The Effect of Signal Expense and Dependability on Family Communication in Rural and Northern Canada

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ABSTRACT

Family communication and technology designed to support it is a widely studied topic. However, most research that focuses on family communication in North America tends to assume high degrees of connectivity and Internet access. We present a study of family communication practices in rural and northern areas of Manitoba, Canada where Internet connectivity is intermittent or severely limited in some communities. Our results show the ways in which individuals stay connected with outside relatives can be hampered by communication infrastructure challenges. In particular, these challenges can dictate how, where and how often conversations with loved ones take place. Our results also indicate that these experiences, many of which are negative, can create lasting impressions that may be difficult to alter as infrastructure improves. This suggests opportunities for designing family communication technologies for outdoor locations with better connectivity, scheduling communication during times with better connectivity, and combating social isolation.

ACM Classification Keywords

H.5.3. Information interfaces and presentation: Computer Supported Cooperative Work; H.4.3 Communication Applications

Author Keywords

awareness; family communication; ict4d; mobile devices; rural environment

INTRODUCTION

Family members have a natural desire to stay in touch with one another when they are separated by distance [23, 31, 33]. This allows them to stay aware of what others in their family are up to, coordinate shared activities, and, feel close and connected to one another [23, 33]. We also see systems being designed to support family communication, including

video communication systems [1, 17, 18, 19, 38], photo-sharing applications [4, 22], and messaging systems [11, 14]. Yet the reality is that most of this research focuses on family communication practices and technology design in areas of the world that contain rich technological infrastructures. This means that family members can typically easily stay 'connected,' if they so desire.

There also exists a growing amount of research on communication practices in developing countries where technology and connectivity is more limited. This research shows the ways in which family members still manage to stay connected with one another using only 'basic' forms of technology available. For example, research shows a heavy reliance on mobile devices, phone sharing, and the use of intermediary family members to pass on messages (e.g., [26, 27, 35, 36]).

In contrast to these two settings, our work focuses on family communication in rural communities *within* a developed country—in our case, Canada. Specifically, we investigate family communication practices in rural and northern regions of the province of Manitoba that are relatively 'unconnected' with the rest of the country because of a lack of technological infrastructure and, in some cases, their more isolated location.

We conducted an exploratory study involving in-depth semi-structured interviews with people living in these areas. Our goal was to learn about the communication practices of families with an emphasis on understanding how the difference in technological infrastructure affected communication practices. We also wanted to understand how family communication routines in this area differed from more developed regions of the country that contain nearly instant access to technology and connectivity.

To foreshadow, our results show that families in the rural and Northern communities we studied have a strong desire to maintain relationships with their geographically distributed relatives, with an emphasis on staying current with each others' general well being. Participants' choice of communication tool, however, was rarely based solely on preference. Participants frequently considered anticipated incurred costs, either for themselves or their family members, and reported having to work around poor connectivity by changing the location, communication frequency and conversation format (e.g., often having to

rely on short text messages). At times, these struggles led to diminished contact and closeness with family members, and created lasting negative impressions of media-rich tools. Together, these results suggest future design directions that are aware of and help families mitigate connectivity challenges, as well as those that foster closeness when only low-bandwidth communications are possible.

RELATED WORK

Family Communication in Developed Countries

Research in HCI has a strong history of studies on families, their domestic routines, and how family members communicate with one another over distance. Research on family communication practices in technologically-developed areas of Canada found a strong need to stay connected with family members, but the level of connection varied based on the closeness of the relationships [23]. Regardless of the relationship, people wanted an awareness of the location, activities, and well-being of the person [23]. Thus, conversations were often tied to details about 'how one was doing,' sometimes in a very casual manner [23]. When technology was used to mediate relationship and enable communication over distance, people were very good about knowing which technology to use to most easily reach a friend or family member [23].

Tee *et al.* [33] conducted a similar study of family members in the United States and found that some people desired to have more contact with certain family members than they were able to achieve. This was because of busy schedules or the lack of technology usage by some extended family members [33]. People also did not want to feel obligated to contact family members if they were already too busy [33]. Romero *et al.* [31] studied family communication in the Netherlands and found that people disliked feeling obligated to communicate and had a preference for targeted, in-the-moment communication.

Research has also explored technologies that families use to aid communication. A general trend is to try and connect people with increasingly higher-fidelity mediums (e.g., video chat) and increased bandwidth [1, 17, 18, 19]. This is because family members typically feel closer to their remote loved ones when they can actually see them over systems like video chat [1, 17, 18, 19]. Young children are also more likely to understand communication mediums such as video chat, since the medium is most similar to face-to-face situations [3, 10]. Other technologies like the telephone can be challenging for them to use [3, 10].

We also know that synchronous communication exchanges are not without their challenges. Families often have difficulty scheduling video-chat calls, especially when time zones come into play, and must instead rely on asynchronous communication technologies at times [6]. In cases of health issues, people sometimes prefer simply talking on the phone [29]. This reflects the connection felt by hearing someone's voice, and also a desire to hide one's appearance if in diminished health [29]. Social media sites

such as Facebook are also increasingly being used by people to connect with a broad range of family members and friends [5, 15]. This allows them to 'keep up' with the happenings of others [15] and strengthen their relationships [5]. Prior research has also examined infrastructure-related challenges that families in urban centres can face when communicating with video-based technologies, such as video distortion (e.g., [1, 30]).

Other research looks at the design of research prototypes to support family communication. The aim of these systems is to promote awareness and connectedness between distributed family members [11, 18, 20, 22]. These systems typically focus on the exchange of pictures or textual messages between family members via mobile devices [24, 31] or special-purpose digital frames [18, 20, 22]. Systems have focused on a variety of family relationships ranging from parent-child interaction over distance [38], to the connection of adult children with their elderly parents [22]. There have also been systems designed to provide next-generation video connections between family members [17, 38] where video links can be left going for extended periods of time, if desired. Finally, there is a desire to make family communication 'fun' by encouraging playful interactions [20]. Again, all of these systems rely on nearly instantaneous access to the Internet where people can share information with family members in-the-moment. Little consideration is paid to situations where Internet connectivity may be intermittent or non-existing.

Melvin and Bunt [21] studied the use of communications technology in the same region of rural Canada as reported in this paper. The focus was on workplace communication, however, many people intertwined work and family life. Findings showed that people often needed Internet access for work activities in areas outside of work offices and work hours. They developed unique workarounds for gaining connectivity, including driving out of one's way for cellular service and choosing asynchronous technologies instead of synchronous ones. The authors suggest designing tools that provide feedback and awareness of connectivity levels.

Family Communication in Developing Countries

Research has also explored family communication in developing countries where technology and connectivity is less prevalent. Studies of developing countries have shown heavy reliance on mobile phones for connecting with family members given their low cost [13, 26, 27, 35]. For example, in studies of family life in Jamaica, researchers found that people communicated with clusters or small groups of family members using mobile phones [12]. A large focus was on communication around familial support for economic activities [13]. In El Salvador, mobile phones were shown to be used by family members to exchange information and advice about kinship [34].

Studies of technology usage in Kenya, Africa, again, illustrate a focus on mobile phone usage when it comes to family communication using technology [26, 27, 35]. Here

Figure 1. A partial map of Canada illustrating the two locations in our study. The North-most marker represents Gillam, whereas the Southern marker represents RM Roblin.

we learn that technology-based family communication often focuses around discussing support for economic activities [26, 27, 35], providing life guidance, and coordinating everyday activities [26, 27]. Technology usage is affected, however, by a lack of electricity, the costs of calling, gender, and whether or not one is an eldest child in the family [26, 27]. Mobile phones are often shared amongst family members who live in the same village setting [27]. To reduce communication costs, communications may be pre-planned [37] and activities such as 'beeping' are used [35]. We also know that despite the limited technologies available in countries like Kenya, many companies continue to design for 'advanced smartphones' [36].

Of course, we recognize that there are large differences in culture and the level of development between the regions we have studied as compared to that of many developing countries. Canada is considered a first world country (despite many rural regions experiencing infrastructure challenges) whereas many of the developing countries described above would still be considered 'third world countries.' Despite this, we feel findings from prior work in developing regions present an interesting backdrop for understanding technology usage in areas of Canada that are also struggling with limited connectivity.

In summary, we see a wealth of research on family communication practices and technology usage in both developed and developing countries. While valuable, none of these studies have explored family communication in *developing regions* of a *developed country* like Canada. This is the focus of our study, discussed next.

STUDY METHODOLOGY

We conducted an interview-based study within rural and northern Manitoba to understand family communication practices in areas that have much more impoverished communication infrastructure than what is typically found in urban areas. In the next section we describe the two communities included in our sample and how their Internet

access differs from what is typical in urban areas of Canada.

Communities, Participants and Recruitment

We recruited fifteen participants (nine female) from two primary communities within Manitoba, Canada, marked on the partial Canadian map shown in Figure 1. The locations were selected as previous work suggested they face connectivity issues [21]. Recruiting started with the first author's personal connections and we grew our sample by networking in the communities.

Our first group of participants (P1-P9) came from rural areas in southwestern Manitoba shown at the bottom of Figure 1. This region is located approximately 200 kms from a major city (Winnipeg). We included seven people from the Rural Municipality of Roblin (RM Roblin), whose population is around 1000 people. RM Roblin is primarily a farming community (see Figure 2), and the local geography attracts a number of tourists who come to hunt or fish. We also had two participants from the Rural Municipality of Louise (RM Louise) a municipality adjacent to RM Roblin with the same economic base and geography. This area includes large regions where hardwired unlimited Internet is not available so these municipalities are heavily dependent on wireless technologies for access to Broadband Internet. Dependence on wireless technology to access Broadband Internet means that network access is frequently disrupted by geography, foliage, wind and cloud cover [21]. For example, cellular and wireless signals cannot reach into the local river valley and portions of the municipality are outside the reach of the signals from the nearest cellular towers.

Residents in this area of the province have only two (Internet Service Provider) ISP options, both of which involve data caps, resulting in $135 to $275 per month fees for data transfer of 125G. Download rates in these regions are frequently less than 5 Mbps [8]. In contrast, in Winnipeg, Manitoba's largest urban center, there is a choice of four ISPs, with costs between $43 and $63 per month for 50Mbps or more [8], often with unlimited data caps. Given a median income level of 26K (compared to $32,000 in Manitoba's urban centres [32]), Internet represents a significant expense for residents in these rural communities.

Figure 2. A farmyard in the RM Roblin/RM Louise area.

Figure 3. The edge of Gillam, Manitoba, where the town meets the forest. This is at the 56 parallel, just south of where permafrost begins.

Our second group, comprised of six participants (P10-P15), came from Gillam, a community in Northern Manitoba, located approximately 1000 km from Winnipeg. Gillam, whose population is around 1,100, is one of the north-most Manitoban communities accessible by car. Its major industries include rail, tourism, and construction. The most predominant employer is the provincial utility company, which maintains a number of Hydro Electric damn sites in the region and is constructing more. The Fox Lake Cree Nation maintains Aboriginal reserve sites near to Gillam in addition to band members living in the town itself. Figure 3 provides an aerial view of Gillam and the surrounding, whereas Figure 4 depicts a typical street within the town.

In this second region in our study, only the highest density communities have access to reasonably priced communications. Within Gillam, high speed, unlimited data can be accessed via one available provider for $55/month. Outside the main community, the cost of 125G of data with upload speeds of 1Mbps quickly rises to $275/month.

Across both regions, participant ages ranged from their 20s to 60s. Occupations included farmers, store owners, administrators, child care workers, hunters, and mechanics. Three participants were unemployed. Eleven participants had some level of secondary school education, while the remaining four had completed or taken portions of high school.

Participants were provided with a 15$ honourariam in appreciation for their time.

Semi-Structured Interviews

We conducted a semi-structured interview with each participant that lasted approximately 30-45 minutes. We began each interview by asking the participant to draw his/her family communication network on a piece of paper and to indicate the closeness of these relationships (see Figure 5 for an example); this is similar to other studies on family communication [23, 27, 33]. We then used these drawings to ground discussions in the remainder of the interview, which focused on how often participants communicated with each family member, what they communicated about and what technologies they used. Questions included, for example, *"What is your usual*

Figure 4. A typical street within the town of Gilliam.

method of communicating with [family member X]?" and *"Can you tell me about the last conversation you had?"*

Throughout the interview, we were particularly interested in how the participant's location and that of their family or friends affected communication. We wanted to understand if the availability and cost of accessing and using technology in that location played a role in what technology was used, what was talked about, and who was talked to. We also investigated situations where technological issues meant that particular family and friends were not part of regular communication practices, e.g., it was too hard to reach them so communication dropped off. Thus, our interviews focused on family communication and also a *lack of* communication where we explored technology access, infrastructure, and social barriers.

Data Collection & Analysis

We recorded audio of all interviews, which were later transcribed in full, and took notes and pictures of the communities and participants' homes. We then performed a thematic analysis of the interview transcripts and our notes. Photos and family network diagrams aided our analysis of the transcripts by providing additional details.

Our analysis revealed several main themes that we report on next in our results. First, we describe the focus of communication and which technologies participants chose to use with their family members when communicating over distance. These findings are similar to findings from previous work on family communication in developed countries. Yet what stood out as a large contrast to other regions in North America that face less infrastructure challenges were the ways in which availability of a cellular signal and the cost of services influenced how, where, and when families communicated using technology. We detail this second. Finally, we document the attitudes towards technology that our participants expressed, which reflect
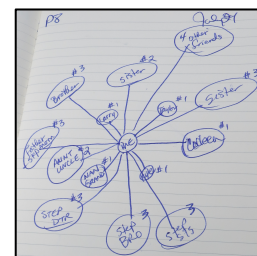

Figure 5. An example family network diagram.

their longstanding 'battle' with poor technical infrastructures due to their location in rural Canada.

COMMUNICATION ROUTINES AND CONTENT
Family Communication Networks
Participants told us that their family communication routines focused around conversations with a range of family members, including immediate family (e.g., siblings, parents), extended family (e.g., cousins, aunts, uncles), and a mixture of friends with varying relationship levels. This is similar to studies of other developed and developing regions of the world [23, 27, 31, 33].

Yet participants also talked about how the availability of technology infrastructures (e.g., cellular tower, Internet connections) played a role in terms of who they talked to and how often. Participants found it easier to maintain relationships with those people who had better access to technology. Family and friends who could not afford robust phone plans, or for whom there was a lack of signal, were more difficult to maintain an up-to-date relationship with. Communication was more challenging and less frequent in these cases. For example, P2's adult grandchildren lived several hours away from her. They had tight budgets and, as a result, they would ration their mobile phone conversations.

> "He doesn't call because it costs him. ... Well, I'd like to talk at least once a week with them all." –P2

Similarly, P4 would like to talk with her sister more often. If cost was not a concern they would speak to each other much more often. Instead, she relied on hearing about other family members through an intermediary, her mother.

> "Probably once a week, we're talking probably once a month right now, everything is through my Mom." –P4

Participants who were faced with limited technology infrastructures described having had much weaker ties with their relatives that lived far away when compared to our other participants. For example, P10 lives near Gillam and has family that live in a community accessible only by winter roads (i.e., frozen bodies of water turned into roads for the winter) and airplane, where only satellite Internet and no cellular signal is available. Maintaining a relationship with these relatives was especially challenging because she had next to no opportunities to see them in person.

> "Two older sisters live far away from me, but they live in [the distant community]. I got relatives that live [there]. I don't even know half of them." –P10

Communication Content
Most communication with friends and family was described as general discussion around topics of everyday life. This included jokes, gossip, and descriptions of one's activities and happenings. Again, this reflects family communication patterns in developed countries. In contrast to developing regions of the world [27, 35], we did not see a heavy emphasis on discussions of finances and economic activities. Thus, this region did not face the same level of economic hardships as is found in many developing countries. As such, conversation could easily focus on 'less pressing' topics about daily life. Our participants described their conversations as occurring whenever it was convenient, sometimes limited by connectivity and cost (described more later). Other conversations were more urgent, needing to take place somewhat immediately.

Communication about health situations was ubiquitous in our interviews. Participants talked about keeping track of family members' medical situations, and about notifying distant relatives of deaths in the community. For example, P4 lives and works in the RM Louise. While P4's siblings are spread out over the province (spanning approximately 80000 square kms), she depends on her sister, a nurse, for healthcare advice about her child on a regular basis.

Technologies Used
Families made significant use of technology as a part of their family communication practices, using different tools for different situations and people. Similar to other research this included the telephone, text messaging, email, video chat [1, 19, 24, 31, 33], and social media [5].

All technologies were used for targeted communication with a particular family member, while social media naturally lent itself to communicating with a large number of family members all at once, via status updates. For example, participants described accessing Facebook on a daily basis to see what was going on in family members' lives in an asynchronous fashion. Participants also talked about migrating between technologies depending on the nature of conversations. For example, when a conversation became more involved, participants described moving from Facebook messaging to a phone conversation, which they felt was a richer method for communicating.

While the choice of tools was often based on communication content (e.g., emotional conversations vs. short discussions about everyday life activities), the availability of a consistent signal played a more dominant role as did the cost of the technology. In the following sections, we detail how these aspects affected communication and technology choice.

THE SIGNIFICANCE OF COST
Our participants often cited the cost of technology as a strong reason for choosing one type of technology over another when communicating with their family members. Thus, even though they typically knew what technologies were most likely to reach their family members, they had to first ensure that it was affordable for themselves and for the recipient. In this way, technology selection reflected their knowledge of their family members' financial situation, as well as their own.

As described in our method section, the options and costs available differed significantly between densely populated and sparsely populated communities, where income levels also tend to be lower. This sharp contrast in cost gives residents additional concerns to consider when planning

Figure 6. A participant's communication station in his living room, dominated by a large screen for VoIP and video calls.

communication with family members spread out across the province.

For example, many family members of participants, particularly the younger adults, had forgone having a landline phone in order to afford a mobile phone. Mobile phones were seen as ways to make themselves more accessible to family and friends, despite infrastructure challenges (described in the next section). They also represented additional levels of safety, e.g., if an emergency situation arose while out, they could easily call others. Family members were very conscious of the cost of using mobile phones, in particular for the recipient of calls. For example, in the quote below, concerns over the cost of phoning a family member lead to communication happening through an intermediary person:

"[We communicate via] Text, [my sister] doesn't have a landline, and her cellphone only accepts phone calls at certain times, she can't afford a full phone. [...] 99% of it is funneled through my Mom, Mom talks to her at least once a day." –P4

As an alternative to either landlines or cellphones, participants also used online voice and video tools to reduce costs. Some participants had unlimited data access through their home Internet service leading this to be an affordable choice.

"And it's the cost, the price is right [with Skype]" -P5

For them, online tools were seen as particularly helpful for contacting friends and relatives outside of Canada, since the cost of phone calls increases significantly for out-of-country calls. As an example, P14 lives in Gillam for work reasons. He lives alone, and owing to his desire to keep in close contact with family members, his communication workstation dominates his living space as shown in Figure 6. P14, who has access to high speed Internet with unlimited data downloads, found the long distance charges on his cellphone to be too expensive and so he prefers to pay a flat rate for calling anywhere in North America using a 'Voice over IP' (VoIP) tool.

"Mainly the Internet now, used to be phone. .... [now] ...I have a magic jack because it's cheaper to use. I can phone anywhere in North America for a flat rate." –P14

The cost of using online tools like Skype and VoIP can vary considerably in the rural areas we studied when compared to urban centres. Service providers put caps on data usage,

which are often lower near the edges of the network's coverage area. This was often where our participants resided, and going beyond data caps was very costly. Since video conferencing involves the transfer of large amounts of data, it could, at times, be too expensive for the residents in these areas to use. For example, P8's family lived in northern Canada for a number of years where she worked as a nurse, while their extended family remained in Southern Manitoba. Video tools were helpful for communication, but eventually the cost became prohibitive as large data downloads carried significant additional costs. Eventually, P8 had to restrict the types of tools they used to keep in touch their extended family.

"In Iqaluit... the Skype was used too much, it used up too much of our Internet, like you couldn't get a high enough setting for your monthly usage ... It ended up being very expensive, and had to tell him to stop calling me." –P8

Thus Internet affordability in rural communities, which is generally higher than in urban centres, can affect both the frequency and format of family communication.

SIGNAL PREDICTABILITY AND LOCATION

For participants in both rural Southern Manitoba and Northern Manitoba, stability and availability of cellular signal was an issue and had a strong effect on when and where one could contact family members. Some participants could not get a signal at all in their local area, and others had to find just the right location to make a call. Sometimes this required driving into nearby towns, which would take between 10 and 30 minutes.

"Cellphones don't work there, so she had to go into town and use the [landline] phone." –P6

For example, P6 did not use a cellphone for communication when traveling in rural Manitoba owing to a lack of consistent signal. Instead, she found a workaround: She subscribed to the OnStar auto security service. Normally this service is subscribed to by people so that they can call for help when an emergency situation arises, e.g., when a person's car breaks downs. As such, it maintains a strong level of reception even in remote areas. P6 used a somewhat unknown feature of this service where she would prepay for calling minutes and then contact people through the service in her vehicle. P6 was always able to get a signal.

"Its fabulous because it does have really good reception, everywhere [...] I don't carry a cell phone for that reason." –P6

Another example comes from P9 who lives and works just past the edge of the local cellular towers' signal reach. He described using his cell phone at these locations as something of an exercise in patience. Here he had to be in just the right location and angle.

"I can't send anything until I open the door and face [my cell phone] towards [local tower]. I go to the house, you cannot send anything unless we point it to the window outside, send it in that direction to [local tower]." –P9

Figure 7. A rural road in the winter months, illustrating that travelling to areas with better connectivity can be difficult.

Besides being generally cumbersome, any type of signal availability workaround involving the outdoors has an additional challenge related to the weather in the region. The winter season typically lasts five or six months, with normal temperatures in the -15°C to -30°C range (with the wind chill making these temperatures feel significantly colder). Figure 7 shows a Manitoba highway in winter. Travel at this time of year is more challenging making technology mediated communication that much more desirable.

RM Roblin is on the edge of two local cell signal 'bubbles'. Other participants in this area, like P9, described similar issues where signals were only possible if there were not trees between them and the cellular tower. By comparison, in the town of Gillam, the signal can be quite strong. However, we observed it dropping to nothing without any explanation as to the reason. Participants confirmed that this was a common occurrence in the area. They also talked about the speculations amongst residence as to the reason for the unpredictable service, including alleged politics between two cellular service providers, Rogers and Manitoba Telecom Services (MTS).

> *"It will go from full service to no service. No cell service… its very choppy up here. Apparently a lot of it is Rogers was on the MTS tower and so MTS took them off, so Rogers didn't work up here at all for a few days, it's very… a lot of drama." - P15*

For people with cellphones, text messaging was often the most economical and reliable option for communication. When signals were poor as described above, a short text message was likely to get to a recipient eventually, while communicating via a voice call could be much more challenging. Thus, participants often favored asynchronous communication over synchronous communication because of the reliability of the technology. This superseded their desire to have conversations that were more 'natural' and similar to face-to-face situations, as would occur over the phone.

> *"Text will go through better than a call … and we did lots of little voice messages." – P6*

> *"It cuts in and out and then you're fighting to get communication and such." - P4*

> *"He's in southeastern portion of Manitoba, there's absolutely zero reception there, and we text or email." –P9*

ATTITUDES AROUND TECHNOLOGIES

Like most people, participants wanted their experience of using technology to be as straightforward as possible. Tools that provided 'one click' access to communication were favored over anything that required additional setup or maintenance. Once a system was understood and used, participants said that they were especially reluctant to move on to new and possibly better systems. This reflected their past experiences in 'fighting' with technology and a lack of bandwidth and connectivity, and often giving up on 'newer' technologies because of such issues.

The strongest example of this comes from video conferencing technologies, e.g., Skype, FaceTime. These systems were very attractive tools for families because they offered communication that was most similar to face-to-face situations. When distance precluded face-to-face communication, most participants tried using video communication tools as a stand-in. These were usually reserved for the types of conversations where visual feedback had the most impact, often this involved children.

Unfortunately, there was variability in the reliability of video conferencing systems and this had lasting effects on the attitudes of our participants towards so-called new and improved technologies. For example, P3 was able to use Apple's FaceTime to converse with a relative. It worked well and so she wanted to use it to see her grandchildren. However, to date, this has not happened because the family continues to face issues in getting the system to work. Because of their consistent struggle with cellular and Internet infrastructures and technology access (Wi-Max Internet and booster required to access cellular signal), they felt this was likely a result of poor cellular or Internet services (which may or may not be the actual case).

> *"Yeah, it is very strange. ... he's trying to figure it out. He's got an iphone and an ipad, I have an iphone and an ipad… and we can't get it to work." –P3*

Another example comes from P6 who told us about how she reached out for help when her experience using a video communication system was unsatisfactory. After talking to the customer service people for the software and to her Internet service provider, she was left in a deadlock. Each blamed the other for her experience problems.

> *"Our help desk had suggested that they update the router, and then [Manitoba Telecom Services (MTS)] came in to see it and said its absolutely fine. So you know you're between a rock and a hard place, you phone a help desk and they say this is an MTS issue, and you phone MTS and they say everything is [ok on their end]" - P6*

Following these frustrating experiences, P3 and P6 said they were reluctant to go back to using video chat and similar technologies. Without knowing what was causing the problem, participants had little faith in a better experience next time.

DISCUSSION

Participants in our study live in a country with established and high-functioning technology infrastructures. However, in their particular geographical locations, the infrastructure is still "developing", in the sense that it lags significantly behind that found in urban areas of the country. Our findings, therefore, provide a unique compliment to two existing, well-established threads of research: studies of family communication within regions with robust and mature technical communication infrastructures, and studies of areas of the world that are as a whole still developing. In this section, we contrast our findings to prior work, and discuss a number of challenges and opportunities that our findings highlight for designers moving forward.

Communication Information

In comparison to studies in similarly developed countries, we find the general communication goals and intents to be similar in both environments. That is, people want to stay in touch with family members such that they can share knowledge of their activities, location, and well being, including health-related information [23, 31, 33]. The reliability and consistency of connectivity in the areas we studied had less in common with issues reported in prior work. While other researchers have found connectivity issues in studies of Skype (e.g., [1, 30]) these are of a different magnitude than that found in our study. In these studies, it is about bouncing connections, reduced fidelity, distortions, etc. where a person can get a connection in their home at some point. In our study it is about a complete lack of connection, a connection at only certain times, or a connection in obscure locations such as driving to a remote area, going outside of one's home, or being in one's car. Despite the limited connectivity at varying points in time, our participants tend to achieve enough communication that their basic goals can be met albeit often with considerable difficulty or on an alternate timeline.

The implication of these findings is that the functional requirements of family communication technologies for rural areas such as those in our study should be very similar to that of regions that have a more developed infrastructure. In other words, the functionality provided in systems such as email, Facebook, and video chat systems (e.g., Skype, FaceTime) is still that which people need and want in these regions. The difference lies in people's ability to use such tools because of limitations in technology infrastructures. Thus, instead of designing to support the exchange of different types of information, communication technologies for these regions should focus on ways to share the same information but at a lower bandwidth, or in creative ways that get around infrastructure challenges.

Communication Systems

Like most people in developed areas of the world, participants in our study also shared a preference for communication tools that could help simulate the experience of being face-to-face, but at a distance, e.g., telephone conversations, or video-chat sessions. However,

for our participants, both economics and infrastructure, as well as the interplay between the two, often made using these preferred tools difficult. While participants spoke of the advantages of multi-media and synchronous conversations, cost and signal predictability made the asynchronous text-message format popular. More in-depth communications often involved a location change, which could mean driving to areas of better reception, communicating through a service that was only available within a car, or moving outdoors, a less than practical solution in the cold (e.g., -30°C) winter months.

Improving the infrastructure will take years and is largely out of the control of system designers. In the meantime, there are opportunities to design technologies that aide users in understanding existing (and ever changing) connectivity levels to enable them to make more efficient use of current infrastructure. As an example of research in this direction, Chetty et al.'s Kermit [7] visualizes real-time local speed and network usage. For wider networks, crowdsourced maps of available connectivity are increasingly available [28]. Integrating such data into communication tools could improve efficiency and user attitude towards them.

We also see design opportunities for researchers and practitioners to rethink the places and locations that family communication technologies are to be used in. For example, video-chat systems are commonly designed to be used on a laptop or smartphone, especially in an indoor setting like a house. In the contexts we have studied, designers would find fruitful opportunities to design communication technologies for the locations where people are likely to get connectivity. For example, this might include a cold outdoor environment or a parked vehicle (after driving to find a cellular signal).

Scheduling Communication

Another design opportunity lies in scheduling tools to help families find reliable times and locations for communication when faced with instable connections. Finding times to communicate with distant family members is challenging at the best of times, but even more so if one has to factor in additional constraints known to affect signal quality like location and cloud cover. For example, designers might think about ways for systems to explore weather forecasts and propose communication times to family members that will be likely to have a strong cellular connection. This could be incorporated into calendar applications that allow one to 'negotiate' communication times between family members in different locations based on weather patterns.

In our study, we also found that asynchronous, text-based communication was considered the most reliable, and often only option for casual family communication. This was because messages sent by family members could be delayed if a cellular connection was poor. Designers may find value in rethinking how the types of rich media found in synchronous tools such as video chat and audio phone calls

may be designed for asynchronous communication exchanges. For example, video chat might be more readily accessible to people in rural areas of Manitoba if information exchange was done with low bandwidth video snapshots (as opposed to high fidelity video). Alternatively, residents in these areas might welcome communication via asynchronous video threads, somewhat akin to the 'video messaging' supported by tools like Skype, Qik, and WhatsApp [25].

Social Isolation

Our study also surfaces knowledge related to social isolation and a lack of relationships with others. Related research has found that older adults in care homes and hospice face challenges related to diminished contact with family members [2, 9]. Our results show that family members in rural areas of Manitoba begin to lose contact with their loved ones because of infrastructure challenges. That is, those who live in regions where connectivity is low or close to non-existent see diminished communication with family and friends because of their poor connectivity. We also saw that people make fewer efforts to communicate with these individuals. Together, this suggests a design opportunity for family communication technologies to focus on ways to connect individuals with very limited connectivity. Such technologies should focus on providing basic pieces of information, even as if to say, "I am still around."

Perceptions of Technology

As infrastructure improves, which is likely to be a slow process due to the economics of servicing these difficult-to-reach and low-population density regions [20], designers face the additional challenge of existing perceptions of communication technologies that have been formed through years of frustrating experiences in the minds of rural Manitobans. Our findings indicate that users may be quick to dismiss media-rich tools as simply not being suitable for their environments, particularly if they have any difficulty with initial setups. Because of this, designers must think about how to alter the perceptions of users within their designs. This may mean designing for 'relationship building' between people and the technology so that they can develop a sense of trust that it will work. How one does this specifically is a certainly an open design question.

This issue also suggests that new technologies should be designed with 'fail safe' mechanisms such that users do not realize their worst fears: that the technology indeed does not work for them, just like the previous technology. In this case, designers could think about ways of providing services of a lesser quality within the same tool, if the highest quality of service fails. Using video chat as an example, one might imagine a system initially trying to send high fidelity video. Yet, if this turns out to not be possible because of infrastructure issues, the system could gracefully downgrade its interaction capabilities to asynchronous video messages while alerting the user to the issue and providing an understanding of why the change in functionality has occurred.

CONCLUSION

In studying rural and northern communities in Canada, we have highlighted the unique challenges that families face when trying to stay connected with their geographically distributed family members. While we sampled from only two communities within a single province in Canada, there is reason to be optimistic that our results will generalize to other similar communities, whose communication infrastructure lags significantly behind the rest of the country, particularly in communities with similar primary industries (e.g., farming) and income levels. Consequently, our findings suggest that designers of family communication technologies should continue to consider lower-bandwidth and asynchronous technology alternatives, even though such considerations are no longer as important in urban centres.

REFERENCES

1. Ames, M., Go, J., Kaye, J., and Spasojevic, M. Making Love in the Network Closet: The Benefits and Work of Family Videochat. *Proc. CSCW*, (2010), 145-154.

2. Baecker, R., Moffatt, K., and Massimi, M. Technologies for Aging Gracefully, *Interactions*, 19(3), (2012), 32-36.

3. Ballagas, R., Kaye, J., Ames, M., Go, J., and Raffle, H. Family Communication: Phone Conversations with Children. *Proc. IDC* (2009), 321-324.

4. Brush, A.J., Inkpen, K.M., and Kimberly, T. SPARCS: Exploring Sharing Suggestions to Enhance Family Connectedness, *Proc. CSCW,* (2008), 629-638.

5. Burke, M. and Kraut, R. Growing Closer on Facebook: Changes in Tie Strength through Social Network Site Use, *Proc. CHI,* (2014), 4187-4196.

6. Cao, X., Sellen, A., Brush, A. J. B., Kirk, D., Edge, D., and Ding, X. Understanding Family Communication Across Time Zones. *Proc. CSCW, (2010)*, 155-158.

7. Chetty, M., Halslem, D. Baird, A. , Ofoha, U., Sumner, B., and Grinter, R Why is my Internet Slow?: making network spepds visible. *Proc CHI (2011)*, 1889-1898

8. CRTC, Communications Monitoring Report 2014 http://www.crtc.gc.ca/eng/publications/reports/PolicyMonitoring/2014/cmr.pdf (Accessed January 2015)

9. David, J., Benjamin, A., Baecker, R., Gromala, D., and Birnholtz, J. Living with Pain, Staying in Touch: Exploring the Communication Needs of Older Adults with Chronic Pain, *Extended Proc. CHI,* (2011).

10. Forghani, A. and Neustaedter, C. The Routines and Needs of Grandparents and Parents for Grandparent-

Grandchild Conversations Over Distance, *Proc. CHI,* (2014), 4177-4186.

11. Hindus, D. Mainwaring, S.D., Leduc, N., Hagström, A.E., Bayley, O. Casablanca: Designing Social Communication Devices for the Home, *Proc. CHI*, (2014), 325-332.

12. Horst, H. Blessings and Burdens of Communication: Cell Phones in Jamaican Transnational Social Fields, *Global Networks*, 6(2), (2006), 143-159.

13. Horst, H. and Miller, D. From Kinship to Link-up: Cell Phones and Social Networking in Jamaica, *Current Anthropology*, 46(5), (2005), 755-778.

14. Hutchinson, H., Mackay, W., Westerlund, B., Bederson, B., Druin, A., Plaisant, C., Beauduin, M., Conversy, S., Evans, H., Hansen, H., Roussel, N., Eiderback, B., Lindquist, S. and Sundbad, Y. Technology Probes: Inspiring Design for and with Families, *Proc. CHI,* (2003), 17-24.

15. Inkpen, K., Du, H., Roseway, A., Hoff, A., & Johns, P.. Video kids: augmenting close friendships with asynchronous video conversations in videopal. Proc CHI (2010), ACM, 2387-2396.

16. Joinson, A., 'Looking at', 'Looking up' or 'Keeping up with' People? Motives and Uses of Facebook, *Proc*. *CHI*, (2008), 1027-1036.

17. Judge, T.K., and Neustaedter, C. Sharing Conversation and Sharing Life: Video Conferencing in the Home, *Proc. CHI,* (2010), 655-658.

18. Judge, T.K., Neustaedter, C., and Kurtz, A.F. The Family Window: The Design and Evaluation of a Domestic Media Space, *Proc. CHI,* (2010), 2361-2370.

19. Kirk, D., Sellen, A., & Xianc, A. Home Video Communication: Mediating Closeness, *Proc. CSCW,* (2010), 135-144.

20. Lindley, S., Harper, R., and Sellen, A. Designing a Technological Playground: A Field Study of the Emergence of Play in Household Messaging, *Proc. CHI*, (2010), 2351-2360

21. Melvin, R. and Bunt, A. Designed for Work, But Not From Here: Rural and Remote Perspectives on Networked Technology, *Proc. DIS,* (2012), 176-185.

22. Mynatt, E.D., Rowan, J., Jacobs, A., and Craighill, S. Digital Family Portraits: Supporting Peace of Mind for Extended Family Members, *Proc. CHI,* (2001), 333-340.

23. Neustaedter, C., Elliot, K., and Greenberg, S., Interpersonal Awareness in the Domestic Realm, *Proc. OzCHI,* (2006), 15-22.

24. Neustaedter, C., and Judge, T.K. Peek-A Boo: The Design of a Mobile Family Media Space Video, *Proc. Ubicomp,* (2010), 449-450.

25. O'Hara, K., Massimi, M., Harper, R., Rubens, S., and Morris, J., 2014. Everyday dwelling with WhatsApp., *Proc CSCW(2014)*. ACM,1131-1143.

26. Oduor, E., Neustaedter, C., Hillman, S., and Pang, C. Family Communication in Rural and Slum Regions of Kenya, *Proc. CHI Extended Abstracts,* (2013).

27. Oduor, E., Neustaedter, C., Judge, T.K. Hennessy, K., Pang, C., and Hillman, S. How Technology Supports Family Communication in Rural, Suburban, and Urban Kenya, *Proc. CHI,* (2014), 2705-2714.

28. Open Signal Maps crowd sourcing connectivity map. http://opensignal.com/,(accessed January 2014)

29. Pang, C., Neustaedter, C., Riecke, B. E., Oduor E., Hillman, S. Technology Preferences and Routines for Sharing Health Information during the Treatment of a Chronic Illness, *Proc. CHI*, (2013), 1759-1768.

30. Rintel, S. . Video calling in long-distance relationships: The opportunistic use of audio/video distortions as a relational resource. Electronic Journal Of Communication, 22 (4) (2013), 23.

31. Romero, N., Markopoulos, P., van Baren, J., de Ruyter, B, Jsselsteijn, W., and Farshchian, B. Connecting the Family with Awareness Systems, *Personal and Ubiquitous Computing*, 11(4), Springer-Verlag (2006), 299-312

32. Statistics Canada. Neighbourhood income and demographics, taxfilers and dependents with income by total income, sex, and age group (2012) http://www5.statcan.gc.ca/cansim/a05 (Accessed September 2014)

33. Tee, K., Brush, A.J.B. and Inkpen, K.M., Exploring Communication and Sharing Between Extended Families, *International Journal of Human-Computer Studies*, 67(2), (2009), 128-138.

34. Vertovec, S. Cheap Calls: The Social Glue of Migrant Transnationalism. *Global Networks,* 4(2), (2004), 219-224.

35. Wyche, S. and Grinter, R. "This is How We Do it in My Country": A Study of Computer-Mediated Family Communication Among Kenyan Migrants in the United States, *Proc. CSCW,* (2012), 87-96.

36. Wyche, S. and Murphy, L. "Dead China-Make'' Phones Off the Grid: Investigating and Designing for Mobile Phone Use in Rural Africa, *Proc. DIS,* (2012), 186-195.

37. Wyche, S.P., Smyth, T.N., Chetty, M., Aoki, P.M. and Grinter, R.E., Deliberate Interactions: Characterizing Technology Use in Nairobi, Kenya, *Proc. CHI,* (2010), 2593-2602.

38. Yarosh, S., Cuzzort, S., Müller, H., and Abowd, G.D. Developing a Media Space for Remote Synchronous Parent-Child Interaction, *Proc. IDC*, (2009), 97-105.