Can you Talk or only Touch-Talk?
A VoIP-based phone feature for quick, quiet, and private communication

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ABSTRACT
Advances in mobile communication technologies have allowed people in more places to reach each other more conveniently than ever before. However, many mobile phone communications occur in inappropriate contexts, disturbing others in close proximity, invading personal and corporate privacy, and more broadly breaking social norms. This paper presents a telephony system that allows users to answer calls quietly and privately without speaking. The paper discusses the iterative process of design, implementation and system evaluation. The resulting system is a VoIP-based telephony system that can be immediately deployed from any phone capable of sending DTMF signals. Observations and results from inserting and evaluating this technology in real-world business contexts through two design cycles of the Touch-Talk feature are reported.

Categories and Subject Descriptors
H.5.3 Information interfaces and presentation: Group and Organization Interfaces – Synchronous interaction.

General Terms
Design, Experimentation, Human Factors.

Keywords
Computer-mediated communication, mobile phones, Touch-Talk, VoIP, telephony, business context.

1. INTRODUCTION
Modern communication technologies bring considerable advantages, as well as burdens, to both senders and receivers. Mobile phone technologies allow many more people to reach each other than ever before. Additionally, face-to-face interaction is not always the optimal communicative context; in fact, some mediated forms of communication have much to offer human-human interaction in ways that face-to-face communication never could [12]. However, mobile phones have also decoupled our

locations from our situations. Callers place phone calls when convenient for them, but they know little to nothing about the receiver's situation. This corresponds with increases in mobile phone use during meetings, interactions with others, and in public spaces [17]. This also results in extended discussions about social norms of mobile phone use [14][15][19][20] as well as the emergence of commercial applications to mitigate inappropriate mobile phone use. One such system is Q-Zone, which makes mobile phones shift into *quiet mode* while in Q-Zone areas such as a church, library, or museum [25].

As a mode of interactive information exchange, the phone is still unparalleled. Empirical laboratory and field surveys suggest that the phone may hit a sweet spot between computer-mediated and face-to-face communication [7]. As a way to initiate contact, however, it leaves much room for improvement. Research on mobile use in the workplace finds that approximately 60% of phone calls fail to reach intended recipients, and only 40% lead to an immediate conversation [24]. As a result, people develop compensatory tactics to circumvent the limitations of phone calling. A current trend that can be observed in business settings is the use of asynchronous and text-based communication rather than traditional phones. People use IM to negotiate availability for phone conversations [5] and write emails about urgent issues. As such, asynchronous communication is becoming increasingly synchronous.

Nevertheless, urgent communication often requires real-time negotiation and confirmation. Phone calls, unlike email or voice mail, enable such immediate responses. Moreover, phone calls have many of the benefits of voice communication, such as paralinguistic cues, backchannels, and cross-cultural understanding. Companies seem to have recognized these shortcomings of pervasive email business cultures, as some firms now mandate weekly no-emails days, e.g., Veritas.

Our recommendation is to augment existing telephone communications with a new feature, Touch-Talk, that allows receivers (i.e., Touch-Talkers) to choose the appropriate input modality for any incoming phone call and allows them to respond to callers without speaking. By pressing a number on their telephone keypad, Touch-Talkers trigger voice prompts to make the phone system talk for them. Instead of hearing touch-tones, the caller will hear recorded or synthesized voice responses. In this way, Touch-Talkers can answer without being heard or letting the caller overhear what is going on at their end of the phone line: Only the sender's verbal communication can be heard. The caller in a Touch-Talk communication is encouraged to ask yes/no questions such as "I'd like to meet with you tomorrow, is that

possible?" or "James cannot do the presentation this afternoon. Should I ask Alice to do it?"

We believe that such an interaction will allow people to manage previously unanswerable calls and deal with simple issues quickly, quietly and privately. While some types of tasks are more appropriate to email, IM, or other media, other types of tasks are more appropriate to phones. According to Media-Richness Theory [22][23], choosing between voice vs. text media for communication is rationally based on the particular degree of communicative richness required by the task characteristics and desired outcomes.

Previous research on "Quiet Calls" [19] enabled similar mixed-modality synchronous communication, but was limited to using a smart phone tethered to a computer in a lab, with participants pretending to be in meetings while sitting with the researchers present. Touch-Talk and its evaluations extend this work by requiring no modification on users' mobile handsets and testing each iteration of system design in real-life business contexts at a large IT company.

The remainder of this paper will introduce the concept and implementation of a one-way phone and describe how findings from studying this system in a business setting informed the design of Touch-Talk in the next design iteration.

2. THE ONE-WAY PHONE

2.1 Motivation
Present telephones are traditionally viewed as a two-way communication channel. But communication can be either a one-way notification or a two-way conversation. When getting a phone call from a sender, the receiver has no knowledge of whether to expect a long conversation and time commitment. This could be one of the reasons why so many workplace phone calls fail to reach intended recipients. What if the sender could indicate to the receiver whether she plans to engage in a conversation or only wishes to send out a notification? What if the receiver could indicate her availability for one-way or two-way communication, and let the sender structure her message accordingly? What if the sender could hit the receiver's phone's mute button?

To empirically examine these questions, we implemented a one-way telephone system that let users communicate either in traditional two-way or a new one-way-only manner. In the following sections, we introduce the design, implementation and evaluation of the one-way phone system.

2.2 System Design
We designed the one-way telephone system entirely on the network, so that users could immediately send and receive calls from any phone capable of sending DTMF signals (i.e., touch-tones). No modification or installation on user's mobile handsets was required. Negotiation of the type of call was realized using interactive voice responses (IVR). This allowed us to deploy and evaluate our system in an everyday business context rather than remaining confined to a controlled laboratory environment.

People using the system were assigned both a one-way and a two-way toll-free phone number, which were ideally both stored in callers address books, e.g. as "John-one-way", and "John-two-way". By pressing the digit '1' or '2' the sender could indicate whether the call is a one-way notification or two-way conversation, respectively. Our system routed the call to the receiver and provided the appropriate caller-id so that the receiver could identify the caller and type of call *before* answering the

phone. Having the caller indicate the type of call instead of inferring it from the dialed (one-way or two-way) number is necessary, because returning a missed call to "John-one-way" happens in a very different situation and should not automatically be routed as a one-way call.

Receivers could join the negotiation process by choosing to receive a two-way phone call, or if their situation did not allow a conversation, they could opt to switch to a one-way call. Under this scenario, the sender was prompted for the change so that she could then scope her message accordingly or call back later. We have implemented this system; an interaction flow diagram is shown in Figure 1.

One-way calls ensured that only the sender's communication could be heard. The receiver's line was automatically muted in order to both preserve privacy for the receiver and to remove any social obligation for conversation.
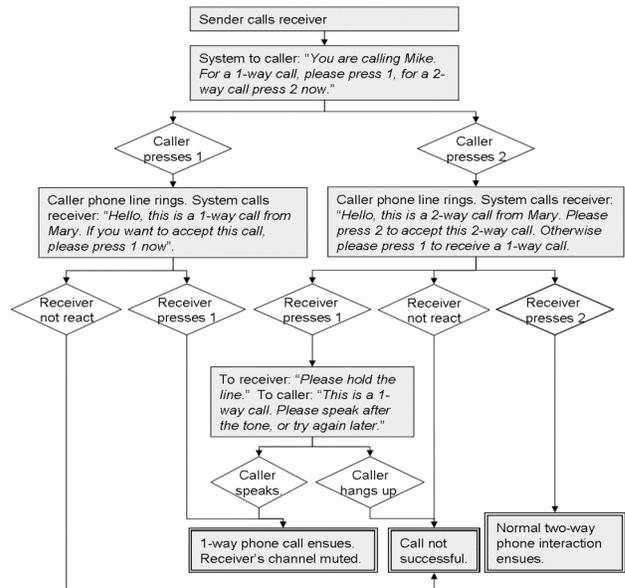

Figure 1. Interaction flow diagram of the one-way telephone system, where sender and receiver negotiate the type of call.

2.3 Technology Implementation
We implemented the one-way calling system so to be immediately deployed from any phone capable of sending DTMF signals. No software was installed on the phones. People using our system could call a person's dedicated toll-free Direct Inward Dialing number (DID), connected to a custom private branch exchange (PBX) network as Voice over Internet Protocol (VoIP) router. We configured our PBX system to facilitate one-way calls.

As calls are presented to the PBX via a gateway in the VoIP network, the number that the caller dialed is given, so that the PBX can decide who the intended receiver is and route the call to his actual cell number, stored in a local database. This setup allowed calls connecting two parties in traditional PSTN or GSM networks to be controlled, monitored, and logged by a server in a VoIP network.

Our system used Asterisk as an open-source PBX daemon completely in software, and SIP as the communication protocol between the PBX and the telephone company hosting the DIDs (see Figure 2). The Asterisk Gateway Interface (AGI), in combination with the Asterisk-java package, is used to launch

Our participants reported that they perceived normal two-way calls to be more polite, and as callers in most cases they wanted to have at least a quick confirmation, and felt awkward not to get any feedback on whether the receiver had understood the message. Also, as callers, they did not feel the urge to send a one-way call since senders can easily pick convenient times to initiate conversations. At the same time, participants reported that they were more likely to *receive* one-way calls than to *send* one-way calls.

We learned that the *receiver* is the critical party in a communication, because the caller, as the initiator of an interaction, chooses the medium convenient for herself and a time when their situation is conducive for communication. Limitations of one-way calls clearly seemed to be that the receiver's interaction was limited to listening only.

3. TOUCH-TALK
Touch-Talk was the next iteration in our efforts towards augmenting traditional phones with novel VoIP-based calling features to enable more socially appropriate communication.

3.1 Motivation
Our observations from the first field study indicated that one-way calls were especially useful for receivers, with the limitation that the receiver had no way to give feedback or confirmations. People desired *synchronous confirmations* during communication, and found it rude in a one-way call to just give instructions and leave the other party with no opportunity for feedback. This is consistent with existing literature in linguistic pragmatics literature, e.g., adjacency pairs [9][21] and maintenance of common ground [4][6]. Compared with asynchronous media, phone calls have the advantage of immediate response.

Touch-Talk allowed receivers to choose and mix input modalities. It enabled people to pick up previously un-answerable calls and deal with simple issues quickly, quietly and privately. With Touch-Talk, receivers could answer incoming calls without speaking aloud by pressing keypad buttons. Each pressed number corresponded to a pre-recorded voice prompt (Figure 3). We assumed that Touch-Talk could be especially useful in meeting situations where one cannot talk aloud or in public spaces where others could overhear or feel disturbed by the conversation.

Touch-Talk imposed a substantial burden on the caller, who needed to structure the conversation and ask clear questions. In exchange for caller's efforts to use Touch-Talk, they would ideally be able to communicate with the Touch-Talker at times when they would have otherwise been forced to voicemail. We designed Touch-Talk such that people could balance the cost of their time and efforts against the benefit of getting the most urgent issues resolved in a Touch-Talk interaction.

3.2 System Design
The overall goal for this iteration of our system design was to create a system that people would be willing to use in real

situations, for their real interactions at the workplace. Because eliminating existing phone features (e.g., voicemail) in the first study caused problems, we decided to preserve existing phone features for the second study.
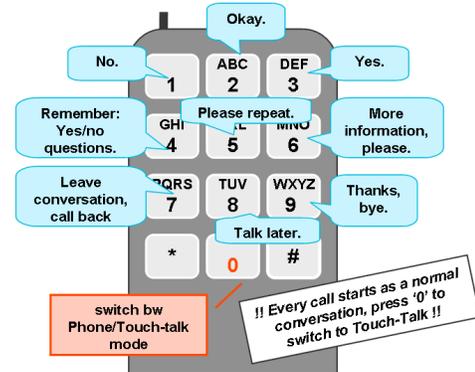

Figure 3. Default Touch-Talk keypad to voice prompt mapping.

### 3.2.1 Switching a call to Touch-Talk
We designed the system so that every call started out as a traditional phone call. Each call could be rejected or answered, routed to voicemail, or switched to Touch-Talk mode. It was possible to switch between Touch-Talk and normal phone modes at any time throughout a call. See Figure 4 for the entire interaction flow.

Once the normal phone connection was made, the receiver could switch a call into Touch-Talk mode by pressing '0' on the phone's keypad. The system would then play a message announcing to the caller that the receiver had switched the call into Touch-Talk mode, and encouraged the caller to start asking yes/no questions. The receiver's channel was muted in Touch-Talk mode. In Touch-Talk mode, pressing any of the digits 1 to 9 played the associated voice prompt, to both the caller and the receiver (see Figure 3). Not using *pound* (#) or *star* (*) was a constraint imposed by our technology setup, which will be described in the next section.

3.2.2 Touch-Talk voice prompts
We selected a set of default voice prompts inspired by extended discussions and piloting with potential Touch-Talk users. *Yes* and *No* were chosen to enable users to accept or reject a question. We assumed that after some practice with Touch-Talk, callers would learn how to ask useful questions to find out what they wanted to know, similar to the "Twenty Questions" game. The receiver and initiator of the Touch-Talk conversation, might either require more detailed information and use *More information, please*, or decide that this issue cannot be dealt with in a Touch-Talk conversation, and use *Let's talk later* instead. There are long-lived expectations derived from social conventions about language use, such as creating and maintaining common ground while conversing [4]. Similarly, one should not simply end conversations; instead, a person is supposed to use an interactive close [21]. We decided to use *Thank you, bye*. Assigning a separate key for *Okay* was inspired by findings suggesting that people do use linguistic feed-back such as *Mmhmm* or *Uh-huh* to show agreement or confirmation of understanding [3], often combined with nodding in a face-to-face interaction. We assumed that users would otherwise heavily use the *Yes* for this purpose, suggesting acceptance; acceptance is different from just understanding. We thought that *Please repeat* would be necessary in noisy environments, or if the Touch-Talker was temporarily distracted. *Remember, Touch-Talk only enables yes-no responses* gives the receiver a way to remind the caller that he cannot answer open-ended questions in Touch-Talk mode. *Sorry, the person had to leave the conversation and will call back later* was designed to

be a quick escape-key, e.g., when someone is addressed during a meeting, and needs to immediately drop his quiet Touch-Talk interaction.
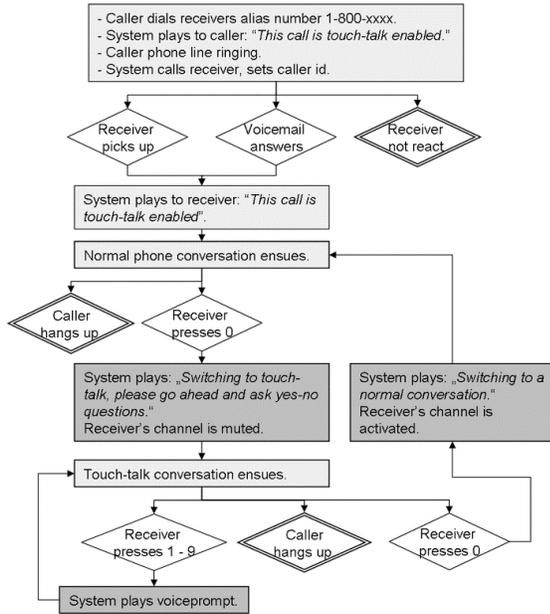
Figure 4. Interaction flow diagram of the Touch-Talk system. Voice prompts played to both the caller and the receiver are shown in darker gray.

We aimed at mapping voice prompts to keys on the keypad as intuitively and easily memorable as possible. Our initial approach was to map voice prompts to the alphabetical letters assigned to each key, such as *Yes* on the 9, *No* on the 6. However, this approach was abandoned after realizing that this mapping does not work for smart phones, such as BlackBerry™, that have QWERTY keyboards. We then decided to place positively valenced answers toward the right side of the keypad, and the more negatively valenced answers to the left, as this mapping of negative to positive onto left to right fits this cultural context. The first keypad row contains acceptance, confirmation and rejection. The second keypad contains row prompts when still undecided and trying to find out more, ranging from least to most polite. The third row contains different closings, also ranging from least to most polite.

We tried to keep voice responses brief, especially the ones that had potential for very frequent use. We decided to use synthesized voices rather then pre-recorded human voices, even though human voices are often easier to understand. This was because we did not want to confuse the caller who might think that there is the actual person talking, as happens sometimes in the beginning of voicemail introductions. We were also trying to match voice quality with Touch-Talk agent ability as recommended by [10], lowering user's expectations of the Touch-Talk agent by using computer-generated voices because the agent could ultimately only convey nine different pre-scripted voice prompts.

Since humans respond to voice technologies as they respond to actual people and behave as they would in any social situation, Nass suggests in [18] that computer generated voices should not use personal pronouns such as *I* or *my*. Therefore, we used *More information, please* instead of *I need more information*, etc. We believe that this avoidance of the first person is appropriate even

when a human triggers the voice responses. Moreover, to match the gender of Touch-Talkers with the gender of voice prompts, female participants were assigned a synthesized female voice; male participants a synthesized male voice.

In order to conform to turn-taking nature of human dialogue, distinct warning sounds were played to announce any Touch-Talk prompt or switching between modes to prevent the caller from feeling inappropriately interrupted while speaking [4]. Error sounds were played to the receiver when a key was pressed that was not assigned to an action.

3.3 Technology Implementation

We adapted and extended the original one-way telephony system so that it supported Touch-Talk conversations, considering design goals and requirements mentioned in the previous section. The main challenge was (1) the interception of DTMF signals from the receiver's channel during the phone conversation, and (2) playing Touch-Talk voice prompts to both channels simultaneously.

In order to keep complete control over the course of a phone call, we reused the idea of simulating a phone call through a conference call. However, the way distribution of incoming voice packets to output channels works in our PBX system, it was not possible to directly intercept DTMF signals with non-Zap channels in the same conference. We bypassed this constraint by using the MeetMe escape functionality, which allows a user to exit the conference by entering a valid single digit extension. In our setup, we allowed the Touch-Talker to escape the conversation by pressing any key between '0' and '9'. This bounces the call back to the dial script, where the Touch-Talker was immediately re-added to the conversation. This transition worked surprisingly fast and was barely noticeable to the users.

It was necessary to play the voice prompt associated to the key press to both partners in the conversation. This was solved by adding a third party to the conversation, acting very much like a proxy that can speak for the Touch-Talker. This proxy was an AGI Java script that was called by the server at the beginning of the conversation by placing a direct outbound call to itself. Whenever the Touch-Talker pressed a key, a message was sent to his proxy. The proxy would consult the database to find the corresponding system action or voice prompt. If a voice prompt was called, then the proxy would create the synthesized voice prompt, and play it to the conference so that both parties can hear it.

3.4 Evaluation

3.4.1 Study Design
We chose to do an open-ended exploratory field study by introducing the technology into a real world business setting, maximizing external validity, rather than doing a controlled experiment with random assignment to conditions,. Fifteen employees of a large IT company in the Silicon Valley, three female and twelve male, participated in the Touch-Talk study.

Each participant was assigned a toll-free number and was urged to practice Touch-Talk by calling a special training program so that . they could practice with the system before they received any live Touch-Talk calls. After familiarizing themselves with the system, participants distributed their number to whomever they chose, including colleagues, friends, and family. They sent out an e-mail to these potential callers which included a link to the Touch-Talk website. This website explained, in detail, what the caller should expect from a Touch-Talk conversation.

Finding 15 busy industry employees to voluntarily use Touch-Talk for their real-life business communications over a several week period would seem to be a daunting challenge. Their participation in this project is an encouraging sign for the future of Touch-Talk.

The biggest challenge of the study, and the primary reason why most people did not receive as many Touch-Talk enabled calls as they would have liked, was the reluctance of potential callers to enter the new Touch-Talk 1-800 numbers into their phone contact lists; this would have made the process simpler and more automatic.

3.4.2 Behavioral Results
Over the four-week duration of the study, 58 calls were made to Touch-Talk phone numbers and 34% of those were switched into Touch-Talk.

To respect the privacy of our participants, we did not record any phone conversations, but we did receive consent to log the key presses of all calls. 105 Touch-Talk voice prompts were used in a total of 20 Touch-Talk conversations.
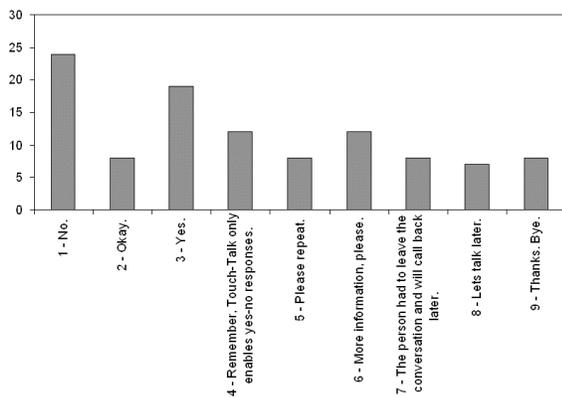

Figure 5. Frequency distribution of voice prompt use.

When creating voice prompts, we worried that users would shy away from *No* because it was somewhat abrupt and could have been perceived as impolite. However, behavioral data showed that *No* and *Yes* were the first and second most popular voice prompts, respectively. There were nearly significantly more *No* and *Yes* responses than all others combined, $X^2(1)=3.77$, $p=.05$. As can be seen, there was clearly an uneven distribution of key selections across all 9 choices, $X^2(8)=23.91$, $p<.01$ (see **Error! Reference source not found.**).

The average Touch-Talk conversation lasted 37 seconds from switching to Touch-Talk mode to the end of the call or switching back to a normal conversation. Investigating endings of Touch-Talk conversations provided interesting insights about the conversation. *Thanks, Bye* was used at the end of 41% of all Touch-Talk conversations, suggesting that a conclusion could be reached. 24% of calls were closed with *Let's talk later* or *The person had to leave the conversation and will call back later*, suggesting that the issue needed a follow-up conversation. Another 18% of calls were switched back to a normal conversation before the end of the call.

3.4.3 Questionnaire and Interview Results
The Touch-Talk users were able to give feedback about the system in biweekly questionnaires and a final interview. Generally users were very enthusiastic about their Touch-Talk experiences, and reported that they would have liked to use it after

the duration of the study. They mentioned using Touch-Talk mainly in meetings and public spaces. Surprisingly, a few participants used Touch-Talk while driving and especially in city traffic. One user explained that he found Touch-Talk very useful commuting to work using public transportation.

Some of our users called their colleagues' Touch-Talk numbers as well. They said that although calling was awkward at first, the more they used the service, the more useful it became. For example, one user reported that she called her colleague who was in a meeting and actually got agreement on several urgent issues.

Participants utilized Touch-Talk for a variety of reasons. Many used Touch-Talk to let the caller know that they were busy, and negotiate an alternative time for a phone conversation. A nonnative speaker explained that he was excited about Touch-Talk because it allowed him to communicate more clearly in the English language. Users also commented that they would feel comfortable changing all conversations into Touch-Talk mode, though a few mentioned they would not do so with an authority figure such as their manager. One user also added that he would not use Touch-Talk with his spouse because the service might be too impersonal. Another user, who was a software developer, mentioned that he did not use the feature often since he spends 80% of his time at his desk, collaborating with colleagues via email in different geographic locations and time zones.

While these results are encouraging, it is clear that the system must be improved with new features to fully maximize the benefits of Touch-Talk. First, users would have liked Touch-Talk to be integrated into their real phone number instead of routed through a toll-free number. Second, even though each Touch-Talker was equipped with a "reminder card" depicting the keypad and corresponding voice prompts, the users still complained about forgetting the mapping of voice prompts. Finally, although all users reported that the default voice prompts were very useful, the Touch-Talkers also wanted an option to customize their own prompts.

4. DISCUSSION & ONGOING WORK
Informed by the results and user feedback from our field study, we added two more features to the existing system in our ongoing design and evaluation of Touch-Talk: personalization and a voice prompt preview feature. Each of these features is currently under development and is discussed in the following sub-sections, followed by a discussion of our lessons learned for future field studies of mobile phone applications.

4.1 Personalization
We implemented the first generation of a *web-based personalization interface* where users can now log in and customize their voice prompts from any web browser (Figure 6). For improved user experience, the interactive website was created using Ajax (Asynchronous Javascript and XML). We are in the process of evaluating this feature of Touch-Talk.
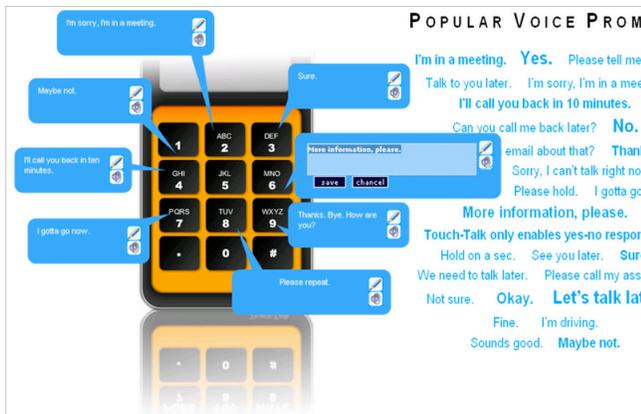
Figure 6. Screenshot of part of the Touch-Talk personalization web interface.

Users can create new prompts and listen to how they sound as synthesized speech. They can even opt to share their voice prompts with others. All shared prompts are displayed in a prompt cloud, with prompt sizes and colors indicating their popularity. This encourages users to browse through others Touch-Talk prompts so that they might leverage and contribute more ideas to the Touch-Talk community. Changing voice prompts is effective immediately with the next phone call.

4.2 Preview

Our second design evaluation showed that people have trouble remembering the keys for specific voice prompts. This problem will likely be aggravated when they can customize their Touch-Talk prompts. To address this issue, we have implemented a *preview feature* that Touch-Talkers can use during a phone conversation to hear what voice responses will be played to a caller before sending them to the caller. Pressing '5' followed by a key will play the associated voice prompt to the Touch-Talker only. To save time, the prompt is played at double the normal speed.

4.3 Lessons learned from Field Deployments

In comparison to controlled lab experiments, field experiments and open-ended field deployment studies involve inherently different challenges and benefits. Because mobile phones are not typically used in environments comparable to laboratories, but are rather used out "in the wild," we have opted for studies with real users engaging in both real-life and canned activities. Some lessons learned from this research may be useful to other researchers who are using similar methodologies.

With regard to system design:

- Pilot extensively amongst yourselves before ever releasing a system for a real-life field study (e.g., several months)
- Continue using the system yourselves during the actual study so that you can help troubleshoot problems
- Create an exhaustive list of possible call outcomes and then design around them and/or log them, including special cases (e.g., receivers getting multiple calls at once, callers hanging up before a call is connected, calls going to voicemail, or frustrated users pounding keys in rapid succession)
- Beware of unreliable DIDs; test every number to ensure that users are not receiving calls from inappropriate callers (e.g., people trying to call the previous owner of the number)

- Build a robust prototype that can run 24/7, including a back-up system (e.g., if errors occur during one call, it should not affect any future calls on the server)

With regard to the field studies:

- Present and demonstrate the system to potential participants
- Build a website with FAQs for both callers and callees
- Build a training system with computer-generated responder for people to try the system without bothering real people
- Use a per-call payment scheme to encourage use of the system; this provides useful incentives to busy participant volunteers
- Minimize work for volunteers as much as possible (e.g., send email templates to share with potential callers, create Vcards to distribute phone numbers, design questionnaires that can be answered via Blackberry)
- Users will vote with their silence; do not wait for them to report problems
- Personal interviews are critical for gauging feedback

5. FUTURE WORK

There are clearly many potential paths for the further design and development of Touch-Talk. These include voice prompt themes and integrating perceptual technologies to enable more context-aware features.

5.1 Voice Prompt Themes

We plan to study and integrate different *themes* of voice prompts that could be useful for different callers, such as a boss/manager theme or a family/friends theme, or different contexts, such as a meeting theme or a driving theme.

5.2 Touch-Talk on Smart Phones

Converting our system to run on devices (rather than in the network) would enable the use of a graphical Touch-Talk user interface. This will be increasingly important with the inclusion of themes and customized voice prompts. A GUI could also enable displaying and navigating through various Touch-Talk options, customizing them, and perhaps even allow software Touch-Talk buttons. Using integrated phone keypads could as well allow to type in customized answers on the fly.

5.3 Integrating Speech Recognition

Integrating speech recognition techniques could finally allow sender and receiver to independently decide on input and output modalities. The receiver could decide to communicate via text only, reading what the caller is saying and answering via Touch-Talk. The sender, who decided to call, would speak and hear speech back. Speech recognition technologies would need to be sophisticated enough to perform reliably on low-quality telephone data.

5.4 Perception and Context-awareness

With the rapid development of new perceptual technologies and context-aware applications in mobile systems, there are new opportunities for Touch-Talk to become more "intelligent" and relieve the user of decision-making burdens. There are already significant research efforts that focus on automating the decision-making process of who to contact at what time and with what communication channel. This delves into issues of interruptability and context-aware systems to help mitigate socially inappropriate interruptions in mobile contexts. Such systems manage trade-offs between the relative cost of interruption and the potential benefit

of information delivered [1]. They range from rule-based and user-driven [14] to sensor-based and system-driven [8] solutions, and appear across a variety of contexts ranging from the office [13] to the mobile user [11][16]. As these context-aware technologies improve, they could extend the Touch-Talk system. For example, Touch-Talk could automatically adapt the template to the Touch-Talk user's context. Reading calendars or sensing that the phone is at the car docking station, the right template for attending a private meeting or driving could be selected.

5.5 Business Touch-Talk

Using context awareness with smart phones could add a new dimension to Touch-Talk, particularly in the business context. A Touch-Talk conversation could be enriched with relevant business objects; for example, a sender, who needs confirmations on an order, could make the form appear on the receiver's phone. The receiver could fill out the form, sign it, and return it via Touch-Talk. Assuming that such business objects may be tagged with semantic information, Touch-Talk may automatically supply the relevant business objects (e.g., orders, receipts, meeting agendas, meeting minutes, etc.).

6. CONCLUSIONS

We report on the iterative design and evaluation cycle of Touch-Talk, a mobile phone feature prototype that aims to enable more socially appropriate mobile communication, particularly in public spaces and business contexts. To this end, we have designed Touch-Talk to place negotiation of mobile availability more in the hands of the receiver than previous models of distance communication, which put the burden of guessing the best communication medium on the caller. Through two design cycles, we have learned that: (1) synchronous telephone communication is inherently two-way and must remain this way, (2) short voice prompt responses may be helpful for enabling quite and private mobile communication in meetings and public spaces, and (3) remembering key-mappings to voice prompts is difficult for users. Using both controlled experimental and open-ended field studies of mobile phone features, we have gained many insights into directions for future Touch-Talk designs, including personalization of Touch-Talk responses, preview options to help remember key-mappings, themes for voice prompts, and how types of callers are associated with various features. This paper reports on our system designs, user studies, and ongoing iterative design cycle of Touch-Talk, pointing the way to several possible paths for future work.

7. ACKNOWLEDGEMENTS

8. REFERENCES

[1] Adamczyk, P.D. and Bailey, B. If not now, when? The effects of interruption at different moments within task execution. In *CHI 2004*, ACM Press (2004), 271-278.

[2] Agre, P., Changing Places: Contexts of Awareness in Computing. In *Special Issue on Context-Aware Computing. Human Computer Interaction*, 2001. 16(2-4): p. 177-192.

[3] Allwood, Jens S. On the semantics and pragmatics of linguistic feedback. Journal of Semantics, 9:1-26, 1992.

[4] Ameka, F. Interjections: The universal yet neglected part of speech. Journal of Pragmatics 18, 2 (1992), 3.

[5] Cherry, S.M. , IM means business. Spectrum, IEEE, Vol.39, Iss.11, Nov 2002, 28- 32.

[6] Clark, H. H. & Krych, M. A. (2004). Speaking while monitoring addressees for understanding. Journal of Memory and Language, 50(1), 62-81.

[7] Connell, J., Mendelsohn, J., Robins, R., & Canny, J. Don't hang up on the phone, yet! *GROUP*, ACM Press (2001).

[8] Fogarty, J., Hudson, S.E., Atkeson, C.G., Avrahami, D., Forlizzi, J., Kiesler, S., Lee, J.C. and Yang, J. Predicting human interruptibility with sensors. *TOCHI 12*, 1 (2005), 119-146.

[9] Goffman, E. Interaction Ritual: Essays on face-to-face behavior. Doubleday, New York, 1982.

[10] Gong, L., Nass, C., Simard, C. and Takhteyev, Y. When non-human is better than semi-human: Consistency in speech interfaces. in Smith, M.J., Salvendy, G., Harris, D. and Koubek, R. eds. *Usability evaluation and interface design: Cognitive engineering, intelligent agents, and virtual reality*, Lawrence Erlbaum Associates., Mahwah, NJ, 2001, 1558-1562.

[11] Ho, J. and Intille, S.S. Using context-aware computing to reduce the perceived burden of interruptions from mobile devices. In *CHI 2005*, ACM Press (2005), 908-918.

[12] Hollan, J. and Stornetta, S. Beyond being there. In Human factors in computing systems 1992 (1992), 119-125.

[13] Hudson J. M., Christensen J., Kellogg W. A. & Erickson T. (2002) "I'd be overwhelmed, but it's just one more thing to do": Availability and interruption in research management, in *Proc. of CHI'02*. New York: ACM Press, 97-104.

[14] Korpipää, P., Häkkilä, J., Kela, J., Ronkainen, S. and Känsälä, I. Utilising context ontology in mobile device application personalization. In *MUM 2004*, ACM Press (2004), 133-140.

[15] Love, S. and Perry, M. Dealing with mobile conversations in public spaces: Some implications for the design of socially intrusive technologies. In Human factors in computing systems 2004, ACM Press (2004), 1195-1198.

[16] Milewski A. E. & Smith T. M. (2000) Providing presence cues to telephone users, in: S. Whittaker & W. Kellogg (Eds.) *Proc. of CSCW'00*, New York: ACM Press, 89-96.

[17] Monk, A., Carroll, J., Parker, S. and Blythe, M. Why are mobile phones annoying? Behaviour and Information Technology 23, 1 (2004), 33-41.

[18] Nass, C. and Brave, S. Wired For Speech. How Voice Activates and Advances the Human-computer Relationship. MIT Press. 2006.

[19] Nelson, L., Bly, S., and Sokoler, T. Quiet Calls: Talking Silently on Mobile Phones. In Proc. of *CHI '01*, pp. 174-181, ACM Press, Seattle, WA., March 31, 2001.

[20] Palen, L., Salzman, M. and Youngs, E. Going wireless: Behavior & practice of new mobile phone users. In Computer Supported Collaborative Work 2000, ACM Press (2000), 201-210.

[21] Schegeloff, E.A. and Sacks, H. Opening up closings, *Semiotica 7 (1973)*, no. 4, 289--327.

[22] Suh, K.S. (1999). Impact of communication medium on task performance and satisfaction: an examination of media-richness theory. Information & Management, 35, 295-312.

[23] Trevino, L.K., Lengel, R.K. & Daft, R.L. (1987). Media Symbolism, Media Richness and media Choice in Organizations. Communication Research, 14(5), 553-574.

[24] Whittaker S., Frohlich., D., Daly-Jones, O., Informal Workspace Communication: What Is It Like And How Might We Support It. In *Proc. of CHI '95*. ACM, NY, pp. 131 - 137.

[25] http://www.bluelinx.com/qzonewhat.htm