compared to the other families. The father answered that his sharing rate of household tasks was 40-50% of the total. He also said that both himself and children are proactive in communicating with each other. Furthermore, he tried to talk with his wife for more than sixteen minutes a day since he got information that it increases feelings of happiness before. With regard to planning family events such as traveling, the couple said they enjoyed doing together while thinking "what they want to do with their family" rather than "what oneself wants to do."

Photos taken in past family events and everyday life were stored on parents' mobile phones, respectively; however not managed any further. The parents had a hard time finding a specific photo that we asked to show us during the interview. They expressed this state as "a stratum of memories."

2.1.2 Family 3 and Family 4 — Families Feeling Lack of Communication

Family 3 consists of four members: working parents and two daughters, one in junior high school and one

in elementary school. The father was busy with his job and returned home late on workdays. He was not able to spend much time with his family because his holidays were on days other than weekends. The mother worked at home twice a week on Tuesdays and Fridays. The younger daughter was busy with a cram school and five kinds of lessons. Communication between the father and the elder daughter was particularly poor.

Household tasks were not shared, they were done only by the mother. The tasks piled up and reduced the mother's scope and time for family communication. Nevertheless, almost all communication was steered by the mother when we visited. For example, she encouraged family members' voluntary communication during meals by providing conversational materials. Handouts and notes distributed at schools were stuck on the fridge door with a magnet, and only the mother handled them out and gave directions to the other family members.

The photos of past family events were not managed because the parents did not know how to transfer the data from devices to a PC. They enjoyed taking photos, but found the rest of the procedures troublesome.

Family 4 consists of five members: working parents, a son in elementary school, and two preschool children. The father was busy as with the father in Family 3 and went on business trips frequently; therefore, the mother was aware of lack of direct communication with his husband. The mother answered that she kept more than 90% of household tasks. She was tied up with present tasks occurring one after another. When the mother washed dishes after lunch, the children talked to her to attract mother's attention; however, the mother prioritized doing household tasks.

More than a thousand photos were stored in a digital camera of the parents; however, the mother did not know how to display them.

2.2 Problem Setting

We defined the problems to tackle on the basis of findings from a comparative study on family communication.

Members of Family 1 and Family 2 shared domestic routine tasks and individual members' schedules in advance. As described above, the father's intentions to maintain ties among the family members were also shared by setting rules that serve as guidelines for the family. On the other hand, there were no opportunities to do work together in Family 3 and Family 4 due to the busyness of the father and the daughter. Only the mother handled domestic tasks, cared about other

members' schedules, and encouraged family communication, particularly in Family 3. Time for maintaining communication among family members has become more limited recently. Parents spend most of their time at work (Roy and Bhattacharya, 2015), and some children are busy going to cram schools and having extra lessons (Brown et al., 2011).

Temporally and spatially synchronized experiences directly lead to enhancement of communication. In Family 1, daily work such as cooking and cleaning generated the family face-to-face communication. They also shared individual experiences with each other by mobiles on a daily basis.

Another mode of experience sharing was also observed after a phase of planning and experience. As observed in Family 1, accumulated family experiences (e.g., family trips, child growth record, and school events) deepens memories, and can later be triggers for conversation and retrospection. Tools such as social media (Guy et al., 2016) and online chat (Neustaedt et al., 2015) are useful to temporary interactions among family members. In order to further enhance family communication which is the strong ties, it is necessary to share not only as well as temporary communication, but also a whole life cycle of family events including past and future. The photos of past family events were previously physically organized and managed. Family 1 used to create photo albums for each event. However, nowadays photos are taken by ICT devices, managed as electronic data, and tend to be dead-stored on personal devices, as was the case in four families.

We obtained the insight that sharing experiences are important for enhancing family communication. In Family 1 and Family 3, which was maintaining good communication, the experiences such as sharing plans and directions, daily face-to-face communication and household tasks, and retrospection of family events by photos and videos enhanced satisfaction with family communication. By contrast, Family 3 and Family 4 lacked opportunities to communicate in these ways. Thus, we established the concept of a tool that promotes family communication focused on what family members do together. It is necessary to design UXs that comprehensively support family collaboration over planning, experience, and retrospection.

In addition, since communication between a father and child tends to be particularly lacking in a family (Lukoff et al., 2017), we conducted the following user studies focusing on that relations.

3 RELATED WORK

In the field of human-computer interaction (HCI), research on family communication support has received a lot of attention.

Systems that support opportunities for individuals to be together and support online experience sharing have been proposed. Systems for realizing shared-dinners, event remote participation, or remote story reading have been suggested as challenges to the distance gap (Inkpen et al., 2013; Oduor et al., 2013). As for the time gap, there is research on communication taking into account that family members are in different time zones (Heshmat et al., 2017; Cao et al., 2010). G2G project (Forghani et al., 2018) designed a system that allows grandparents and grandchildren over distance to share an awareness of each other's lives by means of a shared calendar and video messaging. These particularly focus on ongoing experience.

In the phase of retrospection, family members retrospect records and memories of their past experiences. Although dead storage of photos was a problem in the case of Family 1 and Family 2, there is rich literature on photoware, which is technology for storing, managing, and sharing digital photos in the field of HCI. Requirements for photoware were discussed regarding the difference in usage situation between conventional and digital photos (Frohlich et al., 2002). Photoware assuming cooperative photo sharing is also explored for home use (Crabtree et al., 2004). Prototypes were created to allow users to easily and flexibly share a digital photo collection on mobile devices in the face-to-face context (Lucero et al., 2011). Souvenirs project (Nunes et al., 2008) proposed a photo-sharing approach that displays digital photos with a link to a physical memorabilia as affordances to increase opportunities of sharing in physical space.

Tools for improving the efficiency of household tasks by utilizing ICT have been proposed. Especially in homes, visual approaches based on the advantage of a calendar is effective for managing schedules and recording experiences. Families use paper calendars as a tool to help stay organized; they are easy to use, share, move, personalize, and create an instant archive of family activities (Brush and Turner, 2005). Previous work has shown that digitalized calendars and other messageboard-like interfaces are useful for families to address cooperative work (Neustaedter and Bernheim Brush, 2006; Neustaedter et al., 2009) and to handle daily tasks and incoming information (Pan et al., 2015). MyCalendar (Abdullah and Brereton, 2015; Wilson et al., 2017), which is a calendar tool with photos and videos as contents, helps children to show what is happening both at home and school to

teachers and parents and to communicate about their motivations and interests, even if the children have limited verbal skills. These functions support the management of domestic routine tasks and temporary interactions or enable the family to retrospect the experience itself later. Families can spend together more time by improving the efficiency of tasks in the home.

In this research, in addition to the experience and the retrospection of the family collaboration, we also consider the “planning” phase preceding the other two phases. We broadened the scope of collaborative work within families to sharing intentions and planning.

4 DEVELOPMENT PROCESS

In this research, we firstly ideated solution. Then we iteratively created prototypes and tested them accordingly. The tests are another chance to understand users from their feedback on the created prototypes. We adopted a formative evaluation approach (Maguire, 2001) to develop prototypes. Each cycle comprises empathy for users, defining challenges to take on, and ideation.

4.1 Ideation

From the results of the ethnographic study, we ideate functions for a family to plan and share family intentions, manage family events and embed them, and preserve past family experiences to be retrospect together. We extracted the features of family communication obtained from the results of the ethnographic study. We refined ideas of a tool while summarizing the features through brainstorming by project members. We repeatedly evaluated the ideas as compared with the results of the ethnographic study.

After we carried out ideation only within the project member, the development project invited an artist¹ to join ideation process, and discussed the features of the communication support tool. An example of her work is “collage of time²” glued to a large calendar that is painted on canvas of 1620×1303 mm and its concept can suit in intent of the tool. It is an assemblage of different materials accumulated in daily life, for example, photos, illustrations, notes, article clippings, movie or concert tickets, railway tickets, QR codes with embedded secrets. She used the work as a calendar for schedule management and also used as an album to be retrospect later by adding contents

¹<http://rieko.jp/>

²<http://renga.com/riekoarc/100LoXXPW/>

to past days. The inspiration of her previous work triggered the idea for a tool with which future plans and past experiences of family events can be managed in time-series relation to each other by using contents such as photos, pictures, and texts.

4.2 Prototype 1

4.2.1 User Study with a Paper Prototype

We tested a simple paper prototyping to clarify the minimum functions necessary to edit materials. Paper prototyping in the early stage of development has the advantages of reducing the risk of reworking in agile development and sharing common perceptions about products among project members. A Japanese pair of a father and his six-year-old child addressed prototyping together for six months as an experimental test. During the period, they expressed their intentions for event planning and memories of past events on the calendar by cutting and pasting the photos taken at events, writing, and drawing.

After the test, the father shared resulting calendars and informed free opinions and characteristic behavior to the other project members. We documented feedback from the father and listed activities seemed to be effective for family communication.

Figure 1 shows the resulting family calendar. There was interaction in the phase of planning between the father and child on the prototype. The child's responses about past events are shown as the texts of "It was fun," and "I want to go skiing again." In terms of hopes for a future plan, we could see that the child wanted to go to KidZania, which is a child-friendly family entertainment center. The father replied, "Nice!" and "Let's go," to the child's remarks.

Since continuous use by the father and child was confirmed over the test period of six months, we presumed that the development was worth moving on to the next process.

4.2.2 Requirements for Editing Function

The user's feedback revealed that there was demand for a function to rotate and zoom in and out of the photos in order to give significance to each content according to its position and size. The resulting prototype, which was created by editing not only photos but also texts and pictures, indicated the need for various ways of inputting. Besides, a function to rearrange the contents was proposed due to difficulty in changing the content layout once glued on the paper.

4.3 Prototype 2

We developed a calendar app taking the results on the paper prototyping into account, and implemented it on the Apple iPad Air. It was used by two families for one month. Through the user tests, the operation of each implemented function and the influence of use on family communication were confirmed. Moreover, we identified problems in UX of the second prototype.

In this subsection, firstly, basic operations and implemented functions were outlined with explanation screens shown in Figure 2. Secondly, problems and insights are formed for ideation to create solutions required for a third deliverable.

4.3.1 Screen User Interface Design

Figure 2 (a) shows the basic screen of the second prototype of the calendar app. By tapping the grid square icon in the upper left corner of the screen, all created contents are listed. The camera icon and folder icon are used to invoke photo import functions. The pencil icon is for handwriting functions. The left arrow icon is used to undo the last action. The preview mode and edit mode switch by selecting either tabbed document interface (tab) in the top middle of the screen. The gear icon is used to confirm and change the settings. By tapping the icon to the left of the gear icon,



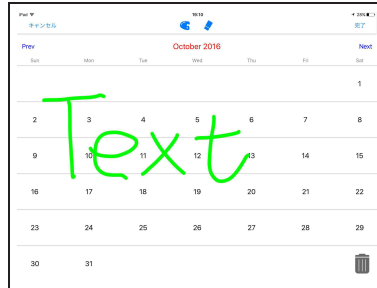
Figure 1: A paper prototype created by the father and child. The Japanese texts in the prototype mean the following (in order from the upper left). "It was fun." "Skiing!" "Nice!" "Hakone Unessun with Ken Grandpa and Eiko Grandma." "Father is at Osaka." "I played with Hikari." "I won a game of tennis." "KFC!" "Snow." "Visiting great grandmother's grave." "I want to go to KidZania." "Let's go." "I want to go skiing again."



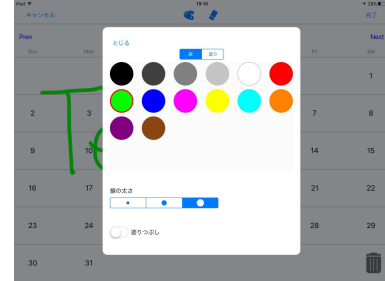
(a) The graphical control elements on the top of the basic screen.



(b) The photo cropping function.



(c) The sample of drawing.



(d) The digital palette.

Figure 2: The user interface of the second prototype.

a screenshot is captured and exported in the Photos app, which is the default app of the iOS. The month displayed in the calendar changes by tapping “Prev” or “Next.”

4.3.2 Functions for Importing and Processing Picture Contents

There are two ways to import photos to the app. One is to cooperate with the iPad default Photos app. This function is invoked by tapping the folder icon. Photos taken in the past and stored in the Photos app are available in this way. The other is invoked by the camera icon and the way to take photos by launching the Camera app.

After selecting or taking a photo, the process firstly shifts to the photo cropping function by which a user can cut out a photo in free form. A desired area of the photo is left as content by tracing the outline of the area to be clipped with the finger as shown in Figure 2 (b). Until the cropping area has been determined, the user can cancel editing or reset the cropping area. Once the operation has been completed and the cropping area has been determined, its area cannot be modified later. The cropped content can be zoomed (by pinching in or out the content) and rotated (by multi-touching and rotating without pinching), and its position on the calendar can be moved (by dragging). The size, the rotation, and the position can be modified later.

4.3.3 Handwriting Functions

The handwriting functions are invoked by tapping the pencil icon (see Figure 2 (a)). Figure 2 (c) shows a sample of the handwriting content in the handwri-

ting screen. By tapping the palette icon at the top of the handwriting screen, the user can choose the pencil tool from three widths and 14 colors in Figure 2 (d). The eraser icon is used to erase handwritten content. By tapping “Done (in Japanese),” editing of the handwriting content is completed. The user can zoom, rotate, and move the handwritten contents in the same way as the photo contents.

4.3.4 Test Conditions

We lent an iPad Air with a calendar app to two Japanese families (Family 5 and Family 6) and conducted the user test on them for a month. The two families are different from the families in the ethnographic study. Family 5 consists of a father in his forties and his family including his three sons. Family 6 consists of a father in his forties and his family including his two daughters. The method of using the app and the purpose of enhancing the family communication were explained before conducting the user study. The subjects were asked to capture the screenshots at the end of the day if they used the app in the day in order to log the transition.

After the families used the app for one month, semi-structured interviews were conducted for about one hour on the fathers of Family 5 and Family 6, respectively. Interview items included usages such as frequency and situations, change in father-children communication, and feeling of use of each function. The screenshots captured by subjects through the test period were reviewed during the interview. We taped the interviews.

4.3.5 An Overview of the Resulting Calendars

Figure 3 shows the final calendars created by each family. Family 5 and Family 6 used photos of past family events, daily meals, and children as contents. The handwriting function was used to create a brief explanation of some photo contents. Family 6 used the handwriting function to draw a picture of a cake. In the case of Family 6, the app was also used to manage future events such as father’s working on a day off and a place where a child wanted to go on holiday. During the 30-day test period, Family 5 and 6 took screenshots (that is, they used the app) seven and 15 times, respectively.

4.3.6 Requirements for Functional Improvement

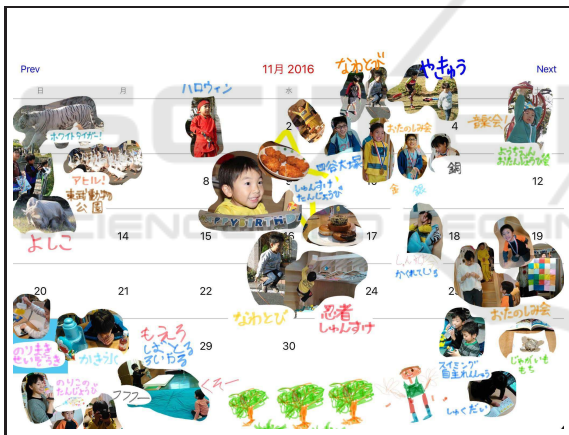
In the interview, comments related to the usability and functions of the app were fed back from the users. We extracted remarks, prioritized them, and decided three requirements for functional improvement to be addressed when development of a next prototype. The requirements are the following. A keyboard interface

was demanded as well as a handwriting function so as to input characters efficiently. When a number of contents are made and cover the calendar, the date indication cannot be seen. Because commonly there are few family events on weekdays and many on holidays, the widths of date boxes in the calendar need to be changed accordingly.

4.3.7 Insights from General Comments

A father commented that he selected the photos to create contents and gathered useful information regarding future family events by utilizing a mobile in his spare time such as time spent commuting. Then, he integrated them into the calendar tool. It is possible to use photos taken in various places with mobiles.

As overall impressions of creation of the calendars by using the second prototype, we obtained the comments below: “It was interesting to start creating the calendars. Especially by cropping the photos, I felt it put on a good show when it was pasted. We did not use the app for the purpose of schedule management,” and “It was interesting to change the photo size to larger or smaller freely because the size expressed my thinking at that time.” The second comment stands for our intention to use functions to edit contents. As for the feeling of accomplishment by planning interactively, there was one comment “I felt like ‘We’ decided the schedule by talking about and writing plans clearly with children.” Moreover, there was the insight that if there are many blanks on a calendar when the users look back at a past month, it motivates them to plan more events in the following months. From the above, it is suggested that the scope of cooperation extends to the planning phase.



(a) Family 5.



(b) Family 6.

Figure 3: Calendars for a month created by two families.

4.4 Prototype 3

In this subsection, we outline additional functions for the second prototype and report the results of a workshop that we conducted as a test of the third prototype.

4.4.1 Added Functions

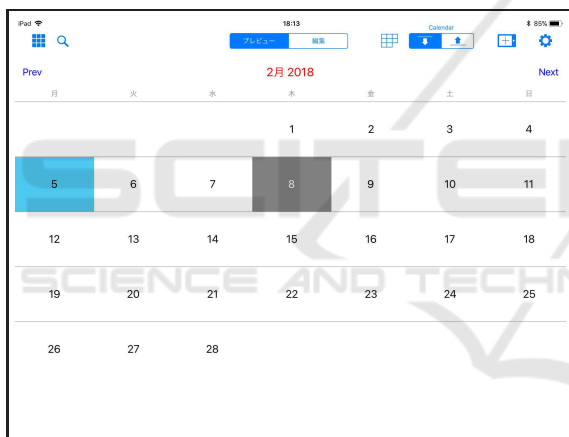
Figure 4 shows the basic screen of the third prototype. The box of the current date is indicated in light blue.

We implemented the keyboard input function to improve the usability of character input. The size, color, and font design of characters can be changed. Similarly to other contents created by using the photo edit function or the handwriting function, the texts created by the keyboard function can be zoomed, rotated, and moved, however they cannot be re-edited.

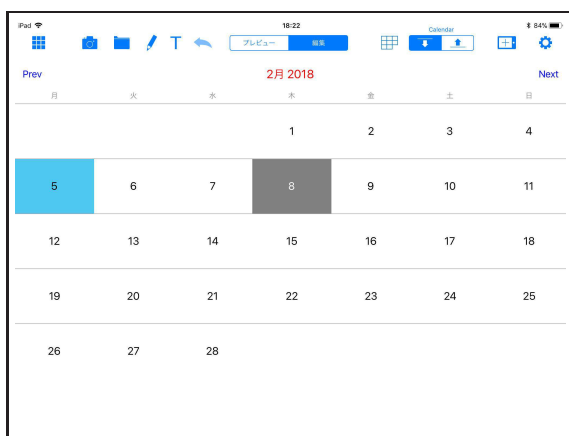
By tapping the magnifying glass icon in the preview mode shown in Figure 4 (a), character strings

previously inputted by using the keyboard function can be searched. When multiple search results are hit, the user interface for selecting a result is displayed, and the calendar turns to the month that includes the selected text content. When there are no corresponding search results, a message informing to that effect is displayed in a dialog box. This search function increases accessibility to past contents.

A function to select the display format of the calendar was implemented. By tapping an icon to the right of the preview/edit mode switching tab, the widths of date boxes in the calendar change. The user can choose the display format from the pattern that the size of all date boxes is the same and the pattern that the date boxes of Saturday and Sunday are wider than the other boxes. By switching the tab, the user can choose whether to display at the forefront calendar dates or created contents. If the calendars are covered with a number of contents, the date indication can be seen by displaying the calendar date in the forefront



(a) Preview mode.



(b) Edit mode.

Figure 4: A basic screen user interface of the third prototype. The calendar part of both modes is the same. The control elements on the top of the screen are different.

owing to this function.

Moreover, by tapping an arbitrary date box, its color turns gray and the contents created or edited on the day are listed. By tapping arbitrary content on the calendar, contents taken on the same day as the content taken are listed. These content-date linkage functions increase accessibility to past family experiences in retrospection.

4.4.2 A Workshop with the 3rd Prototype

We held a workshop to observe the usage situation and to collect impressions. When we tested the paper prototype and the second prototype, we mainly evaluated the finally created calendars. In the workshop using the third prototype, we observed the process by which the father and child created contents together. The participants were four Japanese pairs of a father and a child younger than elementary school age. We asked the participants to bring data of photos taken in the past to the workshop. The data were respectively imported to the four iPad Airls in which the developed third prototype was implemented.

After the introduction, a project member explained how to use the app and demonstrated the creation of the contents for about fifteen minutes. Next, the participants freely created the contents on the calendar for about one hour. Finally, we gathered users feedback on their impressions of the creation process, usability, and their intention to use it continuously. During the workshop, when the participants showed characteristic behaviors, we took notes as event data. Voice data of each pair were recorded respectively. We analyzed users feedback and characteristic behaviors by using the voice data.

As a result, the participants placed contents created from photos taken in the past on the dates the photos were taken. Many of the contents created by cropping photos of past events had an added handwritten explanation, as with Figure 3 (a).

Regarding forward plans, the father and child talked about and decided what they wanted to do. Contents representing intentions such as family trips and going to restaurants were created in the future calendars. Images from the Internet and handwriting contents were used to create the contents related to the future plans as shown in Figure 5 (a). One pair used content created by clipping a photo of the daughter ballet dancing as an icon representing a weekly lesson schedule. Although the fathers utilized the keyboard input function, the children did not utilize it much because they could not read and write yet. Meanwhile, one child utilized the keyboard input function to create decorating contents with Emoji as shown in Figure 5 (b).

4.5 Discussion

Participants planned family events and embedded their past experiences together. Through observation of actual work process, we found that the fathers firstly let their child edit the calendar in the child's own way and then supported them. Fathers who participated in the workshop commented that they would like to see the calendars individually created by other family members although it is good to create the calendars together. From these insights, we assumed that fathers want to know the feelings and thoughts of children and other family members and the calendar tool is helpful for realizing this. There was one comment related to communication in the planning phase, that is, the father could understand what the child wants by using the prototype and determining their intentions together with his child. The father found that there was not much to talk about with the child about plans previously.

One father took about one hundred photos a month. On the other hand, the other three fathers did not take photos often and many of the photos that they brought to the workshop were taken by mothers. Although two fathers indicated their intentions to use the tools continuously, the other two fathers could not decide by themselves because whether to allow their children to use the tablets were dependent on the mothers' decisions. We recognize that it is necessary to consider the mother as an important role in stakeholder analyses.

5 CONCLUSIONS

For enhancing family communication, we advanced the development of the tool in stages. First, we conducted an ethnographic study to understand the users and created the concept of the tool that supports family cooperating work through the UXs including phases of planning, experience, and retrospection. Then, the tool was iteratively prototyped and tested so as to create a tool that enhances family communication by enabling families to share past events and intentions for the future.

In the test on the paper prototype, there were parent-child interactions in the tool. We presumed that the tool was worth developing because participants of the test maintained motivation to use the paper prototype. We embodied the tools as the second prototype, which combines features of a calendar and a photograph album. The second prototype demonstrated usefulness in expressing family intentions and experiences. User comments suggest that the tool is compatible with mobiles. The user can use photos and materials that are selected or gathered with mobiles by utilizing spare times. One of the participants found visually that there had been few events in the past month from the calendar (on which there were many blanks), and was motivated to plan more events in the future. We developed the third prototype by improving the usability of the second prototype and accessibility to past experiences. By using the third prototype, we held a workshop to observe actual usage situation. In the workshop, pairs of a father and child planned family events and made contents of past experiences together by using the third prototype. We identified the user acceptability of the third prototype under temporary use. Moreover, it was suggested that it was essential to arouse the mothers' interests to improve acceptability in the home.

From the series of development processes, we coordinated a user interface through which family members can set plans and share intentions, manage schedules based on them, embed experiences, and retrospect them. We used only qualitative approaches to test prototypes in this paper. In the future, we plan to evaluate the acceptability and usability of the tool especially based on quantitative indicators and criteria (Tullis and Albert, 2013) such as questionnaires and operation logs. Moreover, we conducted user study on limited subjects and conditions. To mention further validity of results, it is needed to increase sample size and test period. Size and composition of a group are also controversial although we focused on pairs of a parent and child in this paper.



(a) Future intentions expressed by images from the Internet. Japanese text written in red lines means "I want to go early."



(b) Emojis inputted from the keyboard function.

Figure 5: Examples of contents created in the workshop.

REFERENCES

- Abdullah, M. H. L. and Brereton, M. (2015). Mycalendar: Fostering communication for children with autism spectrum disorder through photos and videos. In *Proceedings of the Annual Meeting of the Australian Special Interest Group for Computer Human Interaction, OzCHI '15*, pages 1–9, New York, NY, USA. ACM.
- Brown, S. L., Nobiling, B. D., Teufel, J. A., and Birch, D. A. (2011). Are kids too busy? early adolescents' perceptions of discretionary activities, overscheduling, and stress. *Journal of School Health*, 81(9):574–580.
- Brush, A. B. and Turner, T. C. (2005). A survey of personal and household scheduling. In *Proceedings of the 2005 International ACM SIGGROUP Conference on Supporting Group Work, GROUP '05*, pages 330–331, New York, NY, USA. ACM.
- Cao, X., Sellen, A., Brush, A. B., Kirk, D., Edge, D., and Ding, X. (2010). Understanding family communication across time zones. In *Proceedings of the 2010 ACM Conference on Computer Supported Cooperative Work, CSCW '10*, pages 155–158, New York, NY, USA. ACM.
- Crabtree, A., Rodden, T., and Mariani, J. (2004). Collaborating around collections: informing the continued development of photoware. In *Proceedings of the 2004 ACM Conference on Computer Supported Cooperative Work*, pages 396–405. ACM.
- Culén, A. L. and Følstad, A. (2014). Innovation in hci: What can we learn from design thinking? In *Proceedings of the 8th Nordic Conference on Human-Computer Interaction: Fun, Fast, Foundational, NordiCHI '14*, pages 849–852, New York, NY, USA. ACM.
- Dam, E. and Siang, T. (2018). 5 stages in the design thinking process. <https://www.interaction-design.org/literature/article/5-stages-in-the-design-thinking-process>, accessed 12 July 2018.
- Forghani, A., Neustaedter, C., Vu, M. C., Judge, T. K., and Antle, A. N. (2018). G2G: The design and evaluation of a shared calendar and messaging system for grandparents and grandchildren. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems, CHI '18*, pages 155:1–155:12, New York, NY, USA. ACM.
- Frohlich, D., Kuchinsky, A., Pering, C., Don, A., and Ariss, S. (2002). Requirements for photoware. In *Proceedings of the 2002 ACM Conference on Computer Supported Cooperative Work*, pages 166–175. ACM.
- Granovetter, M. S. (1973). The strength of weak ties. *American Journal of Sociology*, 78(6):1360–1380.
- Guy, I., Ronen, I., Kravi, E., and Barnea, M. (2016). Increasing activity in enterprise online communities using content recommendation. *ACM Trans. Comput.-Hum. Interact.*, 23(4):22:1–22:28.
- Heshmat, Y., Neustaedter, C., Yang, L., and Schiphorst, T. (2017). Connecting family members across time through shared media. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems, CHI EA '17*, pages 2630–2637, New York, NY, USA. ACM.
- Inkpen, K., Taylor, B., Junuzovic, S., Tang, J., and Venolia, G. (2013). Experiences2Go: Sharing kids' activities outside the home with remote family members. In *Proceedings of the 2013 Conference on Computer Supported Cooperative Work, CSCW '13*, pages 1329–1340, New York, NY, USA. ACM.
- Lucero, A., Holopainen, J., and Jokela, T. (2011). Pass-them-around: collaborative use of mobile phones for photo sharing. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pages 1787–1796. ACM.
- Lukoff, K., Moser, C., and Schoenebeck, S. (2017). Gender norms and attitudes about childcare activities presented on father blogs. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems, CHI '17*, pages 4966–4971, New York, NY, USA. ACM.
- Maguire, M. (2001). Methods to support human-centred design. *Int. J. Hum.-Comput. Stud.*, 55(4):587–634.
- Neustaedter, C. and Bernheim Brush, A. J. (2006). “LINCing” the family: The participatory design of an inkable family calendar. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, CHI '06*, pages 141–150, New York, NY, USA. ACM.
- Neustaedter, C., Brush, A. J. B., and Greenberg, S. (2009). The calendar is crucial: Coordination and awareness through the family calendar. *ACM Trans. Comput.-Hum. Interact.*, 16(1):6:1–6:48.
- Neustaedter, C., Pang, C., Forghani, A., Oduor, E., Hillman, S., Judge, T. K., Massimi, M., and Greenberg, S. (2015). Sharing domestic life through long-term video connections. *ACM Trans. Comput.-Hum. Interact.*, 22(1):3:1–3:29.
- Nunes, M., Greenberg, S., and Neustaedter, C. (2008). Sharing digital photographs in the home through physical mementos, souvenirs, and keepsakes. In *Proceedings of the 7th ACM Conference on Designing Interactive Systems*, pages 250–260. ACM.
- Oduor, E., Neustaedter, C., Venolia, G., and Judge, T. (2013). The future of personal video communication: Moving beyond talking heads to shared experiences. In *CHI '13 Extended Abstracts on Human Factors in Computing Systems, CHI EA '13*, pages 3247–3250, New York, NY, USA. ACM.
- Pan, R., Forghani, A., Neustaedter, C., Strauss, N., and Guindon, A. (2015). The family board: An information sharing system for family members. In *Proceedings of the 18th ACM Conference Companion on Computer Supported Cooperative Work & Social Computing, CSCW'15 Companion*, pages 207–210, New York, NY, USA. ACM.
- Roy, S. and Bhattacharya, U. (2015). Smart mom: An architecture to monitor children at home. In *Proceedings of the Third International Symposium on Women in Computing and Informatics, WCI '15*, pages 614–623, New York, NY, USA. ACM.
- Thompson, C. F., Goldwasser, E., Stanford, J., Syverson, B., and Haley, K. (2017). Tweaking design thinking

for strategic and tactical impact. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems, CHI EA '17*, pages 1303–1306, New York, NY, USA. ACM.

Tullis, T. and Albert, W. (2013). *Measuring the User Experience, Second Edition: Collecting, Analyzing, and Presenting Usability Metrics*. Morgan Kaufmann Publishers Inc., San Francisco, CA, USA, 2nd edition.

Wilson, C., Brereton, M., Ploderer, B., Sitbon, L., and Siggers, B. (2017). Digital strategies for supporting strengths- and interests-based learning with children with autism. In *Proceedings of the 19th International ACM SIGACCESS Conference on Computers and Accessibility, ASSETS '17*, pages 52–61, New York, NY, USA. ACM.

