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# “Almost Touching:” Parent–Child Remote Communication Using the ShareTable System

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## ABSTRACT

We deployed the ShareTable—a system that provides easy-to-initiate videochat and a shared tabletop task space—in four divorced households. Throughout the month of its use, the families employed the ShareTable to participate in shared activities, share emotional moments, and communicate closeness through metaphorical touch. The ShareTable provided a number of advantages over the phone and was easier to use than standard videoconferencing. However, it did also introduce concerns over privacy and new sources of conflict about appropriate calling practices. We relate our findings to the larger research landscape and present implications for future work.

## Author Keywords

Computer-mediated communication, divorced families, children, tabletop, camera-projector system, home

## ACM Classification Keywords

H.5.2 [Information Interfaces and Presentation]: User Interfaces – *User-centered design*

## General Terms

Human Factors.

## INTRODUCTION

The negative consequences of divorce on parents’ and children’s wellbeing can often be mitigated if the non-residential parent stays instrumentally involved in the child’s life [2]. Kelly & Lamb advise that arrangements should provide “opportunities to interact with both parents every day or every other day in a variety of functional contexts” [22]. This is difficult to achieve for parents and children who live apart, as contact with the non-residential parent decreases dramatically after the first year apart [30].

Non-residential parents sometimes turn to technology to supplement in-person time, a practice known as virtual visitation. As of 2009, six states have passed laws allowing virtual visitation to be incorporated into custody decisions,

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Figure 1. Parent and child using the ShareTable at home.

stating that “technology may be able to help maintain a relationship that would otherwise cease” [31]. Several recent investigations have pointed to the potential of videochat technologies to enrich remote interaction with children by providing a context for the communication and expressiveness (e.g., [3,21]). However despite these opportunities, videochat is problematic for many families because children find it difficult to initiate a videochat session and rarely do so [3] and interaction over videochat is focused on conversation rather than care and play, which are the primary ways children build closeness with their family [9].

This work contributes to the ongoing efforts to address these two challenges by presenting a field deployment of the ShareTable system, which provides easy-to-initiate videochat and a shared tabletop task space for sharing physical objects. We present the results of a month-long field deployment of the ShareTable system in four divorced households. This work has three contributions, emerging from the three research questions that drove our investigation:

- How do families use a system that combines easy-to-initiate videochat and a shared tabletop task space?
- How is such a system different from previous technologies used by these families?
- What social practices and rules emerge around the use of such a system in divorced families?

We begin a brief description of the ShareTable prototype. We proceed with an account of previous related video-

mediated communication systems and investigations of remote parent–child contact. Next, we provide an overview of the study methods. Then, we present the findings of the study in the context of the three research questions above. Finally, we discuss the broader implications of our findings and provide directions for future investigations and design.

### **SHARETABLE SYSTEM**

The ShareTable system consists of two cabinets, one in the home of the parent and one in the home of the child. To make it easy to initiate a connection and to empower the child to connect without help, we use a physical metaphor. To place a call through the system, the user simply needs to open the doors of the ShareTable cabinet. The paired table in the other household rings, as would a phone. Opening the cabinet doors answers the call; closing the cabinet doors ends it. Once a call is connected, the monitor screen of the ShareTable shows a standard face-to-face videochat view (Fig. 1). Additionally, the local table surface of the ShareTable shows a projected view of the remote table surface and vice versa. This allows the system to support the parent and child in shared activities rather than only conversation. For example, the child can draw a cat on her side and the child's parent would be able to draw a hat directly on the head of the projected cat on his table. Since the drawings are aligned and scaled on both tables, both would see the same image of the cat wearing the hat.

The face-to-face video and audio is achieved by leveraging the Skype4COM API to initiate a full-screen videochat session. The ShareTable surface is a C# component that extends the Axis Media Control API to display a processed image of the partner surface. A projector mounted above the table surface provides a 20"x16" projection on the tabletop. The tabletop surface image is captured by a 207MW Axis Camera at 1024x768 resolution and sent directly to the partner table using the Axis camera's internal server. The door sensor that triggers initiation or answering of a call is reed switch on an Arduino board mounted on the cabinet door and a magnet mounted on the table shelf. The technical challenges of this system and employed solutions are described in more detail in previous work [41].

### **RELATED WORK**

In this section, we present relevant video-mediated communication technologies, we discuss the unique characteristics of the parent–child relationship, and we highlight the needs of parents and children in divorced families.

#### **Video-Mediated Communication**

We drew inspiration from the body of research on remote communication in the office, particularly the concept of a media space. A media space is an audio and video connection between two locations for the purpose of maintaining social and work connections. Media spaces have been used since the mid-80s to support collaborations between geographically distributed offices [6]. The audio–video connection can be supplemented with a shared workspace to sup-

port collaboration over documents, data, etc. There are a number of such media spaces which share implementation aspects with the ShareTable, including TeamWorkStation [18] and Videodraw [34].

The PlayTogether system is most similar to the ShareTable in its use of top-down projection for sharing physical objects [38]. Microsoft Research expanded this work into the domain of supporting remote communication between children [42]. Most recently, they created the Illumishare system, which significantly expands on the possibilities of camera–projector-based sharing by creating a robust echo cancellation system usable with any surface [17]. However, all these systems are early prototypes and have only been explored in the lab setting (similar to early investigations of the ShareTable [41]). The ShareTable is the first of such systems to be put in the field and tested with real families.

#### **Remote Contact with Children**

Designing for parents and young children presents unique challenges due to the (1) asymmetry in needs between the parent and child, (2) the challenges posed by the cognitive and emotional abilities of young children, and (3) a greater need for play and care than direct communication.

The parent–child relationship is characterized by asymmetry. Dalsgaard et al. found that the parent carried a greater responsibility for maintaining the relationship by creating a setting for trust and unity, providing care, and participating in play [9]. Children rarely verbally expressed affection and they self-disclosed less than their parents desired. Interviews with work-separated families highlight that parents and children have different emotional responses to separation and technology must balance the disparate needs and motivations of participants to succeed [25,39]. The second challenge is that the child's cognitive and emotional limitations may make long-distance contact difficult. Young children are still developing the communication competencies to participate meaningfully in conversations without shared context [32]. Children also have limited attention resources and motivation for remote contact, so families find it difficult to keep a remote communication session engaging enough to hold the child's attention [5]. The third challenge is that closeness in a parent–child relationship is built more through play and care together than through conversation [9]. Development literature emphasizes the importance of parental involvement in both instrumental care and play activities for secure relationships [22].

A number of systems have been targeted explicitly at supporting remote interaction in adult–child relationships. In eKiss [10] and Collage [36], children could share photos with adult family members to provide a context for later synchronous conversation. Other systems are aimed at supporting remote activities together such as playing games [11,14,25] and reading together [28]. We present a field deployment of a novel synchronous communication system quite different from other field investigations in this domain, in that it is a medium for synchronous communica-

tion that can support a number of different activities, rather than a single activity. We also approach a largely overlooked family context—divorced families.

### Opportunities in Supporting Divorced Families

Two in-depth interview studies with divorced families suggest that members of divorced families balance two major goals: reducing tensions between households and maintaining closeness [27,40]. Children may try to reduce tensions by keeping the details of their involvement with the other parent as private as possible. Parents may seek to reduce conflict by maintaining only minimal contact with each other, respecting each other's autonomy, and minimizing unscheduled interruptions of the other household. However, both of these goals may conflict with the parents' desire to remain aware of the child's everyday activities to provide support and drive conversation. The parent's need to minimize interruption may also clash with the child's goal of achieving spontaneous contact, as it leads to a regimented schedule of interaction with few opportunities for spur-of-the-moment conversation. Both parents and children expressed that they would prefer to stay in touch through something richer than phone conversations, but found that asymmetric rules, technical literacy, and access to infrastructure between households often lead to the lowest common technological denominator. One of the outcomes of this work is a better understanding of these constraints.

### ShareTable in the Larger CSCW Context

The ShareTable represent a long-standing CSCW tradition of taking remote communication from the office into the home space [6]. CSCW explorations of communication in the home center on the ideas of closeness (e.g., [23]) and playful contact (e.g., [33]), both central to the philosophy of the ShareTable design. Our chosen evaluation approach is in line with the typical CSCW epistemological approach of focusing on longer deployments and richer qualitative data gathered from a smaller number of families (e.g., [35]), rather than large-scale quantitative studies.

In its larger scope, this paper contributes to an ongoing CSCW discussion about designing for families [26]. Families are incredibly heterogeneous, so this investigation focuses specifically on divorced families. However, some of the findings may be extended to other forms of separation. Other investigations point out that issues of conflict, control, and motivating communication are not unique to the context of divorce (e.g., [19,39]). Studying divorced families foregrounds these issues that are present in all families but may otherwise not be discussed as primary concerns.

### METHODS

The ShareTable was deployed with two Atlanta-area divorced families (four households) in an A-B design with a two-week pre-deployment and a four-weeks deployment period. The system was evaluated using a mixed-methods approach combining multiple sources data.

### Participants

The two families participating in this study (all names anonymized) were selected through a professional recruitment firm, with a call for divorced families with young children interested in testing a new communication technology. We opted for the benefits of a longer deployment rather than more participants. This allowed us to see use over time and conduct a more in-depth investigation than would have been otherwise possible.

#### Family 1

**Simon** is the 7-year-old son of **Matt** and **Nadia**. Matt and Nadia have been divorced for 5 years and they currently live a 45–60 minute drive apart. Matt and Nadia both describe their current relationship as fairly low-conflict. Matt is recently remarried to **Mary** and lives with Mary and **Jeffrey**, her 3-year-old child from a previous relationship. Nadia is remarried to **Rod** and pregnant with Simon's new half-brother. Simon spends 2–3 nights per week with his father and the rest with his mom. Simon and Nadia communicate almost exclusively by phone. Matt and Simon also communicate by phone, but have recently tried videochat as well. Though Matt has purchased the necessary equipment for Nadia's home, she rarely uses videoconferencing and Matt finds it difficult to do so without her support. In Matt's home, the ShareTable was set up in the living room; in Nadia's home, it was in Simon's room.

#### Family 2

**Taylor** (11, boy) and **Kennedy** (7, girl) are the children of David and Kelly. **David** and **Kelly** have been divorced for 7 years and they currently live 60-minutes apart. Both David and Kelly describe their relationship as fairly low-conflict. Taylor lives with his father, spending alternate weekends with Kelly. Kelly lives with her partner **Jason** and Kennedy. Kennedy spends alternate weekends with David. Taylor and Kennedy spend weekends together. Additionally, David is the father of 2-year-old **Casey**. Casey lives with David's ex-girlfriend but David gets custody every other weekend. Taylor has his own mobile phone and communicates with both of his parents by calling or sending text messages. Kennedy does not have her own phone and Kelly's house does not have a land line telephone, so David usually calls Kelly's cell phone and she passes it to Kennedy to talk. Kelly and David have previously attempted videochat on special occasions, but found that it was too problematic. In Kelly's home, the ShareTable was set up in the children's room; in David's home, it was in the den.

### Procedure

During the recruitment process, we made sure that both sides of the families were interested in participating. At the first meeting, specific consent procedures involved gathering informed consent from each parent, parental consent from the primary parent for each child, and the child's assent to participate. During this process, we described the potential risks and participant rights in an age-appropriate fashion, as approved by our institutional review board. To

protect the privacy of each participant, interviews and questionnaires were conducted separately whenever possible.

During the pre-deployment, we interviewed each family. We spoke to any children over 6 who live in the house, both of the parents, and any cohabitating current partners. The questions focused on current strategies that each family uses to stay in touch and the specific challenges of their arrangement. We asked each parent to fill out a Network of Relationships Inventory (NRI) [15] describing their relationships to their past partner, current partner, and the children participating in the study. We asked each child to fill out a shortened NRI inventory (presenting only one question from each scale of interest) describing their relationships with their parents and any stepparents. For each communication medium that the family used regularly, we asked both the parents and the children to fill out an appropriate version of the Affective Benefits and Costs of Communication Technologies (ABCCT) questionnaire [43]. Finally, we provided each member of the family with a diary and asked them to log any remote contact between the parent and the child. The adult version of the diary asked about the length of the communication, the medium used, and the topic of the conversations. The child version of the diary asked the child to circle or draw the medium used and topic of conversation. Each family kept these preliminary diaries for at least 14 days. We conducted weekly interviews about the provided entries.

During the deployment, ShareTable was installed in each home and the system was introduced using example scenarios. We also explained that the system would log use and record any ongoing calls. However, videos were only stored locally and participants could mark any session for deletion. We asked participants to continue keeping communication diaries and we continued weekly interviews with participants for the next 28 days. Finally, each participant was asked to complete the NRI and ABCCT again.

The two deployments were conducted consecutively since only one pair of prototypes existed. At the end of each deployment, we asked each family if they had advice for the next family who would try out the system, which was a good way for us to elicit best practices. This advice from Family 1 (but no other gathered data) was passed on to Family 2 when we deployed the ShareTable. It was up to the family whether to accept this advice or not (in this case, they did not). This represents an Action Research [37] approach to an intervention. The two case study deployments should be viewed through this lens rather than as tightly controlled studies.

### **Analysis**

There were a number of quantitative metrics gathered through the course of the study: ABCCT responses, NRI responses, and descriptive statistics of log and diary data. Because of the low number of participants in this study, we focus on general descriptive statistics in reporting this data rather than hypothesis testing. There were also numerous

sources of qualitative data in this study: field notes, interviews, video logs, and diaries. These were transcribed and an initial round of open coding and memoing was conducted on all four of these sources of information. We followed the qualitative analysis process described by Seidman to create thematic connections using a data-driven approach [29]. We extracted statements of interest and grouped these together by theme. We conducted three such passes through all of the data, refining the themes with each pass until a set of distinct themes emerged. Though the process was largely data-driven, we were also influenced by the research questions posed at the outset of the study. After conducting the analysis, we grouped the themes by the research question addressed. This is the structure we use to report the results.

### **Limitations**

One limitation of our design is that we were only able to collect self-report data for the pre-deployment communication. This was particularly problematic for the Family 2 who frequently estimated the lengths of sessions. In weekly interviews, we asked the family to specify the length of the session within a range that they thought would definitely include the actual length (e.g., “between 5 and 10”). We use the upper range in the quantitative reporting to not overestimate the effect of the ShareTable on session lengths.

Because the ShareTable is a prototype that combines a number of diverse technologies, it did not work perfectly all the time. In fact, something went wrong in 9 out of the 24 sessions with the ShareTable. These problems included choppy face-to-face video (Skype problems), projector taking more than 3 minutes to start, one of the Axis cameras failing to connect (thus one person could see the other's table, but not vice-versa), and audio being too low. In 3 of these 9 cases, the users contacted us and we were able to correct the system through remote access, but in the remaining 6 cases the families used the system as-is, thus missing out on potential benefits of the ShareTable. Most of these were minor problems and the families still continued using the system. The participants' willingness to put up with system bugs highlights the value that the system provided to their lives, even when everything did not work perfectly.

Finally, as in all such deployments [8], there is a strong potential for the observer effect and demand characteristics to bias the final findings. For example, the parents might feel the pressure to perform as a “perfect parent” for the researcher, thereby increasing the number of communication sessions and changing their content. Brown et al. recommend changes to how HCI researchers conduct field trials to help moderate these effects: diversifying methods, moving beyond success vs. failure analysis, and emphasizing the unique characteristics of each participant [8]. We act on all three of these recommendations in this work.

### **FINDINGS**

Families used the ShareTable to provide a playful context for communication, enable instrumental support, and pro-

vide a virtual meeting place to share moments and affection. It was more effective than the previous technologies used by these families, but structuring social practices around use proved to be a challenge to both families.

### ShareTable Use

The ShareTable was designed to support a number of joint activities by providing both face-to-face video and a shared workspace. We saw use of the system that fell into three categories: (1) creating a playful context for conversation, (2) providing instrumental care, and (3) using the ShareTable as a meeting place for sharing the objects and moments.

#### Creating a Playful Context

Parents and children used the ShareTable to create a playful context for interaction through drawing together, playing around, and show-and-tell.

Drawing together was the most common way that the families in the study used the surface. Frequently, there was a playful and collaborative nature to the drawing, as the remote participant tried to guess what the local participant was producing. Simon frequently leveraged the ability to synchronously share his drawing as it was being created, by asking his father to guess it (video logs are color coded to show remote versus local participants):

*Simon: Awesome! Cool, cool. Look what I drew.*

*Matt: Yeah, what is that? Is that DNA?*

*Simon: No, it's like... Oh wait, it kind of does look like DNA.*

*Matt: That's what I said...*

*Simon: Except there's no lines... Just wait one second...*

*Matt: Yep, there's the DNA.*

*Simon: [Jeffrey], look at my DNA!*

After Matt provided an interesting suggestion, Simon changed his drawing to play along.

Interaction over the ShareTable was inherently playful, however unstructured playful activities were much more common than structured games. The only structured play we saw were four separate examples of playing tic-tac-toe. Other types of play were more focused on playful actions and show-and-tell. Playful actions were frequently spontaneous and child-initiated, such as dancing and playing tag with hands on the table. Parents often became the audience for playful physical show-and-tell activities:

*Simon: Watch my eyes. You ready?*

*Rod: Yeah [Laughs as Simon tries to roll his eyes so that only the whites of his eyes are showing]*

*Jeffrey: Those are zombie eyes.*

The ShareTable became a venue for the child to show off new skills and playact new stories with toys. There were five separate examples of playful show-and-tell, including puppets and showing magic tricks. Most of these examples used the face-to-face video as a primary view, however in two of the cases the tabletop view was used as well to provide the parent with an opportunity to “touch” a particular toy that was being shared. For example:

*Kelly: Where is your baby doll? Or, what's her name?*

*Kennedy: Her name is Daisy ... I'll go get her...*

*Kelly: Oh, there's Daisy! [strokes Daisy's hair on the tabletop] I missed you, Daisy.*

Two examples of playful activities involved mostly audio (e.g., doing funny accents to each other), five involved primarily the face-to-face video (two physical playfulness and three show-and-tell), two involved both the face-to-face video and the tabletop (show-and-tell), and four involved primarily the tabletop (all cases of tic-tac-toe).

#### Providing Instrumental Support

Parents provided instrumental care using the ShareTable by supporting learning and participating in co-parenting.

Parents have frequently described the frustrating interaction of trying to engage in their child's learning experience remotely (e.g., [40]). However, throughout the ShareTable deployment, we saw several examples of parents engaging with their child's learning experience. For example, Simon and his mother practiced math problems remotely:

*Nadia: Good job! Let me give you one.*

*Simon: Give me a math problem I'll write it.*

*Nadia: OK. [Writes on the table]*

*Simon: It has to be a big one.*

*Nadia: It's a plus. [Waits for him to write out the answer]*

*Nadia: That's right, Babbo. Good job!*

However, only two examples of supporting learning leveraged face-to-face or tabletop video. The other three involved only audio: a question-answer session, a quiz, and practicing singing a song in a foreign language.

We did not see explicit homework help activity, though this activity was compelling to the parents in this study:

*I especially want to use it to go over homework. I feel like the other house has been slacking and [Simon] hasn't been keeping up with it. I'd love to look at the homework and get him to practice his spelling and all that. -Matt*

One aspect of the system prevented this from being a more common activity—the participants found it difficult to read small text over the surface of the table. Though we did provide 1024 X 768 resolution for the surface (best possible under bandwidth constraints), this was barely good enough for 16-point text and impractical for anything smaller. Though most of the younger children's worksheets were viewable, it was straining and much more practical for these families to defer this task until they could be together.

Parents used the ShareTable to practice co-parenting and care activities. Co-parenting is a term to describe the activity of parenting together, when both of the parents provide care and discipline to the child [12]. This is seen as a particularly rare occurrence in divorced families, where the most common approach is “parallel parenting” (dad's house, dad's rules; mom's house, mom's rules) [1]. However, we saw several examples of co-parenting in the ShareTable video logs. For example, David and Kelly collaborate to

convince Kennedy to clean her room after David sees its state over the ShareTable face-to-face video:

**David:** *You need to clean your room, princess!*  
**Kelly:** *Yeah, she needs to give away to feel better. She needs to go through her room today and pick some toys to give away. Otherwise, Santa won't have any room, right?*  
**David:** *Yes, I'm going up there to inspect your room and if it isn't clean, it's not a good thing.*  
**Kennedy:** *Okay, okay, okay...*  
**Kelly:** *But you don't mind right, [Kennedy]? You don't mind giving away some of your toys to those in need to make room for some new ones, right?*  
**Kennedy:** *No, I don't.*

There were four other examples of both parents parenting together from throughout the course of the logs. There were also seven additional examples where one parent remotely provided instrumental care for the child, for example:

**Kelly:** *Oh, hey, let me see. Are all of your teeth still there? Yeah? Okay, just making sure. Are you brushing them?*  
**Kennedy:** *... Umm ...*  
**Kelly:** *[Kennedy], you gotta brush those nasty teeth! ...*  
**Kennedy:** *I'm gonna brush my teeth today.*  
**Kelly:** *Okay, that's a great idea.*

Interestingly, children felt confident in turning to a remote adult to resolve a local situation. For example, when Jeffrey tries to take the markers from Simon's table:

**Simon:** *No, give back the markers! [wrestling over them] [Rod], can you make him give me? [looks at Rod on screen]*  
**Rod:** *Play nice and share half of them, okay?*

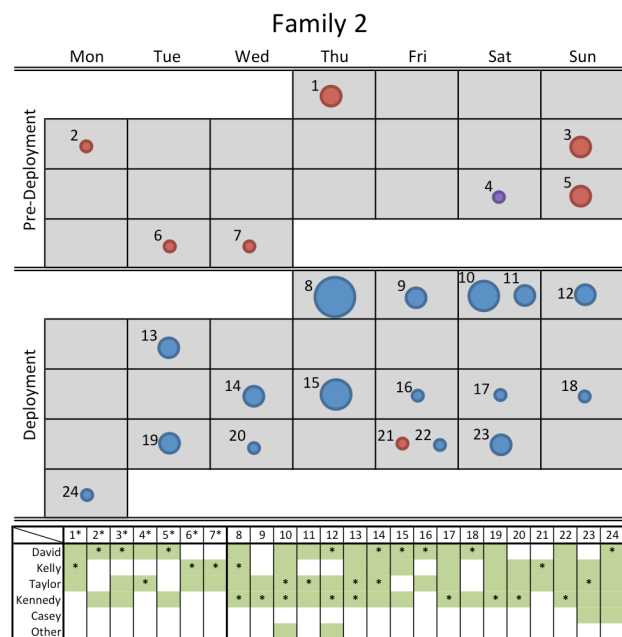
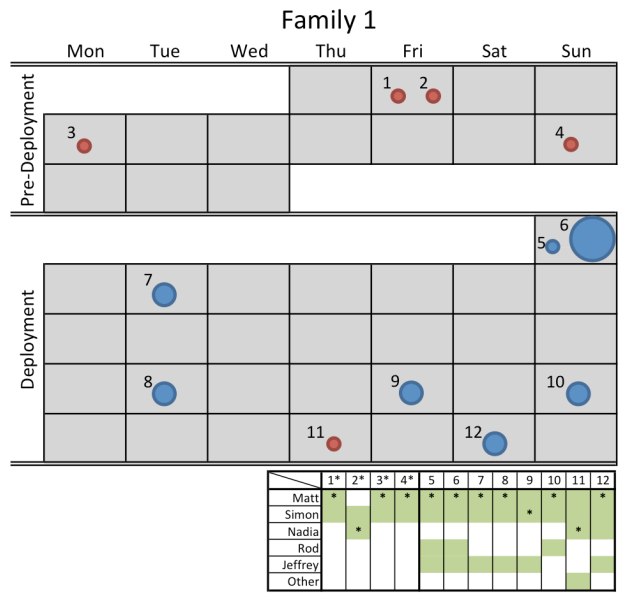
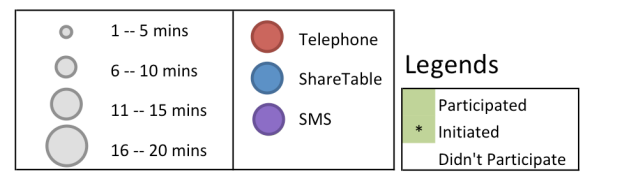
It was encouraging to see that co-parenting and care interactions were possible and common over the ShareTable.

### ShareTable as a Meeting Place

The ShareTable became a metaphorical meeting place where physical objects, special moments, and physical affection could be shared.

One aspect of being a child from a divorced family is having two homes with two mailing addresses and two distinct locations for all of your physical belongings [27], so mail became a common object to be shared using the tabletop surface. Matt shared a card from a grandparent with Simon using the ShareTable system. Thus, the card could be shared on the appropriate holiday, rather than waiting for the next in-person visit several days later:

**Matt:** *Grandma sent you a card, actually, a Halloween card. Do you want to wait or do you want me to open it?*  
**Simon:** *Open it!*  
**Matt:** *"Cooked up these happy wishes, especially for you. Because it's that time of the year, when you send a happy boo. Happy Halloween, Love Grandma & Grandpa." See? Look!*  
**Simon:** *Cool!*  
**Matt:** *And, you get to see this ... this is also in it.*  
**Simon:** *Oh, a check! How much is it?*  
**Matt:** *Grandma and Grandpa sent you a \$5 check!*



**Figure 2. Specifics of each remote communication session in families 1 and 2 before and during the deployment. Medium is specified by color, length of session by size. Session labels in calendar figure correspond to columns in participation tables.**

One benefit of the ShareTable over holding an item up to the face-to-face camera is that the object can remain on the table for the duration of the conversation. This particularly worked well for Family 2, where interactions typically involved three or more people at the same time, tended to get hectic, and a shared item would otherwise be overlooked:

*Kennedy: Look at what daddy did to my nails? [puts her hands on table, while about 5 minutes of other conversation passes between Kelly and Taylor]*

*Kelly [looks down]: Oh my god! Your nails! [points to Kennedy's hand] ... Are these your nails, these long ones?*

*Kennedy: No, they're fake. Dad put them on.*

In the logged videos, there were three cases of mail being shared, two cases of showing toys and games on the surface, and two cases of schoolwork being shown.

Family 2 frequently used the ShareTable to share special moments and everyday life. Several times, the father would call the children over the weekend before a sports game that all three of them were planning to watch. Even though the ShareTable was not used during the actual game, the father found this to be a compelling interaction:

*We ended up talking around noon and before the game. So, that was almost like we were watching together! -David*

The father's communication with the children in Family 2 was generally spontaneous. As such, the children frequently included him in whatever they were doing, rather than interrupting their activity to talk. In one moment, Taylor shares playtime during a friend's visit, while Kennedy narrates:

*Taylor: Look, this is a game that me and [my friend] made up... [Taylor and his friend tackle each other]*

*Kennedy: Look. It's so funny! They tackle each other as boys.*

*Taylor: Then we start punching each other! [laughing]*

Family 2 celebrated Christmas towards the end of the deployment period. The ShareTable became the medium for the children to share the excitement of the moment and show off their newest presents to their father. Overall, sharing the moment occurred more in the second family than in the first, because the former incorporated spontaneous messaging into their practices with the ShareTable. In the first family, Matt attempted to initiate similar sessions (e.g., calling late on Halloween hoping to see the candy that Simon received during trick-or-treating), however all spontaneous connections were usually rejected by Nadia.

The most common type of interaction with the ShareTable focused not on a specific activity or topic, but rather on building closeness and communicating love through metaphorical touch. Perhaps the best example of this type of interaction was Kelly talking to Taylor while he was sick:

*Kelly: What's going on, baby?*

*Taylor: Well, my throat is acting up...*

*Kelly: Awww, well take care of yourself ... what else is wrong, sweetheart? ... You look like you're really sad, honey!*

*Taylor: I just don't feel good.*

*Kelly: All right, well listen. I love you ... Do you see my hand, holding on to your hand? [Strokes his projected hand]*

*Taylor: Yes, I do.*

*Kelly: I love you, baby.*

*Taylor: I love you too, mom.*

*Kennedy: Hey, Bubba. [Also puts her hand on the table]*

*Kelly: There's my hand. Keep your hand in there, we're going to do a family handshake, okay? [Kelly, Kennedy, and Taylor move their hands on the table together]*

Family 1		
	Pre	Deployment
Avg. Mins/Week	5.25	17.50
Avg. Session Mins	2.63	8.75
Avg. Sessions/Week	2.00	2.00
Initiated by Child	0%	12.5%
Family 2		
	Pre	Deployment
Avg. Mins/Week	14.98	33.67
Avg. Session Mins	7.50	7.35
Avg. Sessions/Week	2.00	4.58
Initiated by Child	14.3%	64.3%

**Figure 3. Aggregate session characteristics data.**

The face-to-face video was key to Kelly noticing that Taylor may have been more sick than his voice sounded, but it was the ShareTable surface that allowed her to act towards him to convey emotional care through “physical” touch. All in all, there were 20 separate examples of metaphorical physical touch interaction in the video logs. Most of these were fairly brief kisses or hugs towards the end of the conversation. However, four separate cases were longer interactions as the one above and involved the table surface.

### Comparing ShareTable to Previous Technologies

One goal of this investigation was to understand how the ShareTable was different from other communication technologies routinely used by the families in the study.

### Participation in ShareTable Use vs. Previous Technologies

In the pre-deployment phase, we asked the parents and children to keep diaries of remote communication. Family 1 collected four diaries over the course of 14 days. All four described telephone calls. Family 2 collected seven diaries over the course of 21 days (the extra week of pre-deployment was due to a delay in getting the ShareTable installed). Six of these described phone conversations, while one described an SMS exchange. Both families continued keeping communication diaries during the deployment. Family 1 recorded eight conversations in a 28-day period, with seven of those being over the ShareTable. Family 2 recorded 17 conversations in a 26-day period, with all but one of those using the ShareTable. Figure 2 shows the specifics of each communication session before and during the ShareTable deployment. It is important to note that children initiated a greater proportion of conversations during the ShareTable deployment, ShareTable sessions generally involved a greater number of participants, and more time was spent communicating using the ShareTable than previous technologies. Figure 3 shows the overall statistics of the amount of time each family spent communicating, showing the weekly average for each family increased more than two-fold.

### Effect on Relationship Quality

We asked each parent and child in the study to complete a Network of Relationships Inventory [15] before and after the deployment. The NRI uses a five-point Likert scale,



asking the participant to evaluate different aspects of various relationships. Here, we highlight those aspects that changed by more than 1 point before and after the deployment, but all findings are displayed in Figure 5. The most striking changes can be seen in Taylor's inventory, which reported a more supportive relationship with his mother and a less antagonistic relationship with both his mother and father. In interviews he reflected that much of the antagonism was previously due to the fact that he did not call enough—an issue eased by the ShareTable. Kelly (Taylor's mom) reported a greater sense of intimacy with him after the deployment. The ShareTable also seemed to have the same effect on David's relationship with his daughter. Family 1 reported fewer changes on their NRI. Simon reported a higher level of satisfaction in his relationship with his father, but no other positive changes. There was a negative change that Nadia reported in her sense of reliable alliance with Matt. It seems that the table did introduce some conflict for this family that was captured by the NRI. Overall, the ShareTable may have contributed to some positive relationship outcomes for both families, though also some potentially negatives ones for Family 1. We emphasize that the quantitative findings are meant to be used to corroborate the qualitative findings, not to make broad generalizations about all families. Additionally, small changes should be treated conservatively as they can represent natural variation rather than an actual difference between pre and post measurements.

#### Comparison with the Telephone

The families in the study were aware of the challenges of using the phone to talk to a child even at the onset of the study. As David said, “the phone is really too short and it's so easy to get distracted and want to go do something else.” This is consistent with findings from previous investigations (e.g., [5]). However, these families also faced additional challenges due to tensions introduced by divorce:

*[Kennedy] doesn't have a phone and her mom doesn't have a landline, so I really have to call [Kelly] to talk to [Kennedy]. And that's awkward and I really can't even call every day and even when I do, it's for about 5 minutes, no more. -David*

*[David] can be really a [problem] about it ... He wasn't picking up and [Taylor]'s phone was turned off or dead or whatever so I had no way of contacting him. -Kelly*

One contribution of this work is pointing out the specific factors that may make the phone less effective than the ShareTable. Figure 4 presents the results of the ABCCT questionnaire comparing the phone and the ShareTable. Overall, the ShareTable scored higher on each measure of benefit and lower on all but one measure of cost. Of most significant note, the ShareTable created fewer unwanted obligations to communicate, supported greater emotional expressiveness, more engagement & playfulness, and a greater sense of connectedness outside of the actual interaction (presence-in-absence) than the phone. These findings were also confirmed in the interviews:

*Just in general, having the interaction is better. It's more fun and more like just killing time together ... It definitely makes it easier to keep it engaging for more than five minutes. -Kelly*

However, not all comparisons between the phone and ShareTable were favorable. In particular, the ShareTable introduced additional privacy concerns and did not provide the flexible mobility of a phone.

#### Comparison with Videochat

A previous investigation has compared the ShareTable to videochat in the lab [39]. However, in the field, the main difference between the ShareTable and videochat was that the first was used while the second was not. Though both of the families in the study reported trying out videochat, neither family used it routinely and not a single pre-deployment diary from either family described a videochat session. The father from Family 2 articulated the problem:

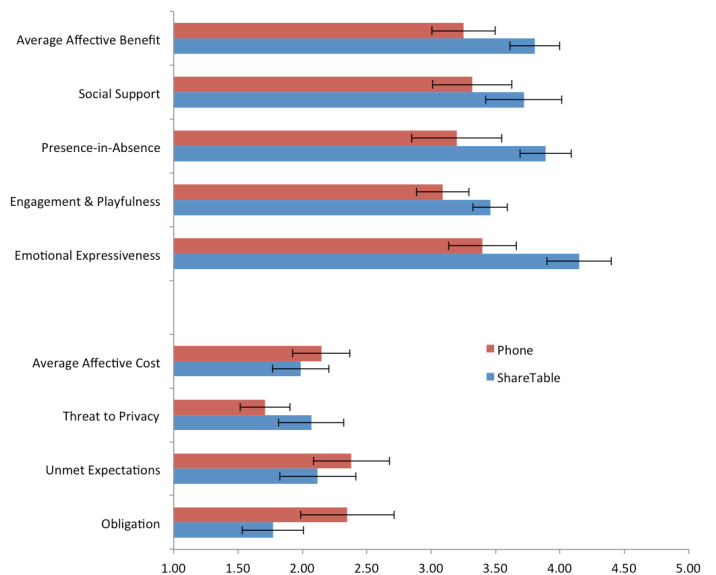
*Video is nice, but getting it to work wasn't worth it ... we spent an hour and a half setting up a call, which lasted five minutes. It gets to the point when it's not worth it. -David*

It seems that without an easy way to initiate and answer a connection, videochat was simply not a usable solution for these families. In fact, these results are consistent with findings from other studies, which show that only some families who try videochat use it routinely (e.g., [39]). This was confirmed by the extremely positive feedback from families about the physical metaphor of interacting with the system. For example, Kelly stated:

*I think the biggest thing is just being able to just open the doors and connect. We don't have to log in or anything. It's just already there. -Kelly*

Additionally, interviews revealed that participants saw the surface as a significant component of the interaction that was different from the previous technologies:

*It really added an extra depth dimension and another layer to*



**Figure 4. Results of the ABCCT questionnaire from 4 parents and 3 children in the study. Overall, ShareTable provided greater benefits but lower cost (except on the privacy scale).**

the experience. I was surprised by how different it was from trying to do an online white board together. -Matt

The table itself ... there's just something about it, when you put your hand there and your daughter puts her hand on top, where you feel like you're almost touching. It's like, now I know why you called it the ShareTable. You really feel like you're sharing the moment. -David

Overall, participants recognized the ShareTable as a compelling medium and almost all parent-child communication during the deployment occurred over the ShareTable.

### Social Practices around the ShareTable

During the four-week deployment, participants reflected on their experience through weekly interviews. These results provided insights into the rules and practices that emerged around use of the ShareTable system.

A big concern with the ShareTable was that remote contact might interrupt routines in the home:

If his dad calls, that just kind of means that [Simon] has to disengage from us in order to engage with his dad. -Rod

In Family 1, all contact was preceded by a telephone call to the mother to make sure that no household routines would be interrupted. Even when a ShareTable call was planned and a ShareTable connection was established, there were several times when the collocated parent decided that it wasn't a good time to talk:

Matt: I didn't get you guys at a bad time there?

Nadia: Well, I mean. Normally, we're at the church at this time but we're really busy today, so ...

Matt: Oh, all right ... Well, I'll catch you later.

Nadia also cited concerns over interrupting the other household as the main reason she kept contact with Simon to a minimum while he was visiting his father:

I didn't use it that much and that was mostly because I feel

guilty using it. We have [Simon] the majority of the time, so when he's at [Matt]'s, I want to respect that and give them time to be together. -Nadia

By contrast, in Family 2, the remote parent prioritized continued contact over the worry of interrupting the other home. While this did lead to more frequent use of the system, it also created conflict as routines were disrupted:

I did end up calling too early. You'll see mom yelling in the video because I called too early. -David

Neither arrangement was ideal for both households.

The ShareTable introduced a new source of conflict over appropriate practices around communication. One disagreement focused on the placement of the system:

I feel like right now, [Simon] would have to be in his room to hear when I call [Nadia's house]. Here, it's set up in a public space, so one of us hears it and lets him know, but there, unless he's in his room, I have to call first. -Matt

I'd say that it needs to be in a private room, especially if the divorced parents don't get along as much as we do. -Nadia

If I had known that this would be the outcome of putting it in [Taylor]'s room—that [David] feels like he can call night and day—I would have probably put it in the living room so that I could have more control over when it gets used. -Kelly

David was the only parent happy with the system's placement; all others thought that the ShareTable would be better in a different location. However, the general requirements of each parent are not contradictory. The ShareTable should be in a location where: (1) the child can hear it ring, (2) the privacy of the others is respected, and (3) parents have an appropriate amount of control over its use. However, families had trouble deciding on the appropriate amount of use.

In both families, the arrangement that was established did not work well for one of the parents. In Family 1, the dad had to call the mom ahead of time. This worked for Nadia,

	↑ Mother Simon	↑ Mother Father	↑ Mother Step-Father	↑ Father Simon	↑ Father Mother	↑ Father Step-	↑ Simon Mother	↑ Simon Father	↑ Father Kennedy	↑ Father Kennedy	↑ Mother Kennedy	↑ Father Kennedy	↑ Step-Father Kennedy	↑ Mother Taylor	↑ Mother Father	↑ Mother Step-Father	↑ Taylor Mother	↑ Taylor Father
Support	-0.7	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	1.0	0.7	0.0	0.0	2.0	-1.0
Criticism	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	-1.0	-1.0
Satisfaction	0.0	0.3	0.0	-0.7	-0.3	0.0	0.0	1.3	0.7	0.0	0.0	0.0	1.0	0.7	0.0	-0.3	0.0	0.0
Companionship	0.0	0.0	0.0	0.3	0.0	0.7	1.0	0.0	0.3	0.0	0.0	0.0	0.0	1.0	0.0	0.0	-1.0	1.0
Conflict	0.0	0.0	0.0	-0.3	-0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Instrumental Aid	-0.3	-0.7	1.3	-0.3	0.0	0.7	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.3	0.0	1.0	1.0
Antagonism	0.0	0.3	0.0	-0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	-3.0	-2.0
Intimacy	-0.3	-0.7	0.0	-0.2	0.0	0.0	0.0	0.0	2.2	0.5	0.0	1.0	1.0	1.2	0.5	1.7	0.0	-1.0
Nurturance	0.0	-	-	-0.3	-	-	-	-	-0.3	-	-	-	-	1.0	-	-	-	-
Affection	0.0	0.3	0.0	-0.3	0.0	0.3	0.0	0.0	-0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0
Admiration	0.0	-0.7	0.0	-0.3	0.7	0.3	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.3	-0.3	-1.0	1.0
Relative Power	-	0.0	0.0	-	-0.3	0.0	-	-	-	-0.3	-	-	-	-	-0.3	0.0	-	-
Reliable Alliance	0.0	-2.0	0.0	-0.3	0.0	0.0	0.0	0.0	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	0.0	0.0

Figure 5. Differences in scores on each of the NRI scales, changes greater than 0.5 are highlighted (beneficial in green, detrimental in red). Children were asked to answer the NRI about each adult that they described as “part of their immediate family.” The adults filled out the NRI about the non-residential/equal-custody child, their current partner, and the former partner. The “Nurturance” scale was only given to parents to describe relationship with child. The “Relative Power” scale was only given to adults to describe relationship with other adult members of the family. Small changes should be interpreted conservatively as they may show natural variation rather than an actual change in status.

but curtailed available communication time for Matt:

*We really try to think about it and arrange communication with the other person in mind. That's why [Matt] always messages me before calling—to make sure he's not interrupting anything.* -Nadia

*I think that the biggest problem ... was actually the social coordination aspect of it. It seemed like it was really hard to get on. I always tried to call [Nadia] first or at least text or something to let her know what I'd be trying to ShareTable later, but that didn't always work.* -Matt

At the end of the study, we asked Nadia and Matt if they could recommend a better arrangement for the next family who would use the ShareTable. Both agreed that an ideal arrangement would be a set time every week to call.

This suggestion was passed on to Family 2 before the ShareTable was deployed. Family 2 tried to heed this, but got in the habit of calling spontaneously instead. This arrangement worked for David but not for Kelly:

*Well, I'd say that our arrangement worked really well. We didn't really have a set time, but I could hear the ShareTable anywhere so the kids could just call any time.* -David

*If you leave it up to a child or the dad, they really just go "Ahhh!" and use it all the time. Sometimes it felt like it was like "Enough calling! He just got to my house!"* -Kelly

After the deployment, Kelly and Taylor both agreed that an arranged time would have served the family better. However, David and Kennedy maintained that the existing way worked well. Unfortunately, the ShareTable can only work in the long run if all can agree on acceptable practices.

## DISCUSSION

We provide some implications for design and consider the ShareTable deployment in the context of previous work.

### Implications for Design

There are three lessons from the ShareTable that could be beneficial to other communication systems for families.

One of the big factors that contributed to the ShareTable's use was that **the connection was easy to initiate**. There was no log in screen, no user list, and no way to contact the wrong person. This allowed children initiate sessions without help. While ethnographic studies have acknowledged the difficult "work" behind videochat [3], most studies of communication technologies have not addressed this issue. In field studies of such systems, the issue has been avoided through always-on connections (e.g. [20]) or by assuming that a parent will help set up the session (e.g. [28]). Neither is a reasonable solution for divorced families. Simplifying the process of initiating a session may be beneficial to use.

Second, the ShareTable was more engaging for families than previous communication mediums because **communication focused on activities rather than just conversation**. The parents described that previous communication was characterized by the brevity of each session. Sometime

after a few minutes of conversation, the parent would run out of questions and the silence would become uncomfortable. With the ShareTable, we saw these silences becoming opportunities for the children to invent activities, show-and-tell with new toys and skills, or simply hold hands and feel together. While the ShareTable allowed these activities to incorporate physical objects, digital sharing may provide similar benefits to remote parent-child interaction.

Third, one of the most valuable aspects of the ShareTable was that **presenting overlapped video of the local and remote spaces** supported emotional interactions, such as holding hands. In fact, there is something powerful about *sharing* the video space rather than a standard videochat window-in-window view. Other studies have noted the power of a shared video arrangement for creating a feeling of shared narrative [13] and for simplifying perspective taking on the part of the child [42]. In this study, we saw another benefit—this arrangement created a greater sense of closeness and a good metaphor for physical touch. Even though the ShareTable is quite different from the remote touch technologies considered in the HCI domain (e.g., [7]), it was successful at conveying an emotionally-meaningful sense of physical touch. In fact, a camera-projector system is not required to create this sense. Simply displaying the participants at the same scale on the screen, subtracting the background, and overlapping the video would let participants give virtual high-fives or even pick each other's nose.

In our future work, we will leverage tablet devices to take these lessons to a platform that can have wider penetration than a custom-built piece of furniture. All three of the lessons above can be integrated into an application. Though such an application will more likely focus on sharing digital rather than physical objects and experiences, comparing the ShareTable deployment with that of an app may help us understand the relative importance of this aspect of the system. Additionally, due to the relative ease of deployment of such an app we may be able to gather a larger number of participants and systematically vary the integration of each of the three lessons about to understand their relative importance to the family's experience (e.g., easy to initiate + built-in activities, but no overlapped video space).

### ShareTable in Context of Existing Theories

Video media spaces have had a long history of exploration in the work place [6] and several CMC theories point to videochat as an appropriate medium for family communication. Media Richness Theory emphasizes that ambiguous and uncertain tasks require more immediate feedback, more cues for communication, and more emotional awareness. Remote parenting is certainly an example of such a task. Social Presence Theory suggests that video affords social awareness of the partner's state in a way that is more similar to in-person interaction than other media, and thus may be better at supporting tasks that are usually carried out in-person. However, there is significantly less theoretical grounding to consider the role of multiple streams of video

on the richness of the interaction. Empirical work in the workplace highlights that videos of the collaborative task space and videos of the larger context of the remote room may often be more useful to remote participants than the face-to-face video view [16]. However, in this investigation we found that families interweaved use of the face-to-face and the tabletop video for each of the three major categories of their activity over the table. Both types of video contributed significant value to the participants.

### Control and Conflict

Though the HCI community has been exploring technologies for divorced families through interview studies (e.g., [27]) and including divorced families in deployments (e.g., [10]), generally most deployments focus on more amicable types of distributed families. This study may provide insight on how communication technologies are adopted in situations where privacy and control may be of paramount importance to users and conflict is a fundamental aspect of the relationship. The idea of designing for conflict or disruption is an important thread within CSCW [24] and this work contributes to the conversation.

The ShareTable became a meeting place, essentially making the room where it is placed part of both the local house and the remote one. It may be hard for family members to develop practices around such a “cybrid misfit” [4]. For preserving privacy, the most likely place for such meeting place would be in the child's room. However, in order for it to work well in that setting the families still need to develop a reasonable agreement about appropriate times for calling.

In this study, parents struggled to control the amount of remote contact with the child. Too much remote contact interrupts household routines and takes time away from interacting with the local parent. Too little remote contact cuts the parent out of the life of the child and does not provide the remote parent with opportunities to share in the joys and burdens of childrearing. The two deployments represent two contrasting cases: one where the local parent limited the interaction considerably and another where the remote parent's spontaneous contact became a point of conflict. In both deployments, one parent ended up feeling slighted by the adopted practices. In the end, use of the ShareTable and similar technologies should be treated as a “virtual visitation” practice [31]. As such, decisions over its use need to be made explicitly and potentially with the help of a court-appointed counselor who can advise the parents in an objective manner. As it was, the ShareTable did introduce additional conflict into the lives of the families in the study. However, in the end, none of the four households rejected the technology. In fact, the ShareTable became the medium for almost all parent-child communication throughout the deployment. The benefits of this technology were seen to outweigh the costs introduced by increasing tensions over appropriate practices around its use.

### CONCLUSION

We deployed the ShareTable with two divorced families for four weeks each. Remote communication more than doubled for these families while using the ShareTable and we saw an increase in the number of communication sessions initiated by the child. The ShareTable provided benefits over previous communication systems and supported activities that are impossible with other currently available technologies. One of the biggest successes of the system was in providing an overlapped video space that families appropriated to communicate metaphorical touch and a sense of closeness. However, the ShareTable also introduced a new source of conflict for the divorced parents and challenged the families as they tried to develop practices of using the system that would be acceptable to all involved. The families' experiences with the system and approach to these challenges inform future directions for investigation and design of communication systems for separated families.

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