Investigating Connectivity Challenges and Available Mitigation for Communication in Rural and Remote Environments

by

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A thesis submitted to
The Faculty of Graduate Studies of
The University of Manitoba
in partial fulfillment of the requirements
of the degree of

Master of Science

Department of Computer Science
The University of Manitoba
Winnipeg, Manitoba, Canada
June 2014

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Abstract

While workers in an urban environment typically enjoy full speed, always available, broadband access, those in rural and remote environments do not necessarily have the same level of service. The goal of this thesis is to investigate positive and negative rural and remote work experiences, looking for novel ways to leverage available strengths in mitigating productivity challenges. An exploratory qualitative study suggests increasing reliance on networked technology by participants, to accomplish work. Larger human networks are common, where members have diverse levels of network access. Search Connected, a prototype tool, looks to leverage this human network to mitigate challenges that might be experienced during work in remote locations, improving search productivity. A preliminary study evaluating the tool suggests that participants see value in the tool and further research be pursued to find a tipping point between added communication overhead and search speed improvement.

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Acknowledgments

I would like to begin by thanking my adviser, Dr. Andrea Bunt, for her insight, perceptiveness and guidance. Appreciation is due to my committee members, Dr. James Young and Dr. Christine Van Winkle for their advice and leadership, and to the Human Computer Interaction lab members for their feedback and encouragement. Thanks to Dr. Pourang Irani for starting my journey by answering my CHI questions and introducing me to graduate studies in HCI. Thanks to Patrick Dubois for making a dual location study possible by facilitating the urban portion of the trials. To Neil, John & Ryan Wojciechowski, thank you for going on this journey with me. Thanks to the too many to name, in my family and community, for all their support.

Much appreciation is owed to the people who agreed to discuss, with me, their experiences working and communicating from rural and remote communities.

for Helen and Sandy

Chapter 1

Introduction

Networked technology, in rural and remote environments, involves a wide variety of levels of connectivity. Access may be on par with levels typical in an urban environment, or it may be as much as 20 years behind. Therefore, networked technology tools typically designed for urban environments may not have the same level of usability in rural and remote locations, where wireless Internet connectivity is more common than wired.

The needs of rural and remote residents have been identified by the Human Computer Interaction (HCI) research community as unique in comparison to urban residents [24]. The Unified Theory of Acceptance and Use of Technology (UTAUT) [63] suggests that perceived usefulness and social factors impact the likelihood of technology use. Thus, development of tools intended for a rural and remote audience should be informed by the perceptions and input of rural and remote residents. Various aspects of residents' relationships with Internet tools have been researched and the availability of tools within the rural environment have been identified, in some case

studies, as lacking e.g. [26; 64].

This thesis focuses on network communication in rural and remote communities. The first goal is to find the specific effects of slow and inconsistent connections on rural and remote residents' ability to be productive in their work, and how these residents respond to said impacts. Second, the thesis seeks to identify if it is possible to leverage available resources to mitigate the identified productivity challenges via the creation of a communication tool.

In order to achieve the first goal and learn about the effects of poor network connectivity on rural resident's work productivity, I sought out members of the rural/remote community in Manitoba. During semi-structured interviews, I asked participants to describe their experience and perspectives on using networked technology. With the interviews, I sought to answer the following questions:

- What types of networked technology do workers in rural and remote areas use and for what purposes?
- Who do workers in these areas need to communicate with and how does this communication take place?
- How do currently available levels of connectivity support or hinder rural resident's work?

Results of this qualitative study were published in the ACM Conference on Designing Interactive Systems (DIS 2012) [53]. These results describe how participants depend on networked technology to support in situ work stations, link work groups distributed over both time and distance, and support their health and safety. Partic-

ipants experienced challenges regarding both the availability of high speed network connections and the stability of connections and they described the impact of this on their work.

To address the second goal, I used the results of my qualitative study to inspire a use case for a software tool I am calling Search Connected. In designing the tool, I looked to mitigate the challenge of slow and unreliable connectivity by taking advantage of distributed work groups. The goal of the tool is to have team members, with good connectivity, provide search task support to team members with poor connectivity. I designed and built a prototype for Search Connected, a chat facility that makes the current connectivity speeds of team members visible to each other. Team members can chat with each other and send web links, allowing team members with fast connections to carry the load of large search tasks and pass on the final results to the team member with the slower connection.

I completed an evaluation study of Search Connected to see if the tool could improve search productivity by connecting rural participants to urban participants with better connectivity. The study involved urban/rural pairs of users communicating over the tool to complete search tasks. Participants responded positively to the Search Connected tool, indicating that they felt it would be valuable in a variety of situations. Given added communication time, further research is required to find a tipping point wherein the size of task, and gap in connectivity levels result in Search Connected providing the most benefit to productivity.

The remainder of my thesis is organized as follows: In Chapter 2, I discuss human computer interaction (HCI) research related to rural and remote environments and

collaborative search. In Chapter 3, I detail how I executed an exploratory qualitative study and what I learned. In Chapter 4, I describe the prototype tool Search Connected, followed by Chapter 5, which includes the preliminary evaluation of that tool. In Chapter 6 I provide a summary and discuss possible future work.

Chapter 2

Related Work

This review of related work focuses first on the intersection of networked technology and rural use in general, followed by a review of areas of tool development for social search and network usage visualization. My thesis work links these areas of investigation to rural and remote technology needs.

2.1 Rural use of Networked Technology

Studies in the area of rural use of network technology have tended to fall into four broad categories: (1) tool deployment in rural, developing areas; (2) the use of the Internet for social purposes in rural communities; (3) technology penetration in rural/remote environments; (4) technology use in rural/remote environments; I include a discussion of each of these here.

2.1.1 Tool Deployment in Rural Developing Areas

Much of the rural-themed HCI research has taken place in developing areas, where researchers have deployed tools, often with an educational focus, and have examined the issues surrounding their use. Valderrama Bahamondez et al. [62] studied the impact of introducing mobile tools into Panama schools. They found that mobile tools were welcome additions to the classroom in part because rural students were much less likely to have access to personal computers than their urban counterparts. Kumar et al. [49] introduced mobile phone tools in rural India, but found that limited access to electricity impeded their use. Finally, Cervantes et al. [28] examined use of One Laptop Per Student (OLPS) computers in Mexican schools. They found that socio-economic status had an impact on schools' ability to support students' laptop use and noted the importance of considering context of use in design.

A number of tool deployments involved improving communication in the domain of health-care. Chetty et al. [29] took a participatory approach to designing a telemedical tool. They found logistics a challenge in not only the product but the design process itself. Ramachandran et al. [59] used mobile devices for storytelling to help motivate rural health workers to gain training. The health-care workers used cell phones to distribute videos among each other, sharing knowledge in a very organic manor. Frohlich et al. [38] also developed a system for digital storytelling, but for more social purposes. Their system allowed residents of a village in India to use cellular phones to create digital video stories for playback in their community, with infrastructure challenges forcing a change in their design. Finally, Bidwell et al. [22] studied digital storytelling in rural Africa, stressing the importance of understanding

cultural and environmental context of use.

2.1.2 Social Internet Use in Rural Areas

Networked technology enables new methods of making social connections. While there are many studies of social media in HCI in recent years (e.g., [50; 52]) there are few that relate to rural and remote communities. One exception is Gilbert et al.'s [39] empirical analysis of MySpace profiles, which focused on how people living in rural US communities interacted with social media. They compared rural and urban user profiles over a wide range of demographics finding that, for example, rural users tended to keep their profiles more private and had geographically closer contacts than urban users. Larson [51] studied social use of the Internet by rural residents in Kansas, finding that rural people had high expectations for the Internet being able to connect them to resources, be it material goods, social contacts, or reference information. At the same time, many participants expressed reluctance to fully engage with technology stemming from intimidation, or the awkwardness of the different social structure.

2.1.3 Penetration of Networked Technology in Rural/Remote Environments

Other work has focused on quantifying technology uptake and penetration in rural and remote regions (e.g., [40; 41; 44; 64]). Examinations of access to broadband and user uptake in rural North America (in particular the United Sates) include those by Glasmeier et al. [40], Wolff et al. [64] and Glass and Stefanova [41]. These

quantitative studies of broadband use have found that communities in rural areas use networked technologies to a much lesser extent than those in urban areas. However, as the above studies admit, and Frieden [37] suggests, FCC reports [34; 36; 35] and the National Broadband Map [3] might be over-estimating the availability of broadband because of the manner in which postal codes are grouped. A single town within a postal code with good connectivity can skew the data for the area. My work includes using qualitative methods to gain more detailed insight into users day-to-day experiences in rural areas in an effort to be inclusive of people who might otherwise not have their concerns included.

2.1.4 Technology Use in Rural/Remote Environment

In contrast to studies on technology penetration, relatively few studies have taken an in-depth look at technology use in rural environments or at how existing connectivity levels impact users' perceptions of technology.

Bakardjieva [19] conducted a focus group with rural residents of Alberta, Canada regarding their experiences with networked technologies. Participants felt they needed the same level of access to networked technology experienced by their urban counterparts, and at a similar cost. At the time (2008), many participants still used dial-up Internet access and were eagerly anticipating wireless-based broadband technology at an affordable price. In their 2010 paper, Bakardjieva and Williams [20] describe impressions of residents and policy makers following the initial implementation of Alberta's SuperNet broadband access. They found that government and media promotion was not as much linked to broadband use as practical uses grounded in

everyday practices of rural residents in Manitoba.

Richards [60] compiled an overview of studies of information technology (IT) penetration and involvement in rural development with a focus on what forms of promotion resulted in increased uptake. They found that promotional campaigns were less likely to increase uptake of IT than suggestions from trusted family and friends. They also found that perceived usefulness of IT by rural business was less than expected. The reasons for these perceptions were not discussed.

McCallum and Papandrea [52] studied technology use in Australian remote aboriginal communities and found that people had very little access to networked technology and typically underused the Internet to a great degree. Under-use was also found by Oreglia et al. [57] who studied technology use by farm families in rural China. The authors found that while many used mobile devices for phone calls, farmers continued to rely heavily on face-to-face communication. While this is one of the few examples to take a detailed look at technology use in rural regions for work purposes, the authors did not explore issues relating to network connectivity, and the cultural and political differences between that area of the world and rural Canada are also significant.

In summarizing the above related work, we note that no one has looked at the intersection of (i) rural perspectives of networked technology use in western, developed nations with a focus on work needs and (ii) technology/non technology choices rural users make and why. Our work also seeks to understand how technology can be designed to mitigate infrastructure challenges as opposed to focusing on policy recommendations.

2.2 Collaborative Work Over Networks and Connectivity Awareness

My initial study (discussed in chapter 3) inspired me to investigate prior work in the area of collaborative search and work related to improving understanding and visibility of network activity. For teams communicating using network technology, awareness of team member working environment supports accomplishment of collaborative tasks [43]. I suggest that teams would incur benefit from including level of network connectivity in team awareness information.

2.2.1 Social Search

The design and implementation portion of my work involves a prototype that aids with Internet search for people in rural and remote locations with poor connectivity by relying on their social network. There is a body of work that looks at the human process of search on the Internet (eg.[23; 32]). During a search, decisions need to be made regarding what link might include the actual information that is being searched for. Once the link is clicked it needs to load, and then the specific information needs to be found within that page. Decisions are made, and there is sense making going on. The sense making can be made by an individual or collaboratively. Research has looked at partnered or group dynamics in search (eg.[46; 55]). When some human processing for search involves multiple people that are socially connected, this can be referred to as social search.

Evans and Chi [32] provide a framework for discussing social search, breaking the

search task down into three types. Evans and Chi recommend including elements to share and communicate search details in the design of social search. My work looks at how such a communication tool might be developed to include information about current connectivity levels of included search partners.

Research has been done to try to improve search engine results by taking advantage of social media networks and their data. For example, Carmel et al. [27] created an algorithm to personalize a search based on previous search topics, bookmarks, and similarities between the user and others in their network. Horowitz and Kamvars [46] approach similarly uses social networks to match people to topics, but allowed users to approach an appropriate person and ask for advice in searching for information.

In comparison to the these projects, my goal in adding a social element to search is specifically geared toward remote users and improving how quickly they arrive at their desired targeted information. I aim to improve search efficiency of workers with poor connectivity by facilitating communication with workers with good connectivity.

Search Together, a prototype created by Morris and Horovitz [55] provides rich communication for collaborative search. The tool is designed to allow for division of labour, participant awareness of each other's progress, and persistence of the collected data. The tool does not consider the network connectivity of participants in collaborative search tasks. I looked at including the concept of connectivity in the awareness aspect of a search task. The prototype I created included visualizations to help users choose search partners based on their level of connectivity and amount of previous communication.

2.2.2 Connectivity Visualization

There are a number of reasons to make connectivity information visible to average network users. Whether in a rural or urban area, most Internet service providers (ISP) have instituted caps on how much data can be downloaded each month. Pricing of network packages may be based on network speeds. There are often multiple users within a household accessing the network. Individuals within the local network want to be aware of when each other is connected to the network. The HCI research community has been working on improving visibility of connectivity visualization to support these needs.

Kermit, as described by Chetty at al. [31] exposes network speeds and bandwidth usage within a local area network as real time visualization and long term logged data obtained via embedded router code. This information arms users with knowledge about how well their connection is performing in comparison to their ISP's advertised speeds as well as the amount of bandwidth usage of connected devices. I have extended this idea by sharing the connection data with communication partners across the Internet in order to better support collaborative tasks.

Mortier et al.'s work [56] creating middle-ware for home networks exposed some of the social challenges of making network traffic visible. They created tools to see and control local network traffic based on user's needs rather than on network structures, at a device level, from familiar controls. They found that having more knowledge about the network traffic had an impact on interpersonal relationships. Without the tool, the sharing of bandwidth was outside the household's control and thus it need not be discussed. With the tool, rules needed to be negotiated.

In my prototype project, information about individuals' network connectivity is provided to communication partners across the Internet. This situation could inspire the need for new social contracts to be developed. New standards about what individuals should expect from each other when communicating in regards to response time, what sort of files or links they can accept, and their ability to support each other in collaborative tasks may develop as more information about each other's connection becomes available.

2.3 Summary

In this chapter, I reviewed work that focused on a number of areas related to the thesis goals. These include (1) the challenges of building tools for residents of rural and remote communities,(2) Social Network use in rural areas, (3) the availability of Internet connectivity and related networked technology penetration, (4) Human-Computer Interaction (HCI) field studies taking place in rural and remote areas, (5) social search, and (6) connectivity visualization. My research begins by talking to people currently working in rural and remote communities about their specific experiences working and communicating using networked technology. I then apply the knowledge gained from this qualitative work to design and evaluate a tool intended to aid in work tasks in rural and remote environments.

Chapter 3

Exploratory Qualitative Study

While workers in an urban environment typically enjoy full speed, always available, broadband access, those in rural and remote environments do not necessarily have access to the same level of service. In this chapter, previously published at DIS 2012 [53], I describe insights from a qualitative study examining the benefits and continued challenges of using networked technologies for work purposes in rural and remote communities. My findings indicate that work in these areas increasingly depends on networked technology to support in-situ and geographically distributed work practices, and to ameliorate health and safety issues, but that participants experience significant challenges in obtaining signal access and stability. I discuss implications for design and future research that arise from my findings.

P	Age	Gender	Type of Work	Area within Manitoba	Distance from Urban Centre	Connection Type
1(1) 1(2)	45-55	F,M	Organic Farmers	South Central	150 km	Was dial up, is now G4 stick
2	45-55	F	Newspaper Owner	South Central	240 km	DSL
3	40-50	M	Beef Farmer	South Central	235 km	Radio Freq.
4	55-65	M	Seed Marketer	Travelling	Various	Cellular
5	20-30	M	Carpenter Contractor	Various	up to 820 km	Satellite, Cellular
6	45-55	F	Construction Project Administrator	North	1100 km	PAX line & other
7	55-65	F	Medical Software Distributor	Throughout	Up to 779 km	Radio Freq.
8(1) 8(2)	50-60	F,F	Adult Educators	South	100 km	DSL
9	40-50	M	Landscape product Distributor and Commodities Trader	South	100 km	Radio Freq.
10	50-60	F	Owner of Bed and Breakfast	West	250 km	DSL
11	30-40	F	Hunting and Fishing Guide and Epicure Distributor	North	670 km	Satellite
12	25-30	M	Grain Farmer	South	240 km	Satellite
13	25-30	F	Homemaker	South	240 km	Satellite

Table 3.1: Participant demographics, occupations, geographic locations and connection types.

3.1 Method

To understand the role of networked technology in rural and remote work practices, and perceptions of available connectivity, I conducted a series of semi-structured interviews with 15 participants (9 females and 6 males) who work in remote or rural locations in Manitoba (located in Western Canada). Participants were recruited through snowball sampling, beginning with my personal contacts and adding additional participants refereed to me by my contacts. Table 1 describes each participant's occupation, location within the region and current connection type. Four participants were interviewed in pairs since they work closely together (denoted P1(1)/P1(2) and P8(1)/P8(2)) and the remaining 7 participants were interviewed individually. Table 1 illustrates the diversity of participants' occupations, including farmers, teachers, and a commodities trader. Participants also represented a range of ages (mid 20s to late 50s) and a variety of areas within the Manitoba.

During the interviews, I asked participants to describe the nature of their work and the corresponding role of networked technology. I asked for specific cases of interaction with customers, vendors, or others they identified they communicated with to ground the data. When possible, interviews took place in the rural workspace of the participant where photos and notes could be taken about the environment. Owing to travelling constraints, four interviews took place over the phone. The interviews lasted 20-45 minutes. Audio recordings of the interviews were transcribed in order to obtain data for analysis.

3.1.1 Interview Questions and Data Analysis

My interviews sought to answer the following questions:

- What types of networked technology do workers in rural and remote areas use and for what purposes?
- Who do workers in these areas need to communicate with and how does this communication take place?
- How do currently available levels of connectivity support or hinder workers ability to complete their work?

Data from the interview transcripts were analyzed by creating affinity diagrams (see 3.1) using a bottom-up inductive approach [21]. Short quotes from the interviews, with links to the research questions, were written out on slips of paper. These slips were analyzed finding commonalities and groupings based on common themes and words. From these affinity diagrams, I extracted commonalities and themes re-

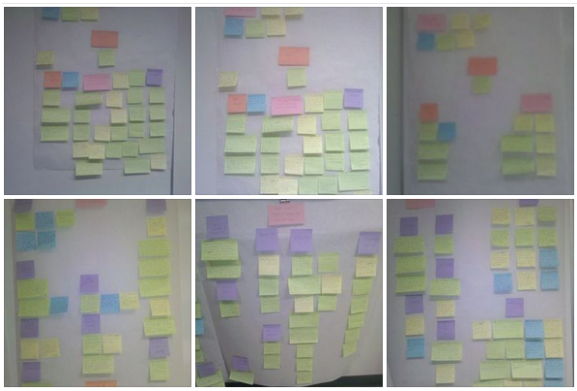


Figure 3.1: Example of the affinity diagrams created during analysis

lating to work practices, technology use and perceptions of available connectivity.

3.2 Findings

3.2.1 Working in Rural and Remote Areas

Types of work that occur in Manitoba rural and remote environments tended to fit within four categories: resource-based business and related construction, tourism/hospitality, urban work transplanted, and public service. To illustrate each type of work, I describe specific practices of four participants (using pseudonyms).

Resource-Based Business

P1, Mary and Sam, are a married couple who together run an organic farm. Sam works long hours in the yard and in the field and is not able to contact people during business hours. In addition to growing grains on their farm, they also grind them into flour and rolled oats. To this end, they share a flour shed with a partner farm on a property several miles away from their home. Mary works at the flour shed several days a week, grinding and milling grain and filling orders. On other days, Sam and Mary load their truck and travel to make deliveries both in the countryside and in the city several hours drive away. They also ship to customers in other parts of the country. Since they switched from a dial-up connection to G4 cellular based Internet access, Mary has been able to bring her laptop computer into the shed and on the road to aid with deliveries and processing customer orders.

Tourism

P11, Tina, works with her husband Randy, a guide for hunters and fishers from outside the province. Tina and Randy maintain and run a camp during hunting season. For client safety, Randy carries a satellite phone, a cell phone, and a two-way radio to ensure signal in the remote location. Randy and Tina prepare successful catch for transport including gathering required customs paperwork. To operate their business, they access government agencies from their home, where they have Satellite Internet access. In the off-season, Tina works as an Epicure distributor, using the Internet to order for her friends and family, many of whom are geographically distant.

Urban Work Transplanted

P9, Ed works as a landscape product distributer and as a commodities trader. For the former, Ed works with his wife Sally in her Landscape Product Distribution company, which they run from their rural acreage. Since logistics and customer service are core to this business, communication technologies are essential. Ed is able to work with his wife because his other work trading commodities can, in theory, be done from 'anywhere' now instead of on a trading floor. Ed monitors real-time charts on his computer, in his home office, and decides when to make trades. This requires that he constantly get up-to-date information and that he does not lose his connection.

Public Service

P8, Kim and Anita, are teachers at an adult education centre that serves clients from a moderately large rural area surrounding the small town where the centre is located. In addition to in-centre education services, they provide distance education via both traditional and online delivery options. The centre enjoys a dedicated high-speed line, so when students come to the centre they have full speed access to the Internet. Since students may be located anywhere in the province, there are varying levels of connectivity in their homes and offices, which can make aiding certain students difficult.

Summarizing Work Characteristics

Examining participants work practices revealed a number of commonalities. Distance is a frequent theme for the rural work experience, with even near neighbours distant as compared to those in an urban area. In particular, customers and vendors are often located far away from the work location. Either due to the nature of the work, or due to this distance, workers rarely spend much time in an office. There is heavy reliance on connectivity in most participants' work and in many cases, maintaining a consistent, stable connection is important. In the next section I delve further into the primary roles of networked technology in participants' work practices.

3.3 Role of Networked Technology

When I asked participants about the use of technology in their community, participants were often hesitant, which appeared to stem from cultural expectations.

For example, in the quotes below P3 and P10 indicate that many 'old-fashioned' individuals in rural communities and farmers tend to avoid technology:

> Most farmers don't handle high tech at all, and cattle farmers even less so [...], if they can't put their hands on it it's not real. - P3

> There's a lot of old fashioned people out there, still like the telephone. - P10

Yet, participants described using technology on a regular basis, in ways that were integral to their work practices. For example, P10, described herself as someone who was not technically inclined, but then proceeded to describe a series of encounters with customers at her Bed and Breakfast who exposed her to various online applications. She ended the interview with the following:

> I'm getting more appreciative of my computer than I ever was. -P10

When participants spoke of using networked technology, the most dominant advantage raised was the ability to complete tasks efficiently and the importance of efficiency to their work. In the following quote, P9 describes how a combination of different technologies (an on-line shipping system and e-mail) enables him to send and receive landscaping supplies with very little time delay:

> Once you enter a shipment [into the computer] it triggers something within [the vendor's] system where it notifies that their driver that there's a pickup to be made at my company [...]. And also there's one of the drivers that we have his email address and he has a blackberry so we just email and say ok we've got a pickup today for you. - P9

Networked technologies have also opened doors to allowing new industries into certain rural areas:

> [Before], in order to have some of the access that you do today, you'd have to be physically there at the trading [floor], at the commodity exchange, or the stock exchange [...]. And now with the advent of electronic trading and the age of the Internet, it's evolved to the point where it's very sophisticated and it's all done electronically so [...] as long as you've got high speed Internet you can do it from anywhere - P9

One of the dominant technologies used by participants is email, as a large part of their work involves communication with relevant stakeholders (e.g., customers, vendors, employees, government, contractors, clients and students). P11, who has run a newspaper for many years, describes how she accepts submissions for articles and advertisements from various community members:

> Email has made my life so much easier, people used to do... they'd call me up and they'd say "I've got this picture I want to send you, and it has to be for this week, and a certain week... can I fax it?" and I'd say "no... a picture you can't fax", now I say "just email it". -P11

I found that in addition to generally improving efficiency, networked technology plays a critical role in the following areas key to working in rural/remote environments: (1) supporting in-situ workstations, (2) enabling reliance on distribution work groups and (3) promoting community health and safety.

Reliance on In-Situ Workstations

Likely typical of many industries in rural and remote areas, the majority of participants work outside of a traditional office setting. Participants commented on mobile networked technologies enabling them to use technology in-situ and the value that this mobility brings. I learned that as farm equipment becomes more technologically sophisticated, farmers are able to do more and more office type work from the

tractor. For example, some tractors come equipped with GPS and auto steering, enabling farmers to both work their fields and keep in contact with vendors, markets, and partners. P4, a seed marketer, described receiving lots of text messages from his farm contacts during seeding in recent years:

> [the] Biggest frequency of contact with producers, farmers, is during seeding, which historically, is no, but they all have auto steering, [...] so I'll get phone calls from people, I'll get text messages [...] I'll get dozens of texts every day from guys in the field. They're doing something and they want something, and before they'd never do that ever. So they're tuned in to what's going on. - P4

These farmers can combine their day-to-day operations with the communications and management needs of their farm, tasks formerly confined to early morning or later evening hours and done back at the office. When cellular connectivity is sufficient, there is a wealth of social media and applications waiting for farmers to use, as described in an edition of Farm Credit Canada AgriSuccess [12] provided to me by P4. According to the magazine, farmers in areas with good connectivity are heavy users of email and other networked technology, which P4 backs up with experience. P1(1), a farmer, talked about being able to work on her laptop while travelling to deliveries, and P10, a bed and breakfast owner, about being able to access community and weather information from her kitchen or living room.

Reliance on Distributed Work Groups

Geographically distributed work groups have been enabled in these areas by increasingly better networked technologies. The small businesses that I talked to had clients across Western Canada and the education facility in which P8(1) and P8(2)

work services clients all over the province. Participants routinely rely on remote communication with their clients/students and use networked technology to access shipping, banking and government services. Participants also described time-distributed work practices that are supported by networked technology. These participants spend long work days away from their desks, in industries such as farming and construction. Having the ability to communicate with government, vendor, and client offices outside of regular business hours is very important and only plausible by accessing on-line services:

> 'cause [government officers] are done at 4 and I'm not done until 10 or so and when they send forms over the line, online it's a lot easier too - P1(2)

Health and Safety

Use of and availability of Internet in rural areas has an impact on health and safety for both participants and those beyond the local area. Participants spoke of the ability to check for hazardous driving conditions and the ability to contain contagious illnesses:

> With all the flooding in [town] [...] There's an update website – I'm always checking the weather - P10

> what roads were closed, where not to drive - P10

> We had the first case of H1N1 in a confined camp [...] getting our message out, getting it out quickly, getting it out accurately was optimum. If it wasn't for email – on that day that we got confirmation from health Canada we emailed all of the contractors, who emailed all of their staff that they could -P6

The use of technology in P6's experience with the H1N1 virus prevented its wider spread by keeping exposed staff from travelling to other areas. P3 spoke of how

on-line auctions have allowed cattle farmers to view livestock without the animals leaving their home farm. These on-line auctions have the efficiency advantage of not requiring the farmers to travel, but more importantly, they are safer for the animals themselves:

> They can take a picture of the feeder cattle and you can go and take a look at those cattle without having to be there. Then they actually don't leave the farm that they come from until you buy them and then they come directly. Instead of actually going through an auction ring, that's where they pick up diseases and things and stress. The animals get stressed the more they're handled and stuff. -P3

A safer food supply for consumers and better protected investment for farmers is possible if the farm owners have access to a good enough Internet connection for the online auction technology to work consistently.

3.3.1 Issues with Rural/Remote Networked Technology

While the vast majority of the quotes I collected about the use of networked technology were actually positive, when I first approached participants, a typical response was "oh you want to talk about how terrible our Internet is?" In this section I describe some of the reasons for these lasting negative perceptions and challenges that remain for improving service in these areas. I begin by describing the type of services that are available in these areas.

Service Availability

Table 3.2 lists the service provider types I encountered during my interviews. As table 2 indicates, these services are not necessarily available to all I interviewed, depending on where they are located.

Service Type	Availability - According to Provider	Availability - According to Participants
Dial Up	Anywhere with a phone line	Provider is accurate
DSL	Select towns, provider shows list	Provider is accurate
Cellular G4	Relative to tower locations, provider shows map	4G does not reach all locations indicated on the map
Cable	Select towns, provider shows list	Provider is accurate
Satellite	Relatively universal	Weather impedes access
WiMax and/or other radio frequencies	Relative to tower location, provider shows map	Provider does a site survey to determine case by case access

Table 3.2: Available Internet Service Provider Types

Participants spoke of the situations where the environment, either geography or climate, has limited their options and access to broadband Internet:

> We had the other one, that was tower to tower, but we're out of sight from the towers here, we're kind of in a hole here so that one didn't work either, satellite was the only option we did have. - P1

> The wrong trees or something in the road and it wouldn't get the strength strong enough to get it. - P3

> Cloud cover, snow storm, rain storm, thunderstorm [cause problems] same as your satellite TV - P3

> You've got to do your online banking on the sunny days - P5

> If [the connection] doesn't work, or the Internet goes off, I look outside, 'ok it's raining or its thunderstorm'. - P11

Importance of Stability

Participants also spoke of the importance of stability of service and considered it to be a key business resource:

> If we're down for a day or two, I mean that really affects your business quite a bit because you communicate with your customers. You want to make sure you're there all the time. - P1(2)

Participant P9 noted that his work involving commodity trading depends on consistent high-speed Internet. P9 was adamant that it did not have to be the fastest connection available, but it needed to be extremely consistent; he could not afford to miss a moment of real-time data. He indicated that dial-up is too slow, and that satellite would be too inconsistent for his needs. For him, missing a few minutes would be a problem. Several participants described frustrating incidents of trying to accomplish tasks and being interrupted by inconsistent network access. For P5, the frustration became so great he has simply quit using the Internet until he can get a new provider.

> But [with this ISP], you have to sign a 2 year contract, so I'm basically stuck with it. As soon as that's done, it's gone. [...] Whenever I can cancel it I will. - P5

Frustration with Multimedia

Participants did not make use of networked technologies when the available connection was insufficient. In particular, video-based media is difficult for participants to access with current network speeds. P3 gives an example of what it is like dealing with streaming video:

> [the video] wasn't one you could stop it and let it download and then play it. As soon as you click it to stop, it started the thing all over again. So it doesn't help. [...] Yeah you get a couple seconds at a time. - P3 [using wireless broadband]

Since multimedia is a large portion of the content found on the web, participants' frustration with this format may be a major contributor to the overall negative impression that many have towards networked technologies.

Unsustainable Coping Strategies

The previous sections reveal that not all participants have a consistent, good enough, Internet connection. Out of necessity, participants all noted alternative communication methods they depended on when a connection was unavailable, or sub-par. For some, this involved using text messaging and e-mail rather than relying on cellular technology for phone calls:

> Cell phones work so poorly here, so if people really need him, he tells them to email him, because that will get through when a call won't. - P2

Others commented on having to rely on two practices that have environmental implications. The first involves printing and faxing documents. They described needing to print documents to take with them, having to request to receive large documents via fax, or needing to send faxes to communicate with groups in under-serviced areas:

> If we knew they were sending a big file we'd tell them to send a fax or put it in the mail or whatever instead of emailing to us depending on what it was. - P1

P1 describes how a more reliable mobile Internet connection immediately reduced her need to rely on the less sustainable practices.

> Yeah [the G4 stick] saves a few miles. And when I've got my computer at the flour shed I don't have to carry the papers, so I'm not printing everything out all the time. [...]It's a little easier on the trees. - P1

Unfortunately, G4 connections are not available to all rural participants. More cellular towers would be needed in places where there may not be the customer base deemed economically necessary by the cellular providers. Participants also talked about travelling to get a better connection and travelling for face-to-face communication, when their connection was not good enough.

> I generally had to drive 6 miles to get any service at all. - P6

> Basically, I don't work from home if the connection isn't good. If I have to go to town, or head back into the city, often it will be because I need a more solid connection. - P7

Improving Service: A Catch 22

While the lack of quality service is disruptive to participants, creating the right financial incentives to increase service levels in rural and remote regions is something of a 'Catch 22' situation. Participants in rural areas with larger communities (e.g., P2, P8, and P10) were able to access wired broadband. As P6 and P5 describe, however, it is less economically feasible for providers to service less densely populated areas:

> These are untouched areas [...] everything's based on numbers, based on amount of users. - P6

> I got them to put me on a list 'cause, if they get enough customers, they're going to put another tower up, somewhere around here. - P5

But lack of or poor service makes it difficult for people to live and work in these communities. Industries in rural and remote areas are also run more and more efficiently:

> [the] farm hasn't changed much in size, but there are less of us doing the same amount of work. [...] Better machinery and we've changed to different methods to streamline things so there isn't as much work that has to be done. - P3

Ironically, greater efficiency means that fewer people have to live in these areas, making it difficult for those who remain to get access to the Internet and cellular services they want. While there are many sections of the country with poor service, it is the north that is faced with the biggest connectivity challenges. Northern Manitoba is the most poorly serviced area in the province according to the 2010 reports [26], and provider maps [5]. Participants sited areas that had no cell service at all and no Internet that they were aware of. P6 described an incentive program created by the government to increase the number of jobs for aboriginal people in the community that was unable to fill its positions due to difficulties communicating with interested parties:

> One of our greatest difficulties is reaching the people, [is] getting the message to them. Many aboriginal communities [are] without cell phone service, without Internet service, many homes do not have phones, they don't have running water, so to expect them to have phones or that sort of thing makes it difficult. - P6

These areas are far from cities, difficult to access, and often sparsely populated. P6 describes how convincing an Internet Service Provider to provide service requires cooperation of multiple parties:

> The only way we could have a cell tower in, was to have [a government owned utility company] partner with aboriginal groups to say that they would utilize it. [The utility company] would provide the hardware, the information, the location, a lot of the service. But you need to have [one of the big service providers] also bring in their equipment and stuff to sustain it [...] - P6

The quote above describes how access to service depends on the utility company building the tower, creating the road and providing access for the service provider to get their equipment to the tower. It depends on the aboriginal groups agreeing to long-term use of the services and on the service provider agreeing to provide hardware and service. Without cooperation of all three groups neither the utility company nor the aboriginal group has access.

3.4 Discussion

Access to networked technology in rural and remote areas is improving and people are taking advantage of this, but lack of stability and poor support for multimedia applications leave a negative lasting impression. While the sample size in this study is small, and based somewhat on convenience, participants include people working in a wide variety of locations in Manitoba, and a diverse range of careers. As such, I am optimistic that the results would generalize to a larger sample. Distributed work groups, over both time and distance, are particularly important constructs for people in rural and remote areas due to the long hours worked in many industries and long distances between communities. The wireless satellite based broadband service common in remote areas is not as consistent or fast as the wired broadband used in urban areas, accounting for users' negative perceptions.

This study suggests that the importance of rural and remote connectivity reaches beyond the residents of these regions. For example, government agencies and large companies need to service constituents/customers in a widely distributed service area. Since some of these customers cannot access multimedia content, these companies and

agencies have three options: restrict all customer communications to non multimedia, ignore rural customers, or create a two-tiered communication system. With each option, both the customers and the company loose out via either higher cost or poorer communication mode. The health of everyone is improved by better rural access to network connectivity. I learned from a participant that online auctions are improving the health of livestock, which improves the safety and consistency of our food supply. Tracking contagions can slow the spread of outbreaks and this requires a network connection between the location of the person who is sick and health officials. Health connectivity keeps people healthier, and saves money in the health care system and all businesses via reduced lost work.

Reliable connectivity in rural and remote areas also plays a role in keeping people safe. Rural and remote highway systems are used for transportation of goods and resources, and access to parks and recreation areas as well as for connecting various urban areas. Reliable connectivity in these areas would allow for faster emergency response to auto accidents and preventing movement of dangerous goods down closed roads due to things like flooding. Good connectivity can also help stop wild fires early and provide easier reporting and publicizing of severe weather and natural disasters. If good connectivity is available in rural and remote areas, safety issues can be reported early, before they reach more populated areas.

3.5 Summary

This chapter described a qualitative study consisting of semi-structured interviews, with people who work in a variety of industries, in rural and remote Manitoba,

about their experiences using networked technology. I found that work in these environments is increasingly dependant on both human and technology networks, across large time and distances. Reliability is a higher priority than accessing the fastest speed, and participants found ways to manage their expectations based on the situation in which they found themselves.

Chapter 4

Prototype: Search Connected

What if we knew more about each others' network connectivity? Could we help each other out? Leave each other alone? Would we be able to better manage our communication and be more productive?

In the previous chapter I discussed various work situations found in rural Manitoba 3.2.1. In this chapter I will describe a communication tool, called Search Connected, designed to support communication needs of the participants of these kinds of work situations. I will discuss how the results of the qualitative work from Chapter 3 led to the development of Search Connected and and how such a tool might be used in practice.

4.1 Perspectives for Prototype Consideration

As discussed in Chapter 3, types and levels of Internet access available in rural areas vary significantly from place to place and from time to time due to weather and

geography. Work in rural regions often involves travelling from one area of connectivity to another, possibly at significant distance, and involving some unpredictability in connectivity. The opportunity to engage in online chat with colleagues, who are currently experiencing a good connection day, may improve access to networked content for people working in rural and remote locations that experience limited network connectivity. In consideration of a number of concerns raised by participants of the qualitative study described in chapter 3, I designed a prototype to support access to online information in situations where team members experience diverse connectivity levels. The tool visually displays each contacts recent level of network connectivity. It keeps track of communication and allows users to share links and photos.

The Human Network vs the Physical Network

Every participant in my qualitative study used the Internet to connect with a distributed network of human contacts for their work. The contacts in each human network included some located in urban and some located in rural communities. Mary and Sam, the organic farmers, are part of a distributed group of farmers linked to food buying groups. This involves communicating with a network of rural and urban contacts on a regular basis. Tourism Industry participants noted communicating with customers from all over the world, and were involved in a marketing network throughout the province. Public service employees served constituents in rural communities and accessed services from centrally located urban service centres.

Noting that participants regardless of work type, all had human networks spanning a large variety of network connection types, I considered how a person's human

network might make up for any shortfall in the quality of their access to the physical network.

Connectivity Awareness during Communication

Participants in the qualitative study noted that in situations of poor connectivity short text messages worked far better than phone calls or long emails. They noted that multi-media worked poorly but plain text was better, and they noted that sometimes all contacts would receive downgraded communications because some contacts had poor connectivity. In addition, participants noted that there were times when they simply could not use the Internet due to slow connectivity.

If the quality of connectivity available to contacts were visible, then users would be able to manage their expectations in regards to the size of media that these contacts would be able to manage, and how quickly they might respond to messages. Less explanation would be required, and there might be fewer misunderstandings due to missed connections. When an individual experienced low connectivity they could reach out specifically to contacts with a good connection to help complete load heavy tasks like search.

So, incorporating testing network connectivity and making this information visible to the members of each member's human network was included as a design point.

Data Access Persistence

Participants in my qualitative study discussed accessing networked technology from multiple locations. With mobile network access becoming more common than desktop, users experience changing network access levels over the course of a work

week. The level of connectivity a person had when they accessed a link originally, may not be available when they next need access to that information. By providing screen-shots of websites, hosted locally, and simplified versions of websites via a tool called loband [18], users of Search Connected could retrieve data from locations where they might not have been able to in the past.

4.2 Rural/Urban Team: A Use Case for Search Connected

One of the participants in my interview study worked in northern camps for a corporation based out of Winnipeg. The corporate headquarters has very good network connectivity while the northern camps and other work locations associated with that company often have connectivity challenges. I developed a use case based on a team working in a similar type of company, one headquartered in an urban area with good connectivity, and having employees working in the field who could have varying levels of connectivity depending on time and place.

I named my imaginary company Prairie Trails Construction. This company maintains a head office in downtown Winnipeg and runs construction crews with multiple members at sites throughout Manitoba and North Western Ontario. Construction team members are provided with smart phones so that they may stay in contact, and construction sites have mobile offices with Internet access where possible. Due to the transient nature of these mobile offices, Prairie Trails Construction (PTC) finds it difficult to predict what type of network service will be available locally. The length

of time that these mobile sites are required is different for each contact and so often PTC does not want to sign up for long-term Internet service provider contracts and invest in vendor specific hardware. This means that often PTC will piggy-back on network services available through other contractors on site. The end result is that the network communications system used by PTC is a mixture of various different service levels, some consistent, others not, some high speed, others dramatically slower. The only location with consistent, reliable high speed connection, is PTC's head office in Winnipeg.

Next, I will describe the components of Search Connected, a prototype tool I developed with work teams like the one above in mind. The prototype's goal is to combine a human network and a technical network together to gain the best work productivity result possible. The keystone component of the tool is connectivity awareness for team members, supporting the team to aid each other with Internet intensive tasks like search, and including data access persistence as an adjunct service.

4.3 A Search Connected Prototype

I created a prototype for a possible tool to support our Prairie Trails Construction Team. Team members log into the tool and are able to communicate with each other. The prototype keeps track of contact's recent connectivity levels, text chats, and web links passed between communication partners. When links are saved the service provides access to an original versions of each link, and a second version mediated by a tool called loband.

Upon logging into the Search Connected tool, a connectivity speed test is initiated

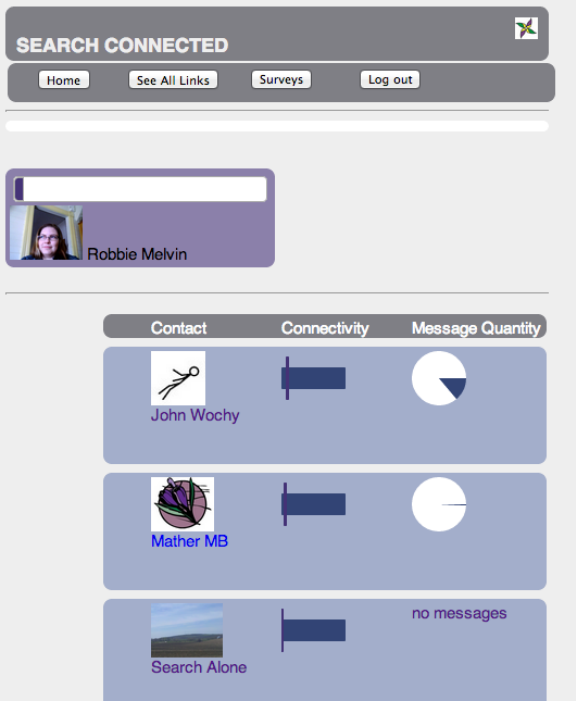


Figure 4.1: Search Connected - Contact list shown in the completed prototype

by the client's request for the home page. Currently, the speed test is based on upload and download speeds. The purpose of the prototype test is to investigate advantages of human users understanding comparative speed, not improving or using the speed itself, so the implementation as it stands was sufficient for my study. The Search Connected tool performs the speed test in the background and records the value for use in displaying comparative connectivity.

Once the speed test is complete, the user sees their home page, complete with details about their own network connectivity, and their team members' connectivity. (see figure 4.1) At any time, a user may retest and update their connectivity record, by clicking the home button.

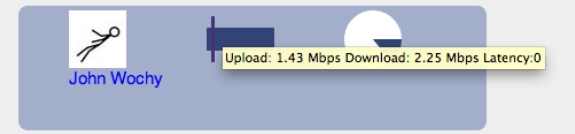


Figure 4.2: Search Connected - Full details of a contact's connectivity are visible upon hover.

Once a user has logged into the system they can view a list of their contacts. Each contact row shows information about that contact's current connectivity, and about the quantity of communication between the user and that contact. This information is shown in a visual graphic. When the user hovers over a contact line with the cursor, they can see more detailed information about the core data that makes up the visualizations (see figure 4.2). This information provides users with a good idea of who on their team has better connectivity than they do and might be able to help them with search tasks, and who on their team has poorer connectivity than they do and might be requesting help.

Links to content will be available as part of the message content shown at the bottom. If a communication partner sends a link, a user will have two options, the direct link, or the loband link.

When a user sends a new message to one of their contacts, the receiving contact will see that message immediately pop up on their browser window for Search Connected, even if they are engaged in a conversation with another user. These messages are tagged to show when the message is sent and who it is sent from (see figure 4.4). Once the page is refreshed due to a new message being sent out, previously recieved messages will appear under the send button.

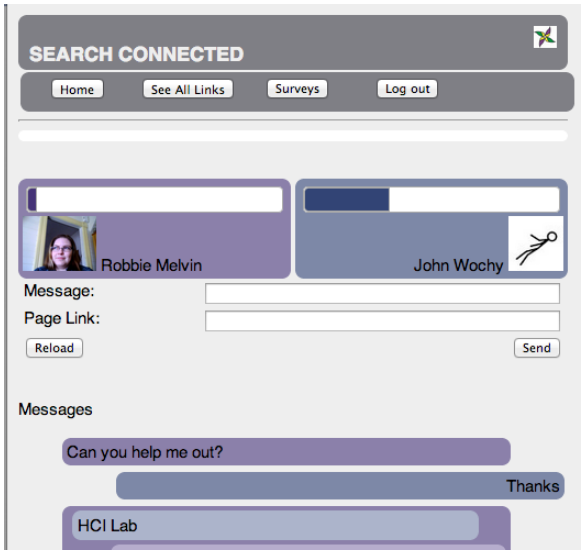


Figure 4.3: Search Connected - During a conversation the user's current connectivity, and their contact's connectivity are shown in the bar graph. The user can type new massages into the textbox or paste in a link. Past messages scroll bellow.

There is a button along the menu bar allowing users to go to "see all links". This takes them to a page with a table showing all links found in any conversation they are associated with (see figure 4.5). These links include both the direct version and the loband version for each. They are tagged with a description provided by the user. This description can be edited by clicking on it. They are timestamped. Future development of the tool could include sorting and screen-shot links.

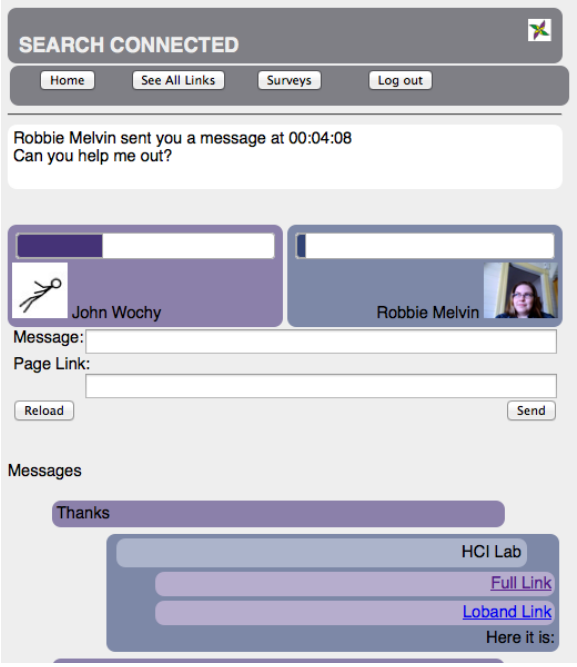


Figure 4.4: Search Connected - A New Message shows up during a conversation in the completed prototype. New messages may be from the current conversation or from another user.

4.4 Prototype Development

I employed an iterative process to develop the Search Connected prototype. I began by sketching out my design ideas in power-point slides. An example of one of the slides can be seen in figure 4.6. I printed these out and shared them with people in my rural community for informal feedback. From that feedback I adjusted the design and began developing PHP based web pages. At the same time, I sourced various open source and test APIs available for providing back end services to the tool. I created a number of component services and created individual access points

Figure 4.5: Search Connected - List showing all links

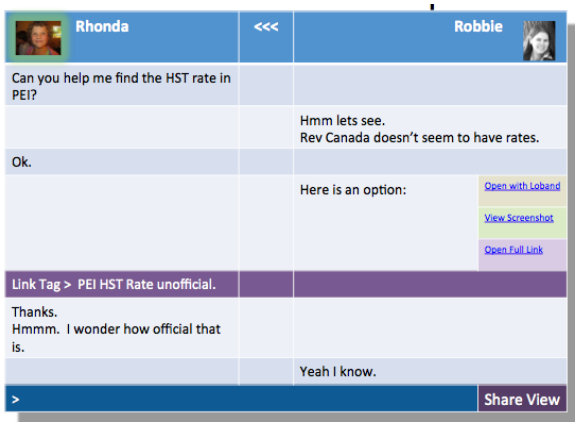


Figure 4.6: Paper prototype - Link during a conversation

for testing each (see appendix A.2).

During the development process of Search Connected I tested the tool with my own contacts, using the prototype to chat and complete search tasks. Adjustments

were made to the tool and to the design of the evaluation study based on this testing.

The prototype for Search Connected was developed as a Client-Server model with the Client side provided in a browser, including some Chrome extensions for additional embedding in a desktop environment. Via the browser, the tool is accessible to team members using a variety of networked devices, advantageous in a prototype. The speed test currently checks download and upload speeds. The Perl CGI script is based on open source code from B. Checketts [9].

All the records of ongoing speed tests from the Search Connected tool, and the Basic Speed Test tool are saved to a database. The details that are recorded include the download speed, the upload speed, the IP address, and browser details of the user. For the Basic Speed Test these details are displayed to the user to ensure that they are aware of their submission to a database.

The loband version of a link sends the regular url as a parameter to a server located at the University of Manitoba. The server loads the page and pre-processes the content before sending back a text only version of that content. I installed the original open source loaband [18] code on a local server at the Computer Science department. The loband tool may be accessed directly at

`http://grackle.cs.umanitoba.ca:8080/loband/main`. [10]

I also created a Chrome extension that allows a url to be typed directly into the Chrome tool-bar and a loband processed url will be opened in a browser window (see appendix A.9). I implemented the web tool using PHP and Javascript with JQuery. I stored contact, speedtest, and conversation data in a MySQL database and used the pusher api to provide real time updates facilitating bi-directional communications

(users do not need to check for new messages, they will be pushed to them).

`http://pusher.com/docs/rest_api`, [14]

I hosted files at a domain managed by Rural Insight Research and Technology with the exception of the loband code which was hosted at the University of Manitoba.

`http://research.ruralinsight.ca`, [16]

The Chrome extensions for speed test and the loband tool are available for download at the above url. Search Connected does not have a secure login and thus is not publicly available for use.

4.5 Summary

Our imaginary company, Prairie Trails Construction, can use the Search Connected tool to aid team members in accessing data in the field. PTC staff could log in to see team members they regularly communicate with listed, showing what the current connectivity status is for each. This is not so different from a typical chat facility that shows when users are online or offline, with the difference that variable levels of connectivity are also visible. When team members with low connectivity need to complete Internet intensive tasks, they can ask for help from members with high connectivity to speed up the process. In addition it allows team members to adjust their expectations prior to engaging others in a conversation. Office workers who regularly have a solid connection will be able anticipate messages requesting support from construction staff who's connection is waxing and waning as they travel

in and out of a cell zone. Testing such a tool requires multiple participants working simultaneously in environments with differing connectivity levels. In the next chapter I will discuss the first study completed to test Search Connected.

Chapter 5

Concept Evaluation Study

In this part of my thesis I explore preliminary use of Search Connected by paired urban/rural communication partners. In addition to exploring HCI research in the rural user environment, I wanted to learn something about how much users might find real time connectivity information useful, and an initial concept of what support Search Connected and remote search might provide to connection challenged workers. Given UTAUT [63], the evaluation study involved residents of rural communities in order include the consideration of the social and cultural influence of the types of people I imagine might use the tool.

In this chapter I will describe the concept evaluation study of Search Connected, its results, and future work related to Search Connected.

Figure 5.1: Rural Location - Mather, Manitoba

5.1 Study Method

My preliminary study involved paired search partners, one located in Winnipeg and one in the rural community of Mather, Manitoba. The partners communicated using the Search Connected tool, using it to complete simple search tasks. I recorded timed data using the tool, had the participants complete surveys and performed semi-structured interviews.

5.1.1 Location

The study involved participants paired from two different locations, one rural and one urban. Mather, Manitoba, the rural location, is >200 km from a city centre, in the Pembina Valley Region of Manitoba. The drop point on the map in figure 5.1 is Mather. The urban partners in the trials were located in the Human Computer

Interaction lab at the University of Manitoba, Winnipeg.

5.1.2 Participants

Participants, eight female and eight male, were recruited from two pools. The first set were residents to the Rural Municipality of Roblin where Mather is located (see figure 5.1). These rural participants were recruited through snowball sampling starting with my personal connections in the community. I also put up posters in the local store and post office. The second set of participants was recruited from the HCI lab and other graduate students in the department of Computer Science at the University of Manitoba, Winnipeg. The two sets of participants fell into the demographic sets described in table 5.1. Urban participants were provided with a $15 coffee card in compensation for their time. Participants in Mather were provided with $25 in Community Bucks to spend in the R.M. of Roblin. The rural compensation was a higher value to cover the costs of transportation to the evaluation site. Urban participants work locations were within walking distance of the lab.

5.1.3 Apparatus

For the trials, I used a public computer running Microsoft Windows XP, 32 bit operating system, 991 MHz processor with 448 MB of RAM , located in the Mather General Store which averages typical 562Kb/s download speed.

Within the HCI lab at the University of Manitoba, participants used a lab computer connected to the University of Manitoba High Speed network with network speeds upwards of 40 Mb/s download. The participants at the university used a

Demographic	Rural	Urban
Male	3	5
Female	5	3
20-24	0	1
25-34	1	6
35-49	2	1
50-65	3	0
>65	2	0
Grad Student	0	8
Retail	1	0
Agriculture	3	0
Administrative	1	0
Health Care	1	0
International Entrepreneurship	2	0

Table 5.1: Prototype study demographics

Windows 7 machine, with a 64 bit operating system, and a 3.4 GHz processor.

The Chrome browser was used in both locations to access the Search Connected system. Details of the Search Connected system and its implementation are described in Chapter 4 .

5.1.4 Design

The study used a within-subject design with one independent factor, search type, with two levels: search alone and Search Connected. The search alone (SA) condition consisted of the rural participant completing a search task without using the tool to communicate with their urban located partner. The Search Connected (SC) condition consisted of the rural participant using the Search Connected tool to communicate a search task with their urban partner and their urban partner completing the task and responding with the result.

The tasks were a list of eight simple, relatively isomorphic, search tasks that I developed. These tasks are shown in table 5.2. Condition order was fully counterbalanced across participants with half of participants completing four tasks under the Search Alone condition first, and the other half of the participants completing four tasks under the Search Connected condition first. The task order and assignment were completed randomly.

5.1.5 Procedure

The rurally located participant had eight search tasks to complete and employed the use of Search Connected to communicate with their search partner at the University to complete half the tasks.

I reviewed the entire procedure with each participant prior to beginning the trial. Each trial then began with the participant completing a pre-survey with some basic demographics and a few questions regarding their expectations of network communications (see A.2). When that was completed, they began the first four random tasks

	Search Tasks
1	Find how to Register for Pharmacare drug program in Manitoba
2	Find how to apply to live in residence at Brandon University
3	Find how to get a fishing license in Manitoba
4	Find what Red River programs are offered in Winkler
5	Find where to renew a Canadian passport - location options in Manitoba
6	Find the link to the National Film Board, Flin Flon movie
7	Find out how late the University of Manitoba Elizabeth Dafoe library is open this Saturday
8	Find when the next episode of CBC Spark, a radio show, is airing

Table 5.2: Search tasks

under the first search type condition.

For the Search Connected condition, the participant would contact their urban parter using the Search Connected tool and ask for help, sending information about the search task. I would record a start time for the entire task as soon as the rural participant received the task goal. After asking for aid in completing the task requested of them the rural participant waited for a response from their communication partner. When a result was provided, the rural participant verified the provided link completed the task. If the participant was satisfied I marked the task as completed recording an end time. For the search alone condition, the rural participant used the computer to browse the Internet searching for the solution to the requested

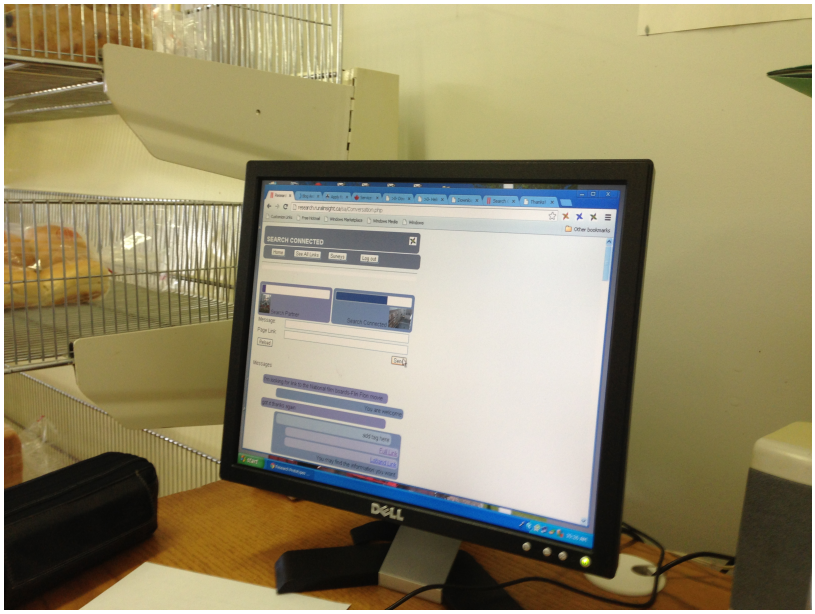


Figure 5.2: Rural Participant Workstation

task. I recorded start and end times for each search alone task from the time the participant started looking until they found a result that they were satisfied with.

As soon as the four Search Connected tasks were completed the rural participants completed the second survey (see A.2). This survey focused on the experience of using the Search Connected tool.

Finally, when all the tasks were complete, the participants completed a third and final survey (see A.2). The last survey asked participants to report their opinions about their expectations regarding using a tool like Search Connected in the future, or some of the features of Search Connected in other tools in the future. Following the last survey I conducted a short semi-structured interview which was audio recorded.

For urban participants, each trial consisted of four tasks. The urban participants also completed the pre-survey form, and a short familiarization with the tool. They

then waited for a request for help from the rural participants. They responded to each request via the Search Connected tool, and when the four tasks were complete, completed a survey gauging their perceptions of the tool and the process of helping someone with a search task remotely. They also completed a third survey looking at future use of the Search Connected tool or other tools with similar functionality. Their trial ended with a short, audio recorded, semi-structured interview.

I acted as facilitator for the rural participants and an undergraduate research assistant facilitated for the urban participants. Each session lasted up to an hour including the interview time. The urban participants spent some of this time waiting for their help to be requested by the rural participant.

5.2 Study Results

I start by presenting the study results with the task times for participants searching. This is followed by the participant perceptions as gleaned from the survey results. Finally, I reveal some of my observations of participant use of the tool and comments from participant interviews.

5.2.1 Task Times

A paired t-test for the overall task time, showed a significantly smaller searching alone time (mean: 94.13 seconds, standard deviation: 33.71 seconds) than searching connected time (mean: 214.88 seconds, standard deviation: 57.62 seconds ; $T(6) = 6.5199$ $P < 0.0006$) Figure 5.3 shows the task times for each of the eight participant pairs (and the mean), comparing the search alone to the Search Connected conditions.

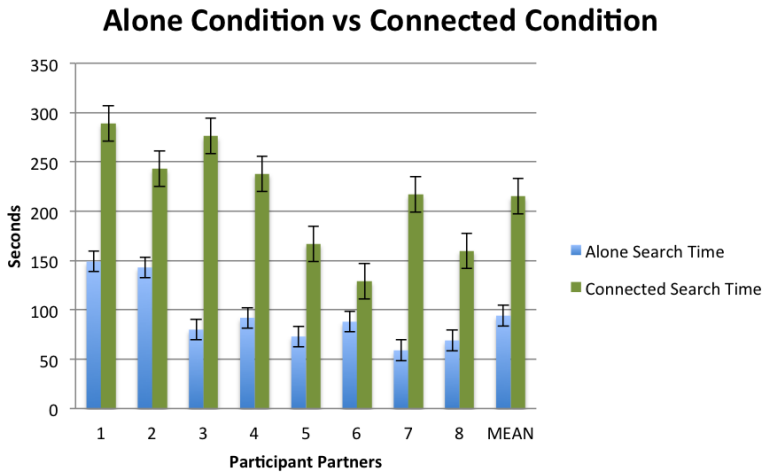


Figure 5.3: A comparison of search times, in seconds, of rural user alone, and with a connected search partner, including communication and confirmation time, broken down by participant pair. Error bars show standard error.

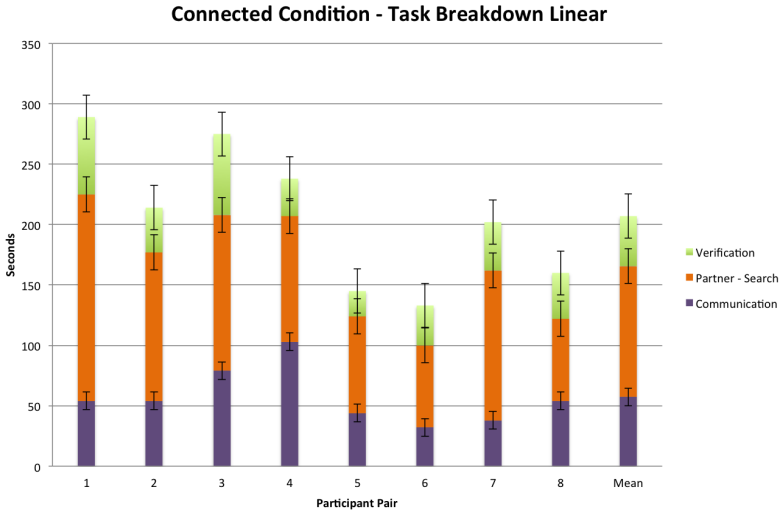


Figure 5.4: A breakdown of task into communication, search, and verification in a linear view. Error bars show standard error.

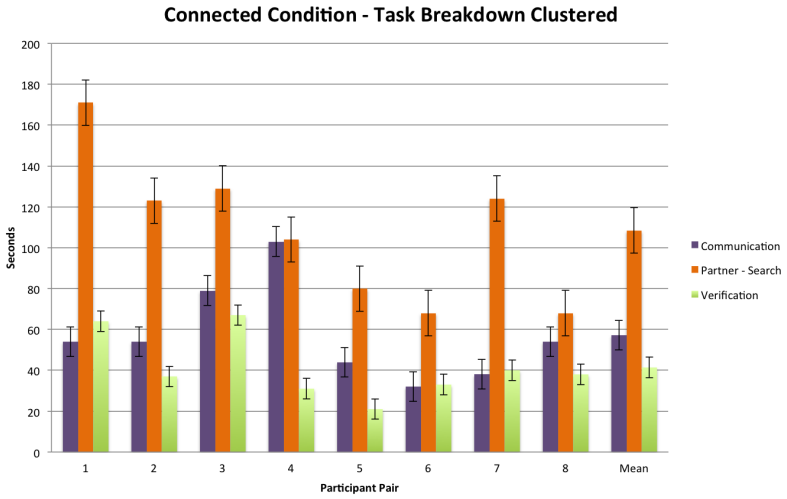


Figure 5.5: A breakdown of task into communication, search, and verification in a clustered view. Error bars show standard error.

I split the process of using the Search Connected tool up further to identify what was taking the bulk of time for the Search Connected condition, this is visible in figure 5.4. The process of using the Search Connected tool can be split into Communication time (mean:57.25 seconds, std: 23.24 seconds), Partner Search Time (mean:108.38 seconds, std:35.64 seconds), and Link Verification time (mean:41.38 seconds, std:16.01 seconds). In the clustered view, figure 5.5, we can see that the partner search is taking the largest amount of time for the Search Connected condition, and that communication and verification combined add up to the other half of the overall time for most of the participant pairs.

I compared the search times, without communication or verification for the urban participants and the Search Alone times for rural participants. Despite the urban partners having faster network connections, a paired t-test showed no significant

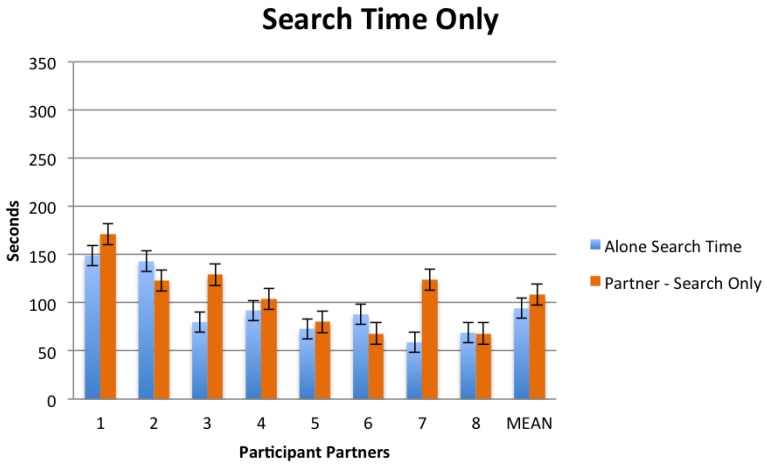


Figure 5.6: A comparison of search times, in seconds, of rural user, and of connected search partner, excluding communication and confirmation time, broken down by participant pair. Error bars show standard error.

difference between the Search Alone time in seconds (mean: 94.13 seconds, standard deviation: 33.71 seconds) and the search time only of the urban search partner (mean: 103.38 seconds, standard deviation: 35.64 seconds; $T(7) = 1.3248$ $P = 0.2269$. Figure 5.6 shows urban partners average search times compared to the rural partner's average time for each participant pair and the mean of all pairs.

5.2.2 Participant Perceptions

During this study I asked rural participants to answer three sets of survey questions A.2. The first included demographic information and an indicator of their current perceptions of how network connectivity affects their search experience (see table 5.3). There was a consensus that yes, network connectivity has affected the participant's

Statement	Mean	Standard Deviation
Network connectivity has affected my experience with search tasks.	4.37	0.74

Table 5.3: Previous experience/perception of rural participants: 1 = Strongly Disagree and 5 = Strongly Agree

experience with search tasks. Only one of the eight rural participants provided an ambivalent answer (3) on a five-point scale, the other seven agreed or agreed strongly with the statement, none disagreed. The one rural participant who was ambivalent about the statement "Network connectivity has affected my experience with search tasks." indicated in the interview that he does not have a mobile phone at this time.

The second set of survey results are shown in table 5.4. This survey was completed by each rural participant after they had used the Search Connected tool. The contents of this survey gauge the participant's perceptions of the ease of use of the tool and related concept. The responses were positive, responses being typical of "Communicating with the Search Connected tool was easy" (mean: 4.64 out of 5, std: 0.52). All answers were 4 or 5 out of 5. Graphs of the likert data can be seen in figure 5.7.

During the design of the Search Connected tool, deciding how much detail to provide regarding the network connection information was an uncertain design choice. Therefore, I gathered a variety of options, implemented two of them, and included a survey question with some images. I asked participants to select what they felt

Statement	Mean	Standard Deviation
I was comfortable asking for help with the search task(s) using Search Connected	4.625	0.74
Communicating with the Search Connected tool was easy	4.63	0.52
I understood the connectivity comparison graphic	4.37	0.74
I understood the message quantity comparison graphic	4.5	0.53
I was able to communicate the search task effectively using Search Connected	4.87	0.35

Table 5.4: Perceptions of the Search Connected Tool by Rural Participants: 1 = Strongly Disagree and 5 = Strongly Agree

was the best graphical representation for connectivity and message quantity based on their experiences with the tool, and with communicating online in the past. The options provided and results are shown in figure 5.8. Six of the eight rural participants preferred the pie graph used in the study for quantity of communication. The largest number of rural participants (four) chose the bar graph (used in the study) as their preferred visualization for network connectivity. Two more chose the option "raw number scale" where my visual was five stars. The urban participants, grad students in computer science, were interested in seeing the raw data in addition to

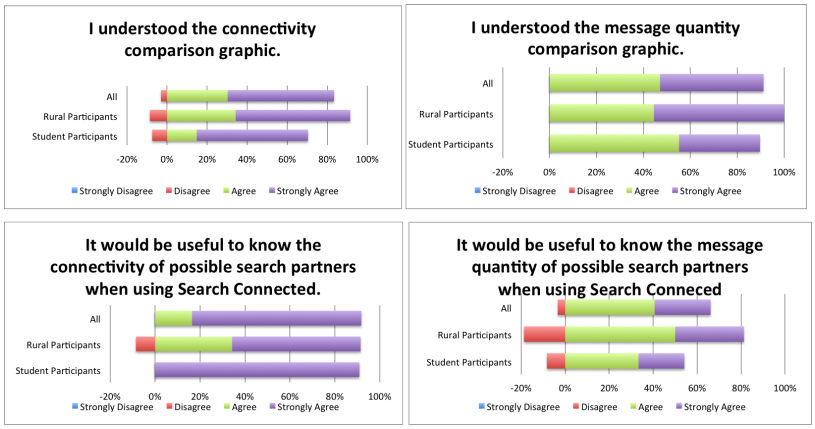


Figure 5.7: Likert Details - disagree and strongly disagree are graphed as negative values to the left, agree and strongly agree are graphed as positive values to the right. Neutral answers are not included.

the graphical representation. They liked that this was provided in the mouse over on the connectivity graphic and indicated so in comments.

The last survey I asked participants to complete related to future iterations of the Search Connected tools, and related online communication. The results in table 5.5 include high scores for telling others about the tool (mean: 4.5, std: 0.75) (one neutral, 7 positive) but less agreement for likelihood of their own use of the tool (mean: 3.75, std: 1.03) (one negative, two neutral, 5 positive). Overall participants felt that knowing the connectivity of people they were communicating with and how much they communicate with them would be useful (mean: 4.0, std: 0.75) (two neutral, 6 positive).

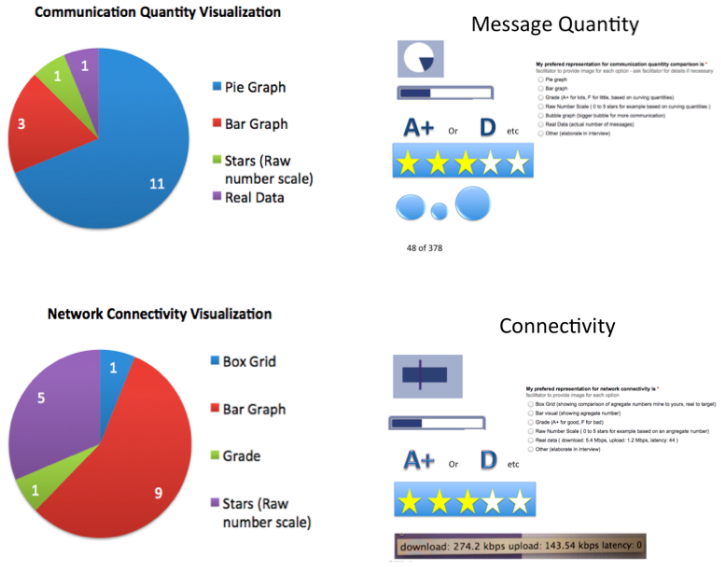


Figure 5.8: I asked participants to compare the visualizations used in the Search connected tool with other options considered during the design process. Participants generally supported the visualization choices made.

Statement	Mean	Standard Deviation
I am likely to ask others to help with search tasks in the future	3.37	1.06
It would be useful to know the connectivity of possible search partner when using Search connected	4.37	0.74
It would be useful to know the message quantity of possible search partners when using Search Connected	4.00	0.75
The loband link would be useful to me when using Search Connected	4.37	0.74
I would use Search Connected	3.75	1.03
I would tell others about Search Connected	4.50	0.75
I am likely to help someone with a search task in the future	4.12	0.83

Table 5.5: Expectations for the future survey results for rural participants: 1 = Strongly Disagree and 5 = Strongly Agree

5.2.3 Observations of Trials and Interviews with Participants

During the trials I took note of some of the behaviour of the rural participants, in particular where it deviated from my expectations regarding the tool. I followed up each trial with a semi-structured interview where I was interested in gaining insight into participants network communication needs which might impact their responses to the surveys. I also wanted to find out their perceptions regarding the value of the loband link incorporated into Search Connected, and what they thought regarding inclusion of connectivity visibility, like that included in Search Connected, in online and mobile communications.

Observations and Follow up

The use of the tool deviated from my expectations two main ways. The communication time took longer than I expected and the search tasks took much less time than I expected at the rural location. In addition, the research assistant and I noted some general usage improvements that can be made to the tool to speed up communication and page load times.

There were two direct observations which relate to communication times. Participants tended to worry about spelling and typos much more than I anticipated. They also sometimes needed to clarify their requests with their communication partner. In the process, the communication time between search partners was more than a quick text message.

I asked participants about their experience explaining search tasks to their communication partners. They perceived this to be a simple communication task and

were not concerned about the length of time the explanations took:

> It's simple actually, you can just ask what you want to know, you don't have to think ... oh what's the technical word here... you know you can just guess [and the communication partner can clarify]

At the same time I gained some insight about why participants worried about typos:

> sometimes you get the words in the wrong place and it makes a different meaning - M2

> well the first time I thought my request was fairly clear, but obviously they didn't understand it so that added another step to the process. - M3

Overall the participants used the tool as a normal chat facility, accomplishing tasks via conversation:

> I just ask the question how I would ask somebody in person... - M8

The network connection at the rural location was slower than the urban location, but it was consistent during all the trials. As a result the rural participants were able to easily perform the alone search tasks without interruption. The connectivity challenged situation, that the tool was designed to help, was not experienced during the trials. I also noticed that a couple of the rural participants were Google search 'stars'. They took advantage of more advanced functionality of the search tool and were able to pull up the right items very quickly and the difference between the search alone times for the rural users and the search only times for the urban users was not statistically significant for this sample size. It would be interesting to repeat such a test for a larger, more diverse sample to find out if lower bandwidth has contributed to compensatory skill development.

In observing active use of the tool the research assistant and I quickly noted a few situations where the Search Connected tool could be improved. Firstly, there was no way for someone who had moved to another tab, to know if their communication partner had sent them updated information. This meant that the urban partner might be searching without key clarifying information that could reduce the overall task time. Secondly, the link was unnecessarily in a separate field (figure 4.3) adding clutter and some confusion during the trials. Lastly, for long conversations, the conversation history content can be quite large to load which is an unnecessary burden on the network.

I also asked the participants to suggest additions to the interface:

> You know personally, I always try to be polite, so I always want to say thank you or something something, so If you had preloaded responses, that might be kind of handy, or you know how those little smiley faces, I never use those things, but if you had something that represented, yes thats what I wanted,"thank you very much", "try again", or "you such", you know what I mean, with a click of a mouse, bamb! ... -M3

Adding quick links to insert pre-programmed text fragments might improve communication time as well.

loband

While using the loband link was not part of the trials, I did show it to the rural participants and asked them what they thought of its usefulness during the interview. I had thought of this as a way to get data faster in situations with slower connections, or even to make it easier to find 'just the data' someone was looking for. This was confirmed by a number of participants.

> for the most part yeah, I mean sometimes its nice you want the picture to come up, but for a lot of things its just the information you want [...] I think 80% of the time - M8

> it would be great for data, [...] and for pictures of course, it wouldn't work, but for quick data, yes, we'd use that 90% of the time. For sure, I don't care about illustrating anything when I'm sending someone a message, it doesn't have to have all the pictures it's only if that's critical for business, so loband that's great for that - M7

In addition one participant brought up another use advantage of the Search Connected tool, saving on the amount of data downloaded when you have a cap or are paying by the Gigabyte.

> particularly if I was on my phone, ok, that would be super useful. - M5

An App for mobile devices which pre-processes websites and provides links to multi-media content could be really useful when navigating between cellular and wi-fi access and managing data use.

Connection Visibility

In the Search Connected tool, a key component is the visibility of each possible communication partner and the comparison of the user's connectivity level, to that of their communication partner's. 5.9

To that end, I asked participants how valuable such information would be to them in their online communication tools in general. There are any number of communication tools available and the network connectivity visibility is a key differentiating component of Search Connected. It is something that could be embedded in other chat or general communication tools to improve functionality. Participants felt that the addition of this kind of information would be helpful.

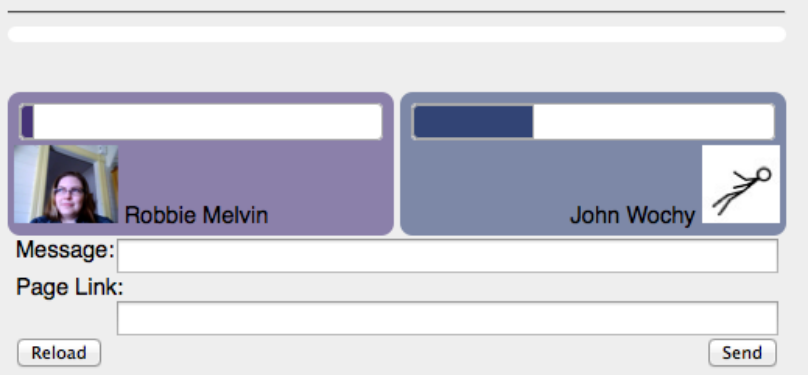


Figure 5.9: My connectivity vs John Wochy's connectivity

> It is nice to know, like when I'm emailing there's lots of things I don't send to people because I know it takes forever, you know it's nice to know. - M2

> exactly, yeah I would, and I would like it especially here, if they could see, ok, because then they see the connectivity, or lack of it, that I have and then they can, and we can work around that and they can accept the fact that I can't send them stuff. - M5

> if we're having problems getting a-hold of them and we knew it was a hit and miss thing like our phone, it would be good to know so you don't get frustrated. - M1

Participants expressed enthusiasm for having knowledge of their communication partner's level of network connectivity. They shared instances where they experienced variable connectivity levels during communication by phone and email, and this kind of knowledge would be helpful.

The sharing of meta data brings up the question of privacy. The tool is collecting connectivity data and posting it for all of a user's communication partners to see. I also asked participants if they were comfortable with their contacts knowing their connectivity information, or if they were concerned about the privacy of this kind

of data. In general, they did not have any concerns. The participants felt that the increased awareness was worth providing the data.

> oh I would rather have that absolutely, and we could kind of like let them know.. we get messages in the middle of the night, we get them in the morning because they could be from China, you know so we could organize when we're going to be talking to somebody on the computer and the sending part when we know we're going to have the best connection. - M7

or at worst...

> well, its no worse than facebook. ... - M5

Participants were comfortable with the tool, and with the idea of increased awareness of connectivity status. They could imagine a variety of situations where that would be advantageous.

5.3 Discussion

This preliminary study, while small, provided enough insight to guide some next steps. The challenges of implementing a study over a distance with both rural and urban users were not small, but also not insurmountable and the results are interesting and different enough to provoke continued work in this area. This study revealed changes that can be made to the Search Connected tool moving forward, and has provided some ideas for planning a follow up study.

5.3.1 Updates to Search Connected

There are portions of the Search Connected tool, while designed, that have not yet been implemented. There are also improvements to the tool that have been identified

based on observations of its use and interviews with participants.

In observing active use of the tool, we quickly noted a few improvements that could be made. Firstly, there was no way for someone, who had moved to another browser tab, to know if their communication partner had sent them updated information. This problem could easily be fixed by adding a browser extension with a visual marker noting a new message was available. Audio notifications are also possible, though these can get lost in all the noise. Secondly, the link and message fields can be combined. Having the link as a separate field adds clutter and some confusion during the trials. Lastly, as the conversations get longer and longer, the interface should be updated to only show the most recent part of the conversation until the user starts to scroll down.

A significant update, will be the addition of a mobile version of the Search Connected tool in app form. My qualitative work highlighted the significance of the in-situ workstation in rural and remote work environments. Connecting mobile users that have intermittent connectivity with team members that have hard wired connections would be key to deploying the tool to a full team of users.

In addition to exposing some areas where the prototype can be improved, this study exposed limitations to the short-term nature of the study itself. Only two levels of connectivity were experienced and thus participants were not able to observe the tool in situations of variability. In this study the communication time dominated our statistics; the amount of time users spent communicating was much larger than the amount of time searching took. I posit that in a longer term study, this may be less so and also that participants may be more comfortable using the tool without

an observer. They may become faster at communicating as they become more familiar with the tool over time. The changes proposed for the tool, like adding special notifications when new messages show up, will improve communication time as well. Most significantly, in a long-term study more connectivity variability would occur, increasing the possibility of situations arising where the connectivity gap between communication partners would make up for the additional communication time. To this end I would like to follow up my previous work with a multi-month study deploying an improved version of Search Connected on desktop and mobile devices in a team environment.

5.3.2 Realistic Search and Communication Situations.

In order to achieve relative isomorphism between search tasks, the tasks in this study were necessarily short. Larger tasks would have introduced increasing variability amongst each other. I suspect though, that with the short search time required by the tasks in question, any improvement that might be made by searching with a fast Internet connection was completely dwarfed by the added communication overhead time required by the tool. It is possible that with larger tasks (multiple searches in the same space), and more subject matter expert oriented urban partners, that there may be enough increase in search speed to make up for the added communication time. In order to test this I would need to deploy with a team, perhaps a company or group with a rural/urban split of workers. Tracking use over weeks or months would allow me to gather data in a variety of connectivity conditions.

By deploying the tool within a team in a real work environment I can find out

how much such a tool might be used for real communication situations. Would use increase over time? What sort of search tasks come up, small or large? Where do the participants most need the tool? By deploying to mobile devices I would be able to add additional tracking data like GPS and note where in the province users most requested help, and also where they lost signal.

5.3.3 Considerations for Future Study

For logistical reasons, I chose to locate my study in a public place and attracted participants in the local rural community. In doing so I ended up with two considerations. Firstly, we experienced a faster Internet connection than what the intended audience for such a product might be. The speed of the network connection from the testing location varies at times, and was particularly good at the times of our trials, which combined with the shortness of the test tasks, lead to diminishing returns on the part of the prototype. Secondly, the diversity within of the participant group was limited and there was no existing relationship between the rural users and their urban communication partners. A future study could include a rigorous participant screening step to identify parameters like personal search ability, contact relationship(s) and connectivity levels commonly experienced. These details could aid in understanding how personal difference influence perception of Search Connected. A larger study could include more varied connection types and more complex communication situations and may be more revealing about the possibilities regarding leveraging support of urban located communication partners to remote users.

A future deployment might be within an existing team. This would mean that the

communication partners would have a familiarity with each other and possibly some sort of common work language. As identified in chapter 4, my intention in designing the Search Connected tool was to combine the advantages of the human network to the process of search. I imagine that participants would either know each other or be communicating about a topic that the helping partner knows well (for example a website help-desk like University of Manitoba's askalibrarian [12]). Communication times in such situations may be reduced.

5.4 Summary

This concept evaluation highlighted where Search Connected worked well, and suggested some adjustments that can be made to the tool. Most importantly I learned that there needs to be enough disparity between connectivity levels and large enough search task to justify the additional communication time required by the tool. Happily, participants found the tool easy to use and responded encouragingly in the survey and interview. The study participants' responses indicate that continued research in this area is worth perusing.

Chapter 6

Conclusion

6.1 Summary

In this thesis I discussed the challenges of accessing network technology in rural and remote environments. I extended HCI research out of the university lab and into the rural environment in search of a different perspective on networked computer usage. While specific connection situations can be simulated, the variability of real world work environments and the culture surrounding them cannot.

I conducted semi-structured interviews with people who work in rural and remote communities and discussed their experiences using networked technology for communication. I found that there are connections between rural and remote work and urban work via distributed work teams. Rural workers have developed coping techniques, are open to any support that can be provided to them, and welcome the opportunity to share their experiences and perspectives. Given sufficient connectivity people in rural and remote communities are increasingly open to adding technology to

their communication routines and come to depend on that connectivity. They value stability in their network connections over speed, and deal with intermittent and slow connections by controlling the size of the data they send and receive.

Based on these rural perspectives, I developed the Search Connected Prototype. The tool is meant to leverage the distributed work teams often available to rural workers to help them with search tasks when they have slow or inconsistent network connections. The Search Connected tool is a chat facility that shows a visual graphic describing team members network connectivity level, and facilitates users sending url links to each other. I performed a concept evaluation study of the tool. Users found Search Connected to be easy to use and responded positively to the concept. The study also identified, however, that a tipping point needs to be found where size of task and disparity of connectivity is large enough to warrant the communication between team members.

The main contributions of this research are:

- identification of where networked technology fits into rural and remote work life
- identification of challenges experienced by workers in rural and remote environments using networked technology
- a prototype tool designed for leveraging distributed work groups to support workers in situations of low connectivity in completing search related tasks.
- an initial study of the tool in a rural setting which confirmed that the prototype tool has promise and identified future research questions

6.2 Future Work

In recent years, there have been significant changes to the network connectivity landscape. The community where I completed the Search Connected study has ever changing connectivity opportunities. New and improved Wi-Max towers are being added, providing significantly improved Internet access for many people while at the same time increased cellular uptake has overloaded the local cell towers reducing the consistent availability of mobile network access.

International companies have taken notice of the remaining digital divide with the launch of Google loon [13] and internet.org [11]. The wireless spectrum auction is poised to change the face of mobile data access in Canada [61].

Given these changes, a follow up with the participants of my exploratory qualitative study, to see how adjustments to available connectivity options may or may not be impacting, could add some continuity to our understanding of rural perspectives.

In the first qualitative study, I spoke to two participants who worked in Northern Manitoba. The experiences described in this region were on the extreme end of the spectrum. A promising avenue of future research would be investigating a possible connection between technical communication challenges in Canada's North and social concerns in those communities. The socio-economic and geographic situations in the North provide a very specific demographic worth more detailed investigation.

I completed a small user study of a prototype with rural users in a rural setting. Even so, there were differences in the way rural and urban participants used and responded to the same tool, indicating that further in-situ HCI testing may lead to further valuable insights. Testing products with rural users in a rural setting may

result in useful new information for other new prototypes particularly when they are meant for use by distributed teams. For example distance education is frequently used by people residing in rural and remote locations. We may learn beneficial design ideas from testing various online education delivery tools in rural locations.

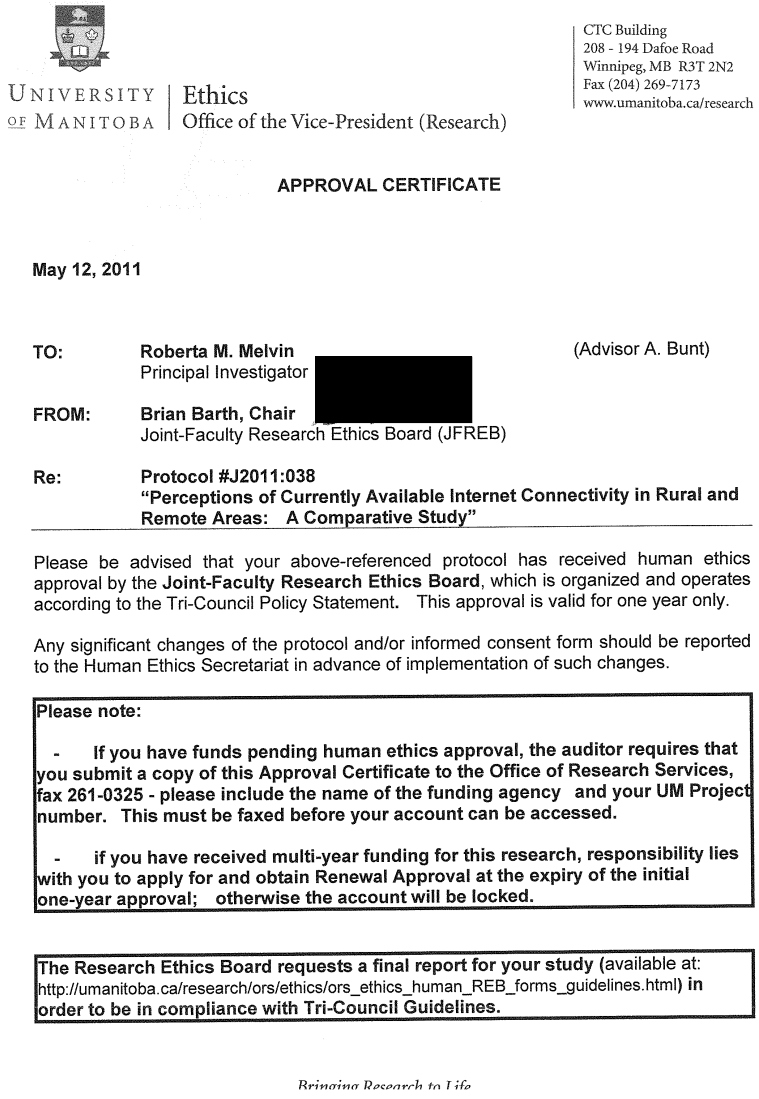
A larger long-term study could be conducted with a goal of identifying what tasks benefit most from the tool, and what disparity between connectivity levels is large enough to justify the added communication time. Deploying the tool within an existing work time like the one described in chapter 4 would provide a realistic variety of tasks and connectivities.

Appendix A

Supporting Documents

A.1 Qualitative Study

Ethics Approval



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www.umanitoba.ca/research

APPROVAL CERTIFICATE

May 12, 2011

TO: **Roberta M. Melvin** (Advisor A. Bunt)
Principal Investigator [redacted]

FROM: **Brian Barth, Chair**
Joint-Faculty Research Ethics Board (JFREB)

Re: **Protocol #J2011:038**
"Perceptions of Currently Available Internet Connectivity in Rural and Remote Areas: A Comparative Study"

Please be advised that your above-referenced protocol has received human ethics approval by the **Joint-Faculty Research Ethics Board**, which is organized and operates according to the Tri-Council Policy Statement. This approval is valid for one year only.

Any significant changes of the protocol and/or informed consent form should be reported to the Human Ethics Secretariat in advance of implementation of such changes.

Please note:

- **If you have funds pending human ethics approval, the auditor requires that you submit a copy of this Approval Certificate to the Office of Research Services, fax 261-0325 - please include the name of the funding agency and your UM Project number. This must be faxed before your account can be accessed.**

- **if you have received multi-year funding for this research, responsibility lies with you to apply for and obtain Renewal Approval at the expiry of the initial one-year approval; otherwise the account will be locked.**

The Research Ethics Board requests a final report for your study (available at: http://umanitoba.ca/research/ors/ethics/ors_ethics_human_REB_forms_guidelines.html) **in order to be in compliance with Tri-Council Guidelines.**

Bringing Research to Life

Figure A.1: Ethics Approval for Qualitative Study

Informed Consent

University of Manitoba April 2010

UNIVERSITY OF MANITOBA

Informed Consent Agreement

Study Title: Perceptions of Currently Available Internet Connectivity in Rural and Remote Areas: A Comparative Study

University of Manitoba HCI Lab http://hci.cs.umanitoba.ca/
E2-551 EITC

Principle Investigator: Roberta Melvin
960.4395 or melvin@cc.umanitoba.ca

Co-Investigator: Dr. Andrea Bunt
bunt@cs.umanitoba.ca

This consent form, a copy of which will be left with you for your records and reference, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

Purpose of the research study: We are examining perceptions of currently available internet connectivity options in rural and remote areas. The focus of the study is on the impact of levels of connectivity on business activities.
Method of research: As a participant in this study, you will be interviewed by the primary researcher. The researcher will ask to audio record the interview. As a result of the interview, you may be asked to allow the researcher to shadow you as you go about some business activities. During the interview you will explain your work, what communication you currently engage in as well as any additional communication that might be beneficial in future. At times the researcher may stop to ask clarifying questions and may ask to take video recordings of the environment and/or of activities. The discussion and shadow sessions will include activities both with and away from computers as the entire context is important to the research. The audio and video recordings will serve as references in our data analysis allowing us to review items in detail. Only the research team will review the recordings.
Time required: The researcher will schedule work shadow sessions with you. There will up to 3 sessions, totalling no more than 8 hours.
Risks: There are no anticipated risks in this study.
Compensation: You will receive a copy of the report generated from the results of this study. The report is intended to encourage future research into improved communication tools for rural and remote internet users.
Confidentiality: The information that you give in the study will be handled confidentially. It will be viewed by the researchers working on this project only. That may include faculty, research assistants in addition to the primary investigators. Your name will not be included in association with the published data associated with the study.
Voluntary participation: Your participation with this study is entirely voluntary.
How to withdraw for the study: You may withdraw from the study at any time. If an interview is in progress simply tell the researcher and the interview will end. If you wish to withdraw during the analysis portion of the study, notify either the principle investigator or co-investigator via the contact information above.

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time, and /or refrain from answering any questions you prefer to omit, without prejudice or consequence. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.
The University of Manitoba Research Ethics Board(s) and a representative(s) of the University of Manitoba Research Quality Management / Assurance office may also require access to your research records for safety and quality assurance purposes.
This research has been approved by the Joint-Faculty Research Ethics Board. If you have any concerns or complaints about this project you may contact any of the above-named persons or the Human Ethics Coordinator (HEC) at 474-7122. A copy of this consent form has been given to you to keep for your records and reference.

Agreement:
I agree to participate in the research study described above.

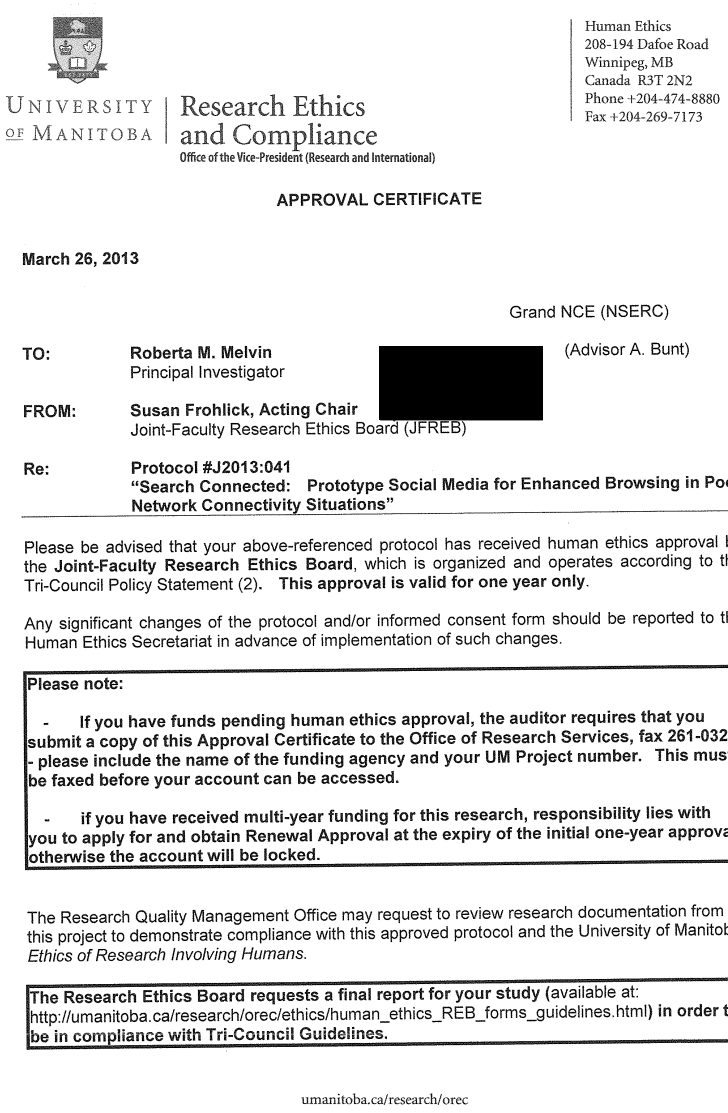
Name:		☐ Consent to Audio Recording
E-mail:		☐ Consent to Video Recording
Phone (optional):		☐ Interested in being contacted for future studies.
Signature:	Date:	

Researcher Signature:_____ Date:_____

Figure A.2: Informed Consent form for Qualitative Study

A.2 Search Connected Study

Ethics Approval



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APPROVAL CERTIFICATE

March 26, 2013

Grand NCE (NSERC)

TO: **Roberta M. Melvin** (Advisor A. Bunt)
Principal Investigator

FROM: **Susan Frohlick, Acting Chair**
Joint-Faculty Research Ethics Board (JFREB)

Re: **Protocol #J2013:041**
"Search Connected: Prototype Social Media for Enhanced Browsing in Poor Network Connectivity Situations"

Please be advised that your above-referenced protocol has received human ethics approval by the **Joint-Faculty Research Ethics Board**, which is organized and operates according to the Tri-Council Policy Statement (2). **This approval is valid for one year only**.

Any significant changes of the protocol and/or informed consent form should be reported to the Human Ethics Secretariat in advance of implementation of such changes.

Please note:

- **If you have funds pending human ethics approval, the auditor requires that you submit a copy of this Approval Certificate to the Office of Research Services, fax 261-0325 - please include the name of the funding agency and your UM Project number. This must be faxed before your account can be accessed.**

- **if you have received multi-year funding for this research, responsibility lies with you to apply for and obtain Renewal Approval at the expiry of the initial one-year approval; otherwise the account will be locked.**

The Research Quality Management Office may request to review research documentation from this project to demonstrate compliance with this approved protocol and the University of Manitoba *Ethics of Research Involving Humans.*

The Research Ethics Board requests a final report for your study (available at: http://umanitoba.ca/research/orec/ethics/human_ethics_REB_forms_guidelines.html) **in order to be in compliance with Tri-Council Guidelines.**

umanitoba.ca/research/orec

Figure A.3: Ethics Approval for Prototype Study

Informed Consent

University of Manitoba April 2013

Informed Consent Agreement

Study Title: "Search Connected: Prototype Social Media for Enhanced Browsing in poor Network Connectivity Situations"

University of Manitoba HCI Lab E2-551 EITC http://hci.cs.umanitoba.ca/

Principle Investigator: Roberta Melvin
960.4395 or melvin@cc.umanitoba.ca

Co-Investigator: Dr. Andrea Bunt
bunt@cs.umanitoba.ca

This consent form, a copy of which will be left with you for your records and reference, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

Purpose of the research study: We are evaluating the feasibility of a social media tool to support Internet browsing in poor network connectivity environments. **Method of research:** As a participant in this study, you will be asked to evaluate a social media prototype tool. This prototype is web based, accessed via a web browser extension, and written by the Principle Investigator. You will log into the tool using a test login provided by the researcher, complete search tasks on safe public sector websites, and communicate with a fellow participant. The software will record the network connectivity at the time you use the tool and the content of your conversations using the tool. The data collected via the software will be saved to a web server. You will be asked to complete a survey about your experience using the tool, and to participate in a short interview with the researcher. We may ask to record the tests and the interviews using video or audio equipment. The recordings will serve as a reference point in our data analysis allowing us to review the test and interview(s) in detail. The level of recording used is your choice. **Time required:** The prototype evaluation, survey, and interview together should take no more than 60 minutes. **Risks:** There are minimal anticipated risks in this study. **Compensation:** You will receive a gift card and a copy of the report generated from the results of this study. **Confidentiality:** The information that you give in the study will be handled confidentially. The researchers working on this project will view it. That may include faculty, and research assistants in addition to the primary investigator. Your name will not be included in association with the published data associated with the study and the raw data will be deleted once results are published (thesis and peer-reviewed papers). **Voluntary participation:** Your participation with this study is entirely voluntary. **How to withdraw from the study:** You may withdraw at any time prior to May 31, 2013, by contacting the above investigators. Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time, and /or refrain from answering any questions you prefer to omit, without prejudice or consequence. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.

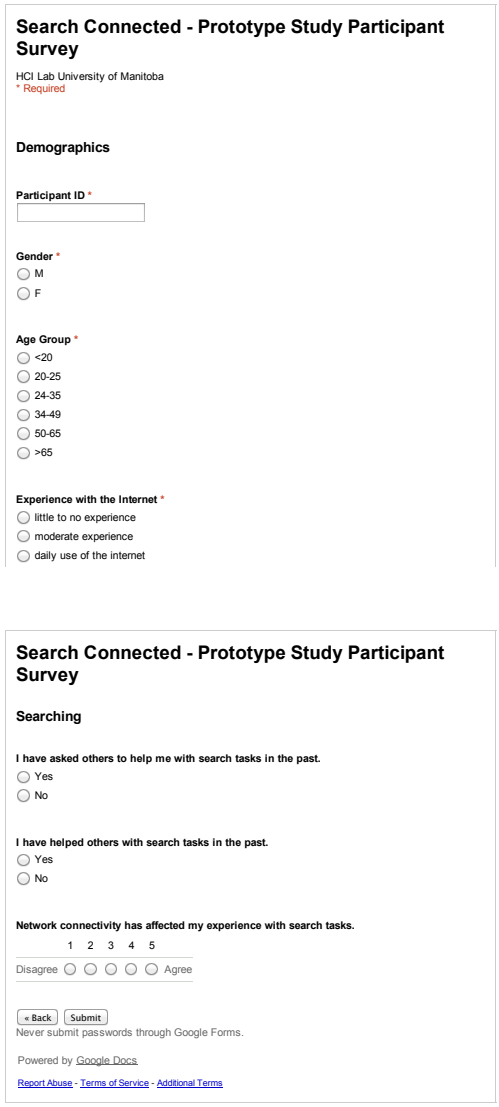
The University of Manitoba Research Ethics Board(s) and a representative(s) of the University of Manitoba Research Quality Management / Assurance office may also require access to your research records for safety and quality assurance purposes. This research has been approved by the Joint-Faculty Research Ethics Board. If you have any concerns or complaints about this project you may contact any of the above-named persons or the Human Ethics Coordinator (HEC) at 474-7122. A copy of this consent form has been given to you to keep for your records and reference.

Agreement: I agree to participate in the research study described above

Name:	☐ Consent to Audio Recording	
Email:		
Phone:	☐ Interested in being contacted for future studies.	
Signature:	Date:	Researcher Signature

Figure A.4: Informed Consent form for Prototype Study

Survey Components



Search Connected - Prototype Study Participant Survey

HCI Lab University of Manitoba
* Required

Demographics

Participant ID *

Gender *
- M
- F

Age Group *
- <20
- 20-25
- 24-35
- 34-49
- 50-65
- >65

Experience with the Internet *
- little to no experience
- moderate experience
- daily use of the internet

Search Connected - Prototype Study Participant Survey

Searching

I have asked others to help me with search tasks in the past.
- Yes
- No

I have helped others with search tasks in the past.
- Yes
- No

Network connectivity has affected my experience with search tasks.

1 2 3 4 5

Disagree ○ ○ ○ ○ ○ Agree

« Back Submit

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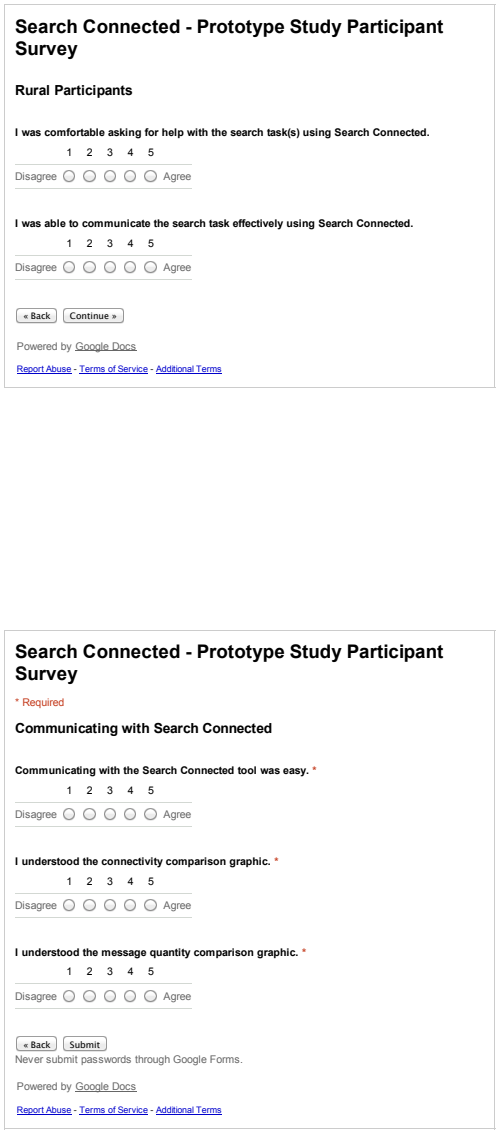
Figure A.5: Pre-Survey



Search Connected - Prototype Study Participant Survey

Rural Participants

I was comfortable asking for help with the search task(s) using Search Connected.

1 2 3 4 5

Disagree ○ ○ ○ ○ ○ Agree

I was able to communicate the search task effectively using Search Connected.

1 2 3 4 5

Disagree ○ ○ ○ ○ ○ Agree

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Search Connected - Prototype Study Participant Survey

* Required

Communicating with Search Connected

Communicating with the Search Connected tool was easy. *

1 2 3 4 5

Disagree ○ ○ ○ ○ ○ Agree

I understood the connectivity comparison graphic. *

1 2 3 4 5

Disagree ○ ○ ○ ○ ○ Agree

I understood the message quantity comparison graphic. *

1 2 3 4 5

Disagree ○ ○ ○ ○ ○ Agree

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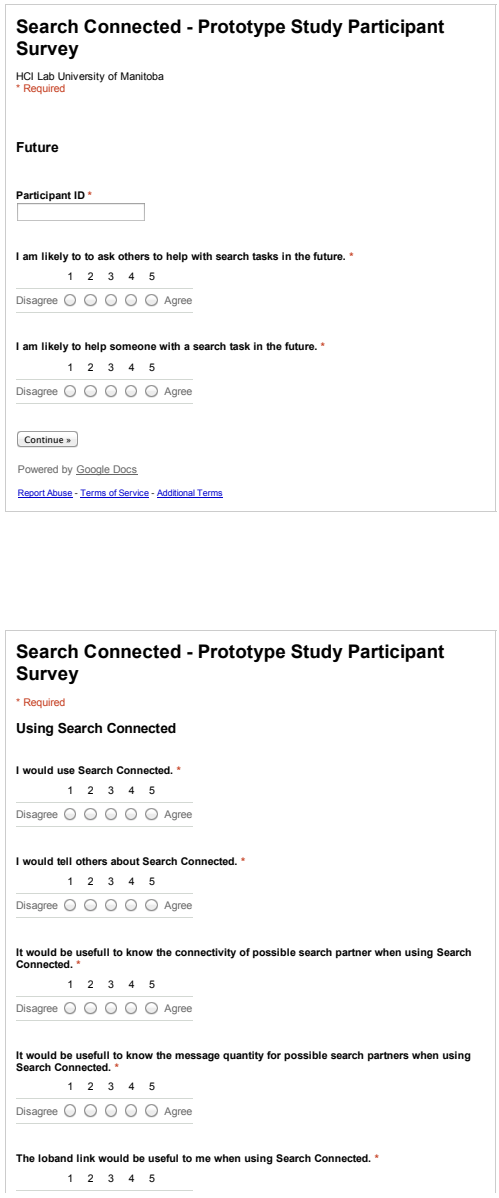
Figure A.6: Content Survey



Search Connected - Prototype Study Participant Survey

HCI Lab University of Manitoba
* Required

Future

Participant ID *

I am likely to to ask others to help with search tasks in the future. *

1 2 3 4 5

Disagree ○ ○ ○ ○ ○ Agree

I am likely to help someone with a search task in the future. *

1 2 3 4 5

Disagree ○ ○ ○ ○ ○ Agree

Continue »

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Search Connected - Prototype Study Participant Survey

* Required

Using Search Connected

I would use Search Connected. *

1 2 3 4 5

Disagree ○ ○ ○ ○ ○ Agree

I would tell others about Search Connected. *

1 2 3 4 5

Disagree ○ ○ ○ ○ ○ Agree

It would be usefull to know the connectivity of possible search partner when using Search Connected. *

1 2 3 4 5

Disagree ○ ○ ○ ○ ○ Agree

It would be usefull to know the message quantity for possible search partners when using Search Connected. *

1 2 3 4 5

Disagree ○ ○ ○ ○ ○ Agree

The loband link would be useful to me when using Search Connected. *

1 2 3 4 5

Figure A.7: Future Survey

Prototype Test Components

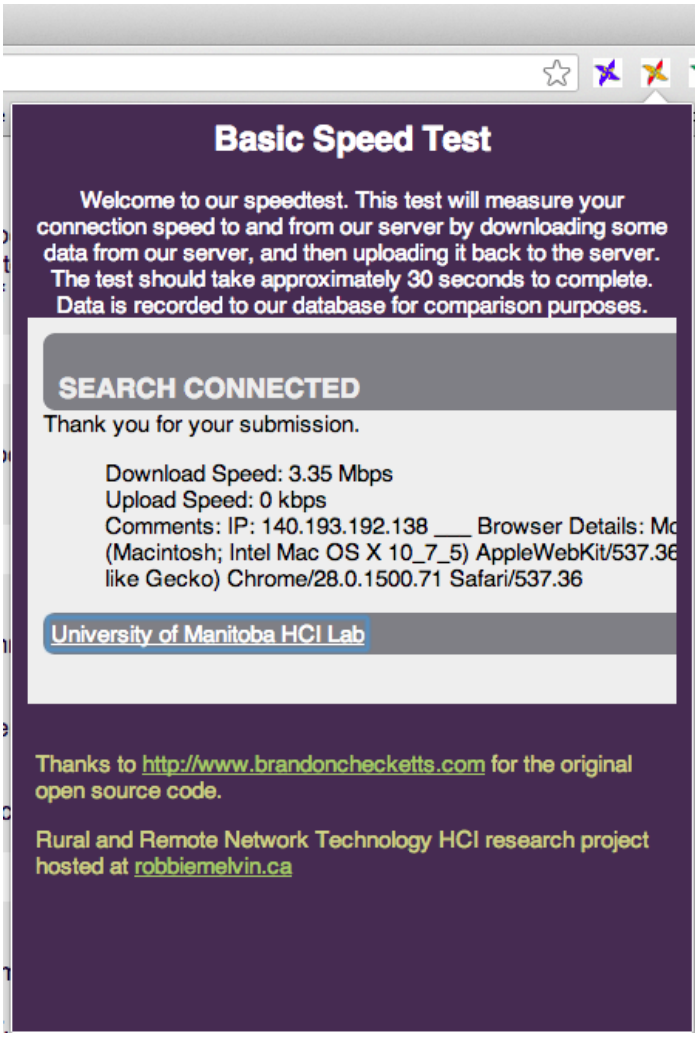

Figure A.8: Speed test Chrome extension - Speed Test browser extension shows download and upload speed details as well as meta data collected from the computer.

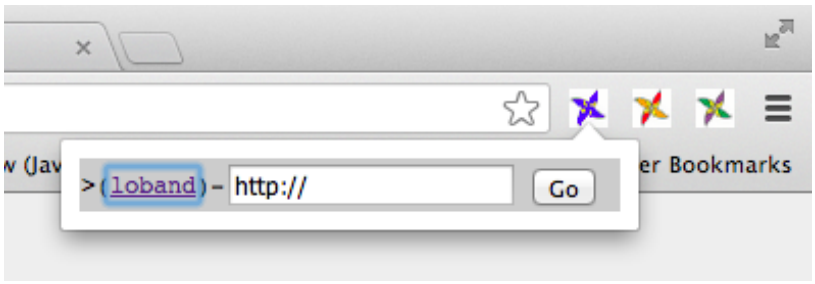

Figure A.9: loband Chrome extensions - accessing loband directly without going through the Search Connected links, type in a url here and the loband processed version of the page will be opened in the browser

Search Connected Results in Detail

Participant Team	Alone Condition	Connected Condition	Commun-ication	Partner Search	Confirm-ation	Msgs	Links
1	02:29	04:49	00:54	02:51	01:04	3	1
2	02:23	04:03	00:54	02:03	00:37	4	1.25
3	01:20	04:36	01:19	02:09	01:07	3	1
4	01:32	03:58	01:43	01:44	00:31	4	1
5	01:13	02:47	00:47	01:20	00:41	3	1
6	01:28	02:09	00:32	01:08	00:33	2	1
7	00:59	03:37	00:38	02:04	00:40	3	1.25
8	01:18	02:40	00:54	01:08	00:38	3	1
Mean	01:35	03:35	00:58	01:48	00:44	3	1.06
Std Dev	00:47	01:35	00:44	01:10	00:21	1.09	0.25

Table A.1: Trial time data

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